

## ORIBATID MITES (ACARI, ORIBATIDA) FROM TOHOKU (NORTHEAST JAPAN), COLLECTED AFTER A TIDAL WAVE IN 2011

Kazunori NAKAMURA<sup>1</sup>, Yoshi-Nori NAKAMURA<sup>2</sup> and Tokuko FUJIKAWA<sup>3</sup>

(Received 07 June 2012; accepted 23 August 2012; published online 29 March 2013)

<sup>1</sup> Graduate School of Life Sciences, Tohoku University, 232-3 Yomogida, Naruko-onsen, Osaki, 989-6711, Japan. knakamura@eco.civil.tohoku.ac.jp

<sup>2</sup> National Agricultural Research Center for Kyushu Okinawa Region (KONARC), NARO, Koshi, 861-1192, Japan. yn1124@affrc.go.jp

<sup>3</sup> Ueminami 1346-3, Asagiri-cho, Kumamoto Pref., 868-0423, Japan

**ABSTRACT** — Each sample of about 200 cm<sup>3</sup> was collected on June 27<sup>th</sup> 2011 by hand from the following three marked points after a large tidal wave (Tsunami) struck on March 11<sup>th</sup> 2011: Two specimens belonging to *Masthermannia* and *Eupelops* were collected from a sample A (about 188 m from sea); five specimens of four species belonging to *Nothrus* and *Tectocepheus* from sample B (about 5 m from sample A) were found; twenty-five specimens of *Trhypochthonius*, *Scheloribates* and *Trichogalumina* from sample C (about 20 m from sample B) were collected. One oribatid species of the *Masthermannia* genus from sample A was found to be identical to an undescribed species from Kumamoto Prefecture, which was studied together with the specimen from sample A.

**KEYWORDS** — *Eupelops*; *Masthermannia*; New species; Northeast Japan; *Nothrus*; Oribatid mite; *Scheloribates*; *Tectocepheus*; *Trhypochthonius*; *Trichogalumina*

### INTRODUCTION

A large tidal wave ('Tsunami' in Japanese) (16.7 m, the highest wave) on the 11th March, 2011 struck the east coast of the Northeast ('Tohoku' in Japanese) in Japan. After the tidal wave, some oribatid mites were found from roadside. Nine oribatid species were found and described in the present work. Of a total of nine oribatid species including six species, new to science, three species of three families belong to the cohort Nothrina and six species of four families to the cohort Brachypylina. Of a total of seven families, the following four families are known from floored forests or seashore (Franklin *et al.* 2001, Fujikawa 2006, Halbert 1915; 1920): Nanhermanniidae Sell-

nick, 1928, Nothridae Berlese, 1896, Tectocepheidae Grandjean, 1953[1954], and Phenopelopidae Petrunkevitch, 1955.

### METHODS

Matsushima-cho of Miyagi Prefecture is located 38°36'8188'N.; 141°05'9042'E, about 6 m a.s.l. in the North-East coast, Japan (Fig. 1). Each sample of about 200cm<sup>3</sup> was collected by hand from the following three marked points at No. 10 Namiuchihama of Matsushima-cho on 27 June 2011 by Fujikawa T.: A, two specimens belonging to two oribatid genera and a single specimen of ant were collected from sample consisting of sands and soil beside unidentified plant; B, five specimens of four

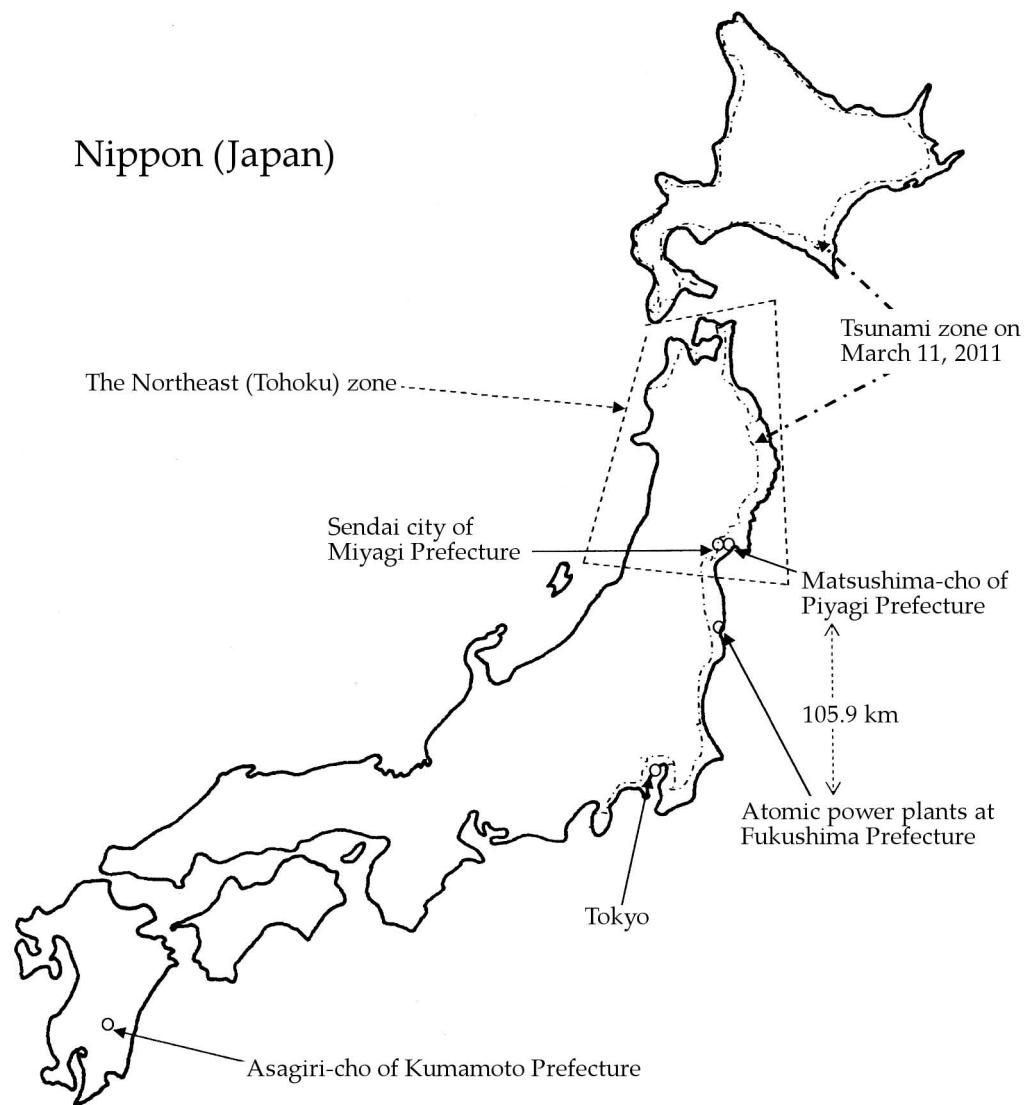


FIGURE 1: Location of sampling plots.

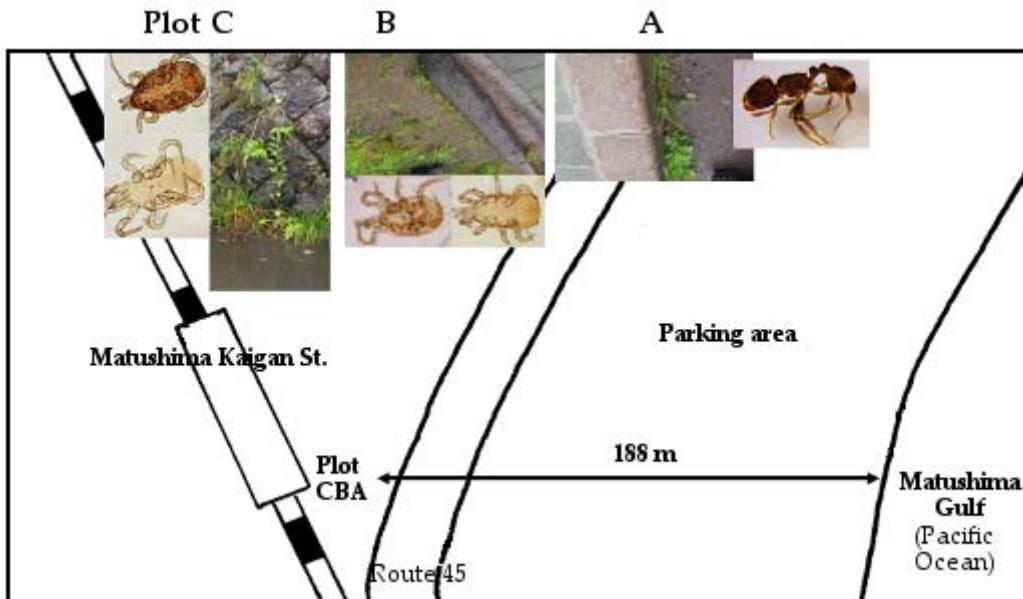


FIGURE 2: The plane figure, cross section and a vertical section of Matsushima-cho and sampling plots A-C (photos by Nakamura Y.).

oribatid species belonging two genera, and two specimens of two mesostigmatid species (NSMT-Ac 13609) from sand and humus of dandelion (species name unidentified); C, twenty-five specimens of three oribatid species of three genera, and five specimens of two mesostigmatid species (NSMT-Ac 13608) from humus and litter of giant goldenrod, *Solidago gigantea* Ait. var. *leioephyla* Fern (Fig. 2). It went on raining; on 26 June, 32.5 mm/day; on 27 June, 30.0 mm/day. One oribatid species from point A was found to be identical with an undescribed species of which specimens had been collected from the garden under no-tillage manner (Nakamura *et al.*, 2003) since 2001 of Nagasato ( $32^{\circ}12'5''N$ ;  $130^{\circ}54'5''E$ , about 195 m a.s.l.) at Asagiri-cho, Kumamoto Prefecture.

In the present work, those specimens from Kumamoto Prefecture were studied together with the specimen from point A in Miyagi Prefecture. After extracted with a modified Tullgren apparatus, animals were kept in lactic acid for cleaning during forty days and mounted on slide glasses.

The type series (NSMT-Ac 13608 to 13611 and 13625 to 13641) are deposited in the National Museum of Nature and Science, Tokyo, and topotypes

together with sampling materials in Tohoku University, Miyagi Prefecture and National Agricultural Research Center for Kyushu Okinawa Region, Kumamoto Prefecture.

The notations and morphological expression of descriptions and figures are mainly based on Balogh and Mahunka (1983), Grandjean (1954a; 1954b), Hammen (1980; 1989), Mahunka and Zombori (1985) and Norton and Behan-Pelletier (2009). Number of tarsal claw(s) common to all legs. Setal formula of legs including famulus but excluding solenidia. Solenidiotaxy common to all examined species belonging to cohort Nothrina: I (1-2-2[exceptionally 3]), II (1-1-1[2][3]), III (1-1-0), IV (0[1]-1-0), and belonging to cohort Brachypylina: I (1-2-2), II (1-1-2), III (1-1-0), IV (0-1-0) except for IV (0-0-0) of *Eupelops* sp. [Right-left] means right and left legs of specimen could be studied. Other measurements ( $\mu\text{m}$ ) in the description are according to holotype. Measurement of T-shaped seta is a total of two rami plus nozzle-like basal portion. The taxonomical grouping followed the systems proposed by Norton and Behan-Pelletier (2009), Subías (2004) and Weigmann (2006).

COHORT NOTHRINA JOHNSTON, 1982  
NANHERMANNIIDAE SELLNICK, 1928

*Masthermannia multiciliata* n.sp.

[Japanese name: Tamou-obaketsukinowadani]  
**(Figures 3 – 9)**

**Diagnosis** — Body length, 407 – 500 µm; width, 200 – 286 µm. Integument of notogaster punctuated and irregularly alveolate with seven pairs of round elevations bearing dorsal seta(e); epimerata granulate; other surface punctulate. Rostral tip rounded. Notogaster with 13 pairs of T-shaped setae, 2 pairs of simple setae ( $p_1$  and  $p_2$ ) and 1 pair of virtual setae  $f_1$ . Sensilli consisting of penicillate swollen head and smooth thin stem. Lateral margin of pedotectum 1 bearing more than 20 ciliary's processes. Semicircular suture (*na*) of ventral region short, not reaching the level of insertion of aggenital seta  $ag_1$  or lyrifissure *ih*. Genito-anal setal formula: 9-2-2-3; all setae biramous. Subcapitulum diarthric, subcapitular setae: 1-2-1; setae *h* biramous. Epimeral setal formula: 4-2-3-4; all setae simple. Monodactylous.

**Material examined** — Holotype (Adult female) (NSMT-Ac 13611) from sand, and soil at point A; 9 paratypes (Adult female) (NSMT-Ac 13635 to 13640) from humus and soil of the garden under no-tillage manner of Nagasato at Asagiri-cho, Kumamoto Prefecture, Fujikawa T. leg, on March 3, 2008, September 20, 2009, April 11, 2011, October 15, 2011, November 6, 2011, December 16, 2011; 1 paratype (Nymph) (NSMT-Ac 13641): same data as paratypes of adults but on December 16, 2011; 7 paratypes (Adult female) for the scanning electron microscopy: same data as paratypes of adults but on November 5, 2009 and March 3, 2012.

**Etymology** — After the numerous ciliary's processes of pedotectum.

**Measurements and body appearance** — Body length (14 exs.): 407 (mean 450) 500 µm; width (11 exs.): 200 (229) 286 µm. Body colour light brown, Integument of prodorsum, ventral plate, subcapitular plate, genital plates, anal plates and legs punctulate; epimerata granulate; notogaster punctulate and irregularly alveolate with seven pairs of round elevations bearing one or three dorsal setae.

**Prodorsum** — Rostral tip widely rounded bearing smooth spiniform setae *ro* (ca. 33 µm) inserting far anterior on prodorsum and close to each other (Fig. 4A). Setae *le* (155 µm) and *in* (281 µm) T-shaped with dilated basal portion and long flagelliform distal portion (Figs. 3B, C). Setae *le* bearing a few acute projections, inserting on round elevations. Bothridia barrel-shaped, opening dorso-laterally. Sensilli (*ss*) (62 µm) consisting of penicillate swollen head and smooth thin stem. Setae *ex<sub>1</sub>* (6 µm) and *ex<sub>2</sub>* (3 µm) short, smooth, inserting at the basal portion of bothridium. Lateral margin of pedotectum 1 bearing more than 20 ciliary's processes (7 – 12 µm). Posterobothridial condyles small acute (Fig. 3A). Relative lengths and distances: *in*>*le*>*ss*>*ro*>*ex*; (*in-in*: 66 µm) > (*le-le*: 21 µm) > (*ro-ro*: 14 µm).

**Notogaster** — Anterior margin straight, shorter than the width of the middle part of notogaster. Notogaster with 13 pairs of T-shaped setae (241 µm), 2 pairs of simple setae ( $p_1$  and  $p_2$ ) (73 µm), 1 pair of virtual setae  $f_1$  and seven pairs of round elevations; six elevations bearing each seta of *cp*,  $d_{1-2}$ ,  $e_{1-2}$  and  $f_2$ ; the last pair of posterior elevations bearing three setae  $h_{1-3}$ . Virtual seta  $f_1$  present posterior to elevation bearing seta  $e_1$ . Posterior projection of notogaster with truncate margin, bearing two pairs of setae  $p_1$  and  $p_2$  at corners. Lyrifissures long, remarkable; *ia* (20 µm) and *ip* (9 µm) aligned along lateral margin of notogaster, posterior to  $c_3$  and  $h_3$ , respectively; *im* (9 µm) longitudinally anterior to  $e_2$ ; *ih* and *ips* situated ventrally (Fig. 4E); *ih* (12 µm) aligned transversely posterior to  $ag_1$ ; *ips* (16 µm) obliquely posterior to  $ag_2$ .

**Ventral region** — Genital aperture (64 µm) anterior roughly triangle, posterior parabola in shape; anal aperture (84 µm) elliptical. Semicircular suture (*na*) on ventral plate between genital and anal apertures, short, not reaching the level of insertion of aggenital seta  $ag_1$  or lyrifissure *ih*. Genito-anal setal formula: 9-2-2-3; all setae smooth, biramous (Fig. 3D). Genital (36 – 48 µm) and anal (17 µm) setae inserting at the inner margin of each plate (Figs. 4D-E). Setae  $ag_1$  inserting at level of insertion of *g7*;  $ag_2$  (91 µm) aligned in latero-posteriorly to genital aperture. All adanal setae (64 µm) aligned in adanal. Lyrifissures *ian* (19 µm) longitudinally anterior to

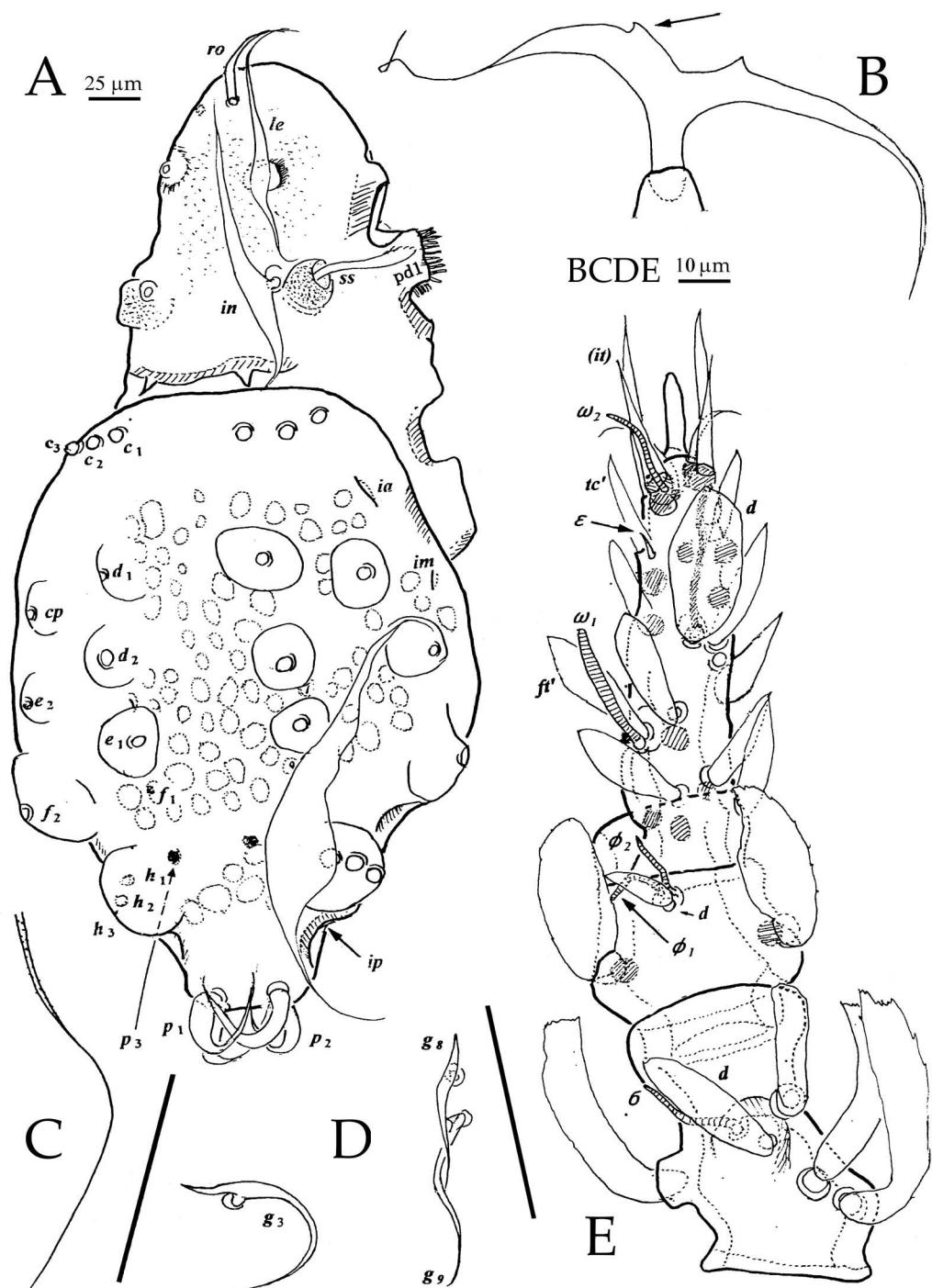


FIGURE 3: *Masthermannia multiciliata* n.sp.: A – Dorsal view; B – Lamellar seta with projection (arrow); C – Fine distal portion of T-shaped setae; D – Genital setae; E – Tarsus to genu of left leg I. (A, D, E: Paratype NSMT-Ac 13639; B: NSMT-Ac 13635; C: NSMT-Ac 13640).

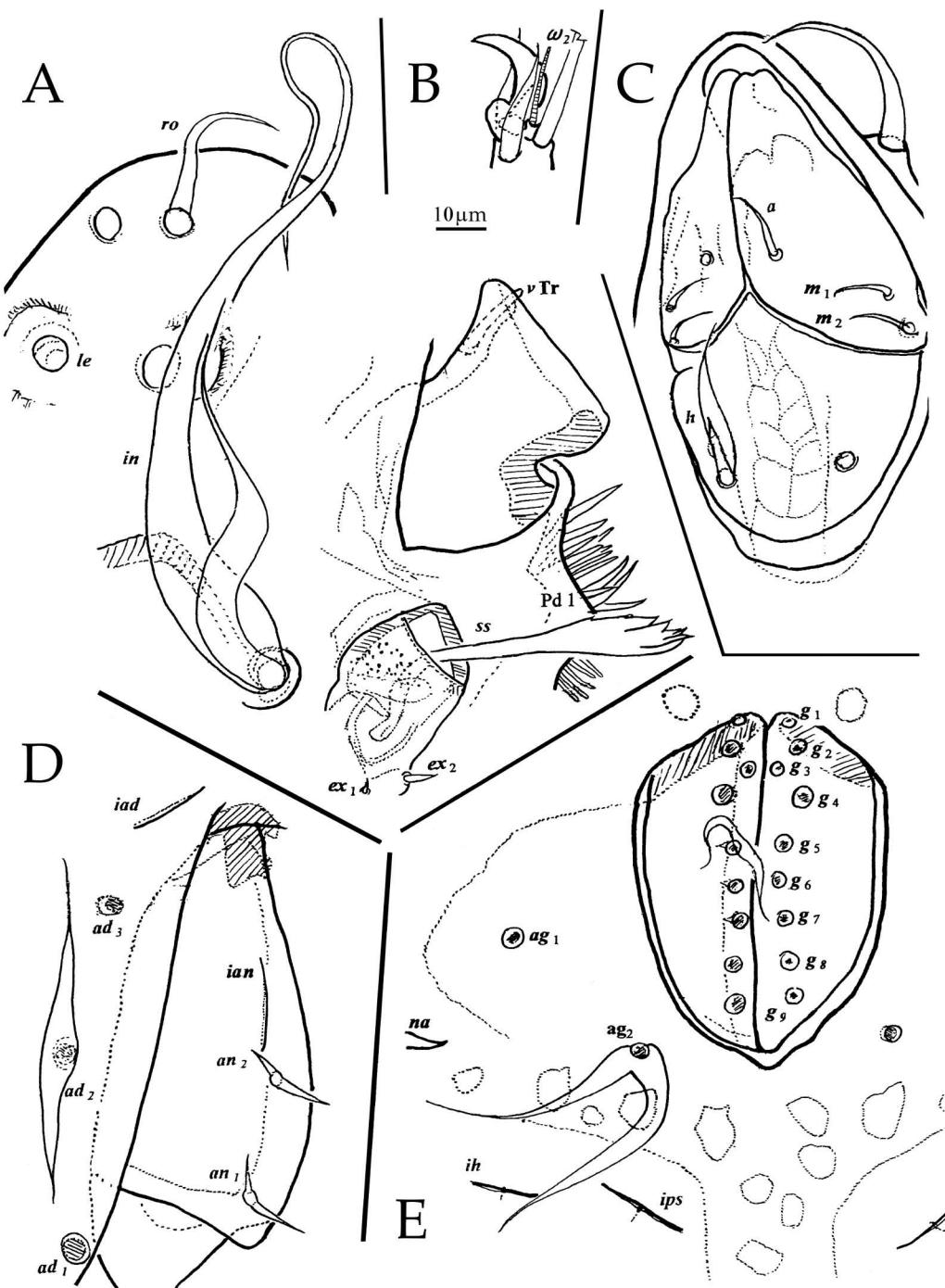


FIGURE 4: *Masthermannia multiciliata* n.sp.. (Holotype NSMT-Ac 13611): A – Rostral and right bothridial region; B – Claw at right tarsus I; C – Gnathosoma; D – Right anal plate region; E – Genital plates region.

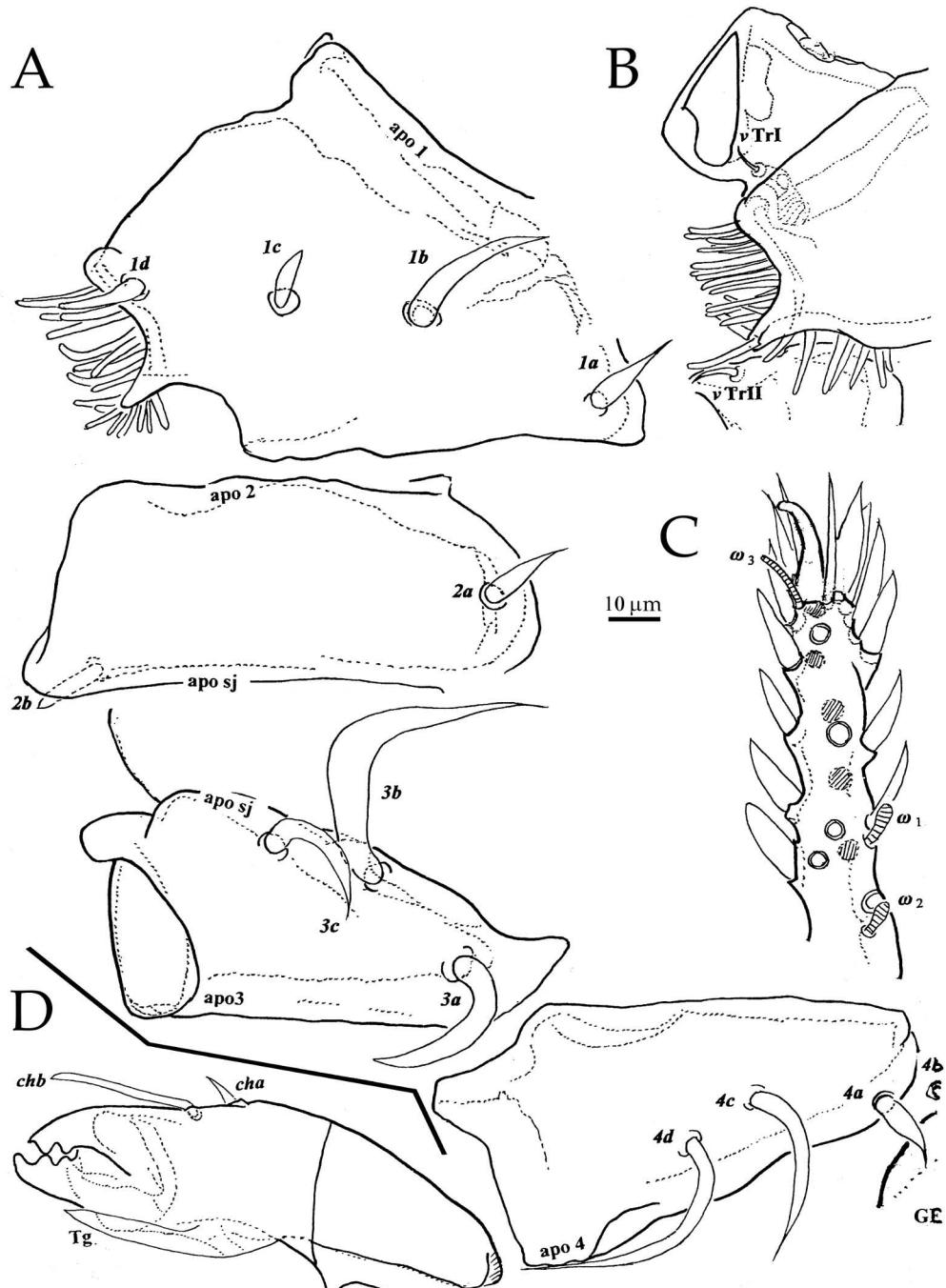


FIGURE 5: *Masthermannia multiciliata* n.sp.: A – Right epimeral region (Paratype NSMT-Ac 13640); B – Ventral view of right pedotectum I (Paratype NSMT-Ac 13640); C – Left tarsus II (Paratype NSMT-Ac 13635); D – Chelicera (Paratype NSMT-Ac 13637).



FIGURE 6: *Masthermannia multiciliata* n.sp. (Nymph) (NSMT-Ac 13641): A – Part of prodorsam; B – Part of right notogaster; C – Right pedotectum I.

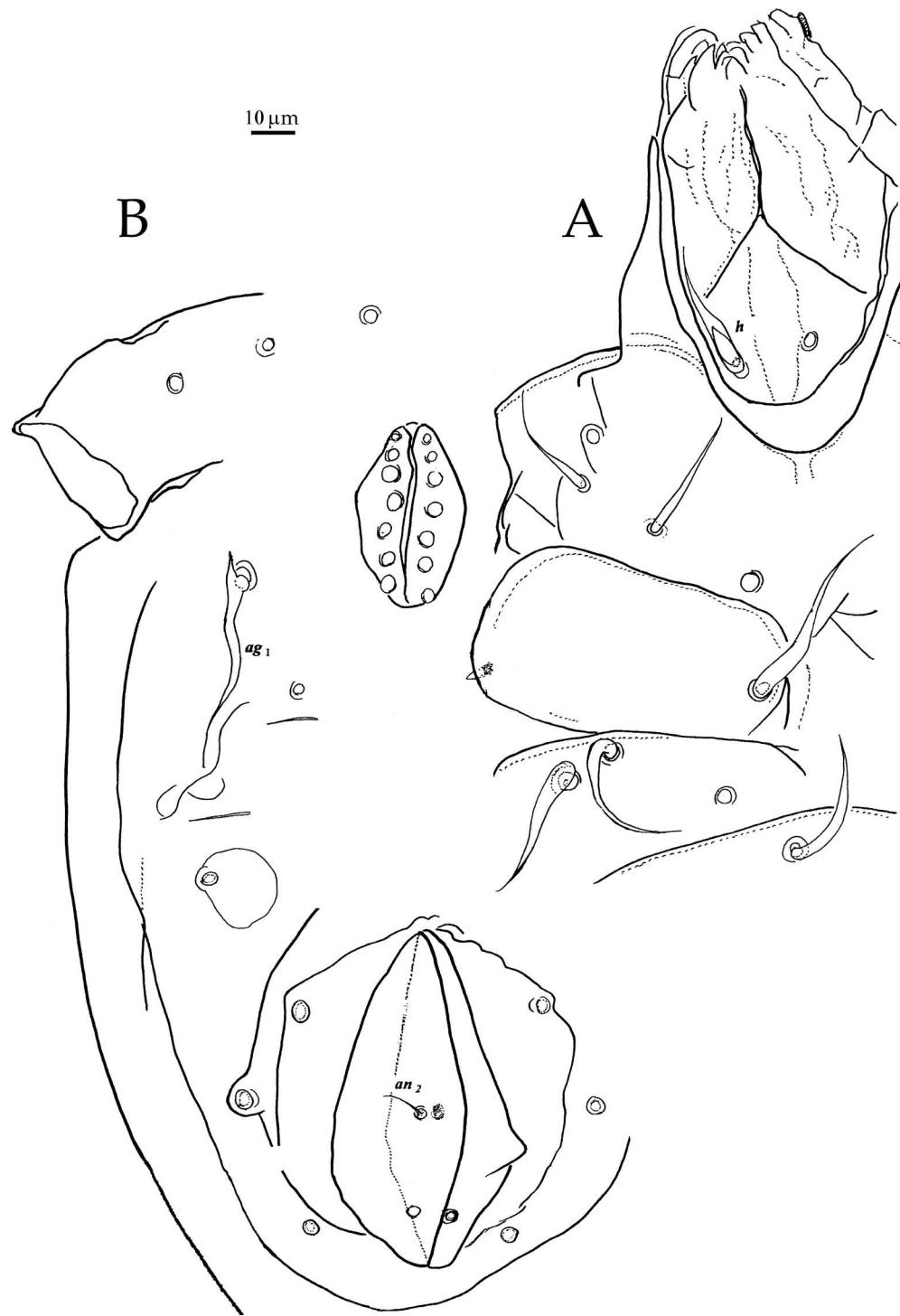


FIGURE 7: *Masthermannia multiciliata* n.sp. (Nymph) (NSMT-Ac 13641): A – Gnathosoma-right side of epimeral region; B – Right side of genito-anal region.

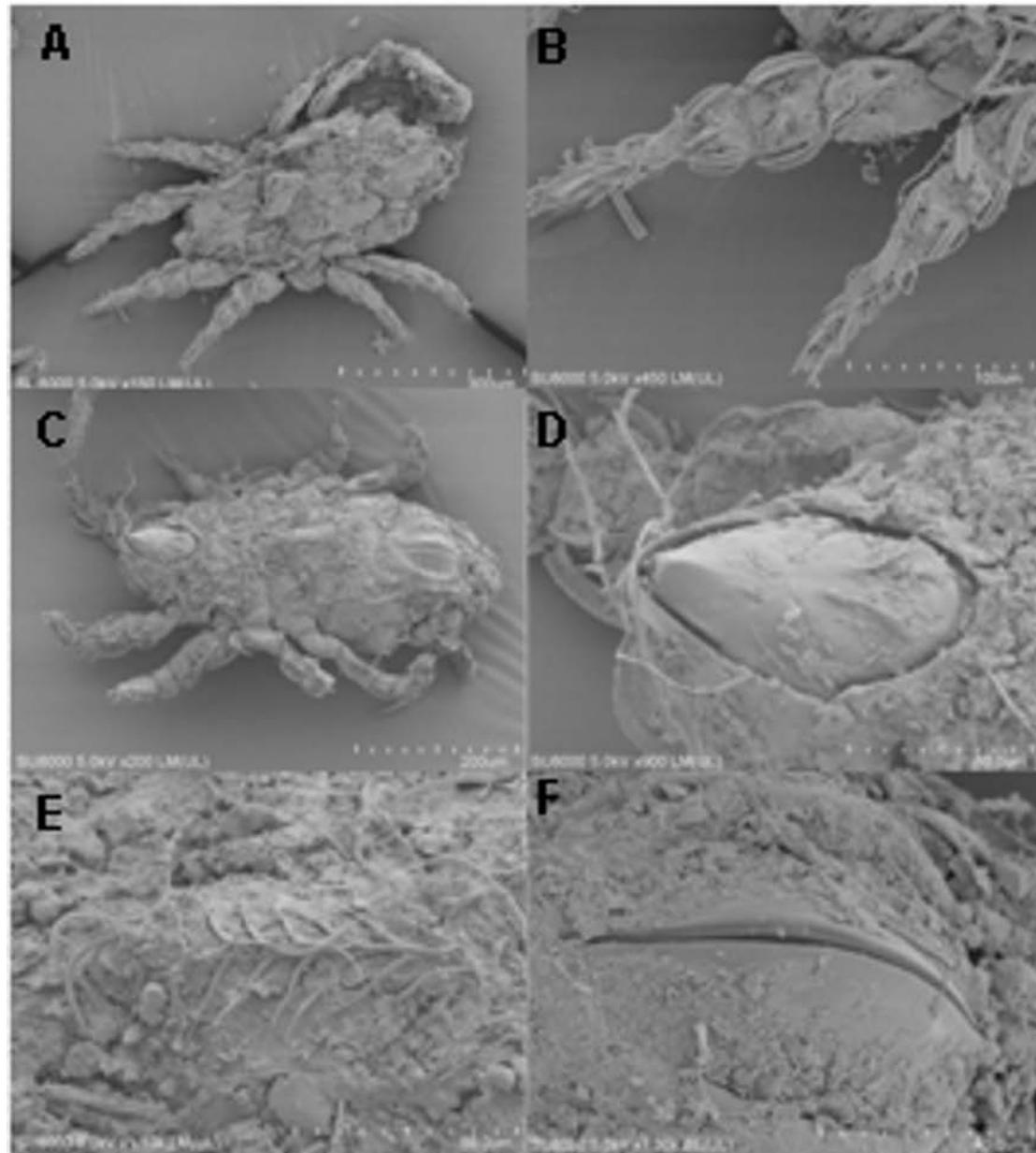


FIGURE 8: *Masthermannia multiciliata* n.sp. by the scanning electron microscopy (photos by Nakamura Y.-N., Ohgi Y. and Shiroasaki T.). Adult female: A – Dorsal view; B – Left legs I and II; C – Ventral view; D – Gnathosoma; E – Genital plates; F – Anal plates.

FIGURE 9: *Masthermannia multiciliata* n.sp. (photos by Nakamura Y.).

*an<sub>2</sub>*; *iad* (14 µm) inverse apoanal, located near anterior margin of anal aperture. Subcapitulum diarthric, subcapitular setae: 1-2-1; setae *h* (41 µm) smooth, biramous; *a* (16 µm), *m<sub>1-2</sub>* (11 µm) smooth, simple (Fig. 4C). Epimeral setal formula: 4-2-3-4; all setae (11 - 65 µm) smooth, simple spiniform (Fig. 5A); *3b* the longest, *1c* the shortest. Sternal ridge, apodemata 1-4 and *sj*. distinct. Setae *cha* (8 µm) thick basally; *chb* (26 µm) long bacilliform (Fig. 5D). Trägårdh's organ (31 µm) taeniform.

Legs — Monodactylous; claw (22 to 27 µm) smooth (Fig. 4B). Setal formula of legs: I (1-6-5-6-26), II (1-8-5-6-23), III (5-3-3-4-21), IV (1-3-3-4-19). Solenidiotaxy: I (1-2-2), II (1-1-3), III (1-1-0), IV (1-1-0).

#### Measurements (µm) of segments:

##### Holotype:

I ([41-46]-[84-80]-[54-52]-[39-41]-[93-86]),  
II ([54-48]-[70-71]-[39-45]-[36-36]-[75-80]),  
III ([71-?]-[61-59]-[32-27]-[36-36]-[61-57]),  
IV ([71-?]-[71-63]-[38-30]-[41-41]-[71-80]).

##### Average value according to paratypes:

I ([45-45]-[79-83]-[49-54]-[46-45]-[85-92]),  
II ([39-41]-[64-67]-[44-46]-[40-37]-[77-87]),

III ([60-62]-[56-64]-[33-31]-[31-36]-[66-62]),  
IV ([62-60]-[72-67]-[37-37]-[38-45]-[75-75]).

Legs I, II and III bearing solenidia of all tibiae and genua contiguous to dorsal seta (Figs. 3E, 5B). On tarsus I (Fig. 3E), famulus *ε* (5 µm) spiniform situated lateral to seta *tc'* (19 µm), posterior to solenidion *ω<sub>2</sub>*; *ω<sub>2</sub>* (20 µm) thin bacilliform, lateral to seta *it'* (25 µm); *ω<sub>1</sub>* (25 µm) thick bacilliform, narrow basally, posterior to seta *ft'* (26 µm); laminate dorsal seta (29 µm) large, smooth, with longitudinally running nerve-like line. Tarsus II bearing short clavate *ω<sub>1</sub>* (10 µm) and *ω<sub>2</sub>* (8 µm) posterior, and long thin bacilliform *ω<sub>3</sub>* (13 µm) at the basal portion of claw (Fig. 5B). On tibia I, solenidia *φ<sub>1</sub>* (12 µm) and *φ<sub>2</sub>* (12 µm) contiguously anterior to smooth entire seta *d* (14 µm); lateral setae (31 µm) broad, large bearing minute barbs. On genu I, *σ* (21 µm) thin bacilliform, contiguous to smooth entire seta *d* (28 µm) situated on a small apophysis; lateral setae (41 µm) minutely barbed, long, broad taeniform with truncate, serrate anterior margin.

##### Juvenile instar (Figs. 6 and 7)

A single tritonymph: length, 443 µm; width, 179 µm. Body surface wrinkled, light whitish-

yellow coloured without any ornamentation. Rosstrum widely rounded bearing simple, smooth rostral setae (21  $\mu\text{m}$ ) laterally. Setae *le* (83  $\mu\text{m}$ ) and *in* (152  $\mu\text{m}$ ) T-shaped originating from apophysis (Fig. 6A). Sensillus lost. Lateral margin of pedotectum 1 bearing 8 ciliary's processes (5 - 16  $\mu\text{m}$ ) (Fig. 6C). Posterobothridial condyles absent. Relative distances: (*ro-ro*) = (*le-le*) = (*in-in*). Gastronotum covered by ten pairs of large round elevations bearing T-shaped seta(e) (238  $\mu\text{m}$ ); eighteen pairs of notogastral setae recognized (Fig. 6B). Semicircular suture between genital and anal apertures absent. Distance (70  $\mu\text{m}$ ) between genital (40  $\mu\text{m}$ ) and anal (71  $\mu\text{m}$ ) apertures almost as long as the length of anal aperture. Genito-anal setal formula: 7-2-2-3; *an*<sub>2</sub>(10  $\mu\text{m}$ ) short, smooth, thin, simple setiform; other setae lost. Seta *h*(40  $\mu\text{m}$ ) and *ag* (47  $\mu\text{m}$ ) smooth, biramous (Figs. 7A-B). Epimeral setal formula: 4-2-3-4; all setae (6 - 46  $\mu\text{m}$ ) smooth, simple spiniform; the longest 2*A*, the shortest 2*b*. Setal formula of legs: I (1-6-5-5-21), II (1-8-5-4-20), III (3-3-3-4-18), IV (1-3-3-4-16). Solenidiotaxy: I (1-2-2), II (1-1-2), III (1-1-0), IV (1-1-0). Measurements ( $\mu\text{m}$ ) of segments:  
 I ([30-32]-[57-59]-[45-36]-[36-39]-[68-59]),  
 II ([36-36]-[54-63]-[39-32]-[32-30]-[52-50]),  
 III ([36-39]-[45-36]-[18-23]-[21-26]-[41-50]),  
 IV ([50-41]-[36-54]-[21-23]-[27-26]-[59-59]).

**Remarks** — The new species differs from all the species of the genus *Masthermannia* Berlese, 1913 by having (1) short semicircular suture between genital and anal apertures, not reaching the level of lyrifissure *ih* or insertion of aggenital seta *ag*<sub>1</sub> and (2) biramous genital, aggenital, anal and posterior subcapitular setae. The new species is distinguished from *M. nematophora* (Grandjean, 1954) by number of the ciliary's processes of lateral margin of pedotectum 1, shape of solenidia on tarsus I of leg, and length of solenidion on genu I of leg, from the original description of *M. hirsuta* (Hartman, 1949) by the shape of ornaments on notogastral surface and shape of notogastral posterior region, and from *M. hirsuta* sensu Aoki (1980) by shape of notogastral posterior region, shape of genital setae, and number of setae on the last pair of median round elevations on notogaster.

Genus *Masthermannia* Berlese, 1913 *Masthermannia* Berlese, 1913, Redia, 9, p. 100, pl. 8, fig. 92; Hammen van der, 1959, Zool. Verh., (40), p. 81. *Posthermannia* Grandjean, 1954, Rev. franc. Ent., 21, pp. 298-311, figs. 1-3. Members of the genus are very dirty and seem as if they are "mimicking small particles of earth" expressed by Balogh (1961) (Fig. 8).

### Key to the species

1. Notogastral surface without foveolate ornament ..... *Masthermannia extrema* (Balogh, 1958)  
— Notogastral surface with foveolate ornament .. 2
2. Notogastral surface with ornament longitudinally ..... *M. grandjeani* (Balogh, 1958)  
— Notogastral surface with ornament not longitudinally ..... 3
3. Bothridium absent ..... *M. runcifer* Sellnick, 1959  
— Bothridium present ..... 4
4. Leg tridactylous ..... *M. saharaiensis* Al-Assiuty, Bayoumi, Abdel-Hamid and Khalil, 1988  
— Leg monodactylous ..... 5
5. Rostral setae T-shaped .....  
..... *M. ornatissima* Pérez-Iñigo and Baggio, 1988  
— Rostral setae simple ..... 6
6. Notogastral posterior margin convex .....  
..... *M. seropedica* Badejo, Woas and Beck, 2002  
— Notogastral posterior margin concave or widely rounded ..... 7
7. Notogastral surface with angular foveolae .....  
..... *M. hirsuta* (Hartman, 1949)  
— Notogastral surface with round foveolae ..... 8
8. Semicircular suture between genital and anal apertures extending beyond the level between lyrifissure *ih* and insertion of *ag*<sub>1</sub> .....  
..... *M. mammillaris* (Berlese, 1904)  
— Semicircular suture between genital and anal apertures not extending beyond the level between

- insertion of *ih* and *ag<sub>1</sub>* ..... 9
9. Semicircular suture between genital and anal apertures reaching the level of insertion of *ag<sub>1</sub>* ..... *M. hauseri* Mahunka, 2009  
— Semicircular suture between genital and anal apertures not reaching the level of insertion of *ag<sub>1</sub>* ..... *M. multiciliata* n.sp.

## NOTHRIDAE BERLESE, 1896

### *Nothrus separatum* n.sp.

[Japanese name: Suehiro-amimeonidani]

(Figures 10 – 11)

**Diagnosis** — Body length 807 µm; width 386 µm. Prodorsal surface punctulate and irregularly alveolate. Notogastral surface medially and laterally tuberculate; alveolate between medial and lateral portions. Rostral incision short. Sensilli long, rod-like bearing sparsely spins. Notogaster anteriorly broadly rounded, posteriorly roundish angular, with a pair of longitudinal ridges extending from *c*-series line to insertion of seta *f<sub>1</sub>*. Of all notogastral setae, *f<sub>1</sub>* the longest. *Solenidia*  $\varphi_1$  and  $\sigma$  longer than each dorsal seta. Genito-anal setal formula: 9-0-2-3. Subcapitulum diarthric, subcapitular setae: 1-2-1. Epimeral setal formula: 11[9]-5-6-5. Heterotridactylous.

**Material examined** — Holotype (Adult female) (NSMT-Ac 13634) from sand, soil and humus at point B.

**Etymology** — After longitudinal ridges on notogaster divergent posteriorly

**Measurements and body appearance** — Body length 807 µm; width 386 µm. Body colour light brown. Prodorsal surface punctulate and irregularly alveolate. Notogastral surface medial and lateral portions of notogastral surface tuberculate; surface between medial and lateral portions alveolate.

**Prodorsum** — Rostral incision short (Fig. 10B). Transversal ridge distinct between insertions of setae *ro*, and between those of setae *le*. Setae *ro* (21–23 µm), *le* (45 µm) and *in* (50 µm) thick, short rod-like,

closely barbed. Sensilli (179 µm) long, rod-like bearing sparsely spins (Fig. 10A). Bothridia cup-shaped, opening dorso-laterally. Setae *ex* (30 µm) barbed setiform inserting at the basal portion of bothridium. Lateral prosomatic mark (m) distinct antero-laterally to bothridium.

**Notogaster** — Anterior margin broadly rounded; posterior margin roundish angular; a pair of longitudinal ridges extending from *c*-series line to insertion of seta *f<sub>1</sub>*, not joining posteriorly. Of all 16 notogastral setae, the longest *f<sub>1</sub>* (89 µm), the shortest *c<sub>2</sub>* = *c<sub>3</sub>* (39 µm). Lyrifissures *ia* aligned obliquely posterior to *c<sub>3</sub>*; *im* longitudinally, between *d<sub>3</sub>* and *e<sub>2</sub>*; *ip* perpendicular, postero-laterally to *glu*; *ih* and *ips* situated ventrally (Fig. 11A). Relative distances: (*f<sub>1</sub>*-*f<sub>1</sub>*: 571 µm)>(*e<sub>1</sub>*-*e<sub>1</sub>*: 104 µm)>(*d<sub>2</sub>*-*d<sub>2</sub>*: 89 µm)>(*h<sub>1</sub>*-*h<sub>1</sub>*: 75 µm)>(*p<sub>1</sub>*-*p<sub>1</sub>*: 68 µm)>(*c<sub>1</sub>*-*c<sub>1</sub>*: 54 µm) = (*d<sub>1</sub>*-*d<sub>1</sub>*).

**Ventral region** — Genito-anal setal formula: 9-0-2-3; all setae spiniform; anal setae sparsely barbed, other setae smooth (Fig. 11B). Genital (35 µm) and anal (24 µm) setae inserting at the inner margin of each plate. All adanal setae (51 µm) aligned in adanal. Lyrifissures *ani* and *adi* aligned almost longitudinally at the level setae *ad<sub>3</sub>*. Subcapitulum diarthric, subcapitular setae: 1-2-1; setae *h* (26 µm), *A* (40 µm), *m<sub>1</sub>* (20 µm), *m<sub>2</sub>* (14 µm) smooth spiniform. Epimeral setal formula: 11[9]-5-6-5; all setae (14 µm) thin, short, smooth setiform. Epimeral borders distinct.

**Legs** — Heterotridactylous; claw (40 µm) sparsely, minutely dentate (Fig. 11F). Setal formula: I (1-9-5-6-26), II (1-9-5-5-26), III (4-6-5-5-22), IV (1-6-5-5-20). Solenidiotaxy: I (1-2-3), II (1-1-1), III (1-1-0), IV (1-1-0). Measurements (µm) of segments: [Right-left]

I ([71-61]-[164-164]-[89-89]-[79-82]-[148-154]), II ([71-71]-[136-136]-[71-75]-[61-68]-[125-125]), III ([71-71]-[100-100]-[64-61]-[61-57]-[129-139]), IV ([107-107]-[114-125]-[68-71]-[71-68]-[182-182]).

All legs bearing one solenidion of all tibiae and genua contiguous to dorsal seta (Figs. 11D-E). On tarsus I (Fig. 11C), famulus *ε* (4 µm) spiniform situated antero-laterally to *ω<sub>1</sub>* (35 µm), posterior to solenidia *ω<sub>2</sub>*; *ω<sub>2</sub>* (16 µm), postero-laterally to *ω<sub>3</sub>* (14 µm); *ω<sub>2</sub>*, *ω<sub>3</sub>* thin bacilliform; *ω<sub>1</sub>* thick bacilliform,

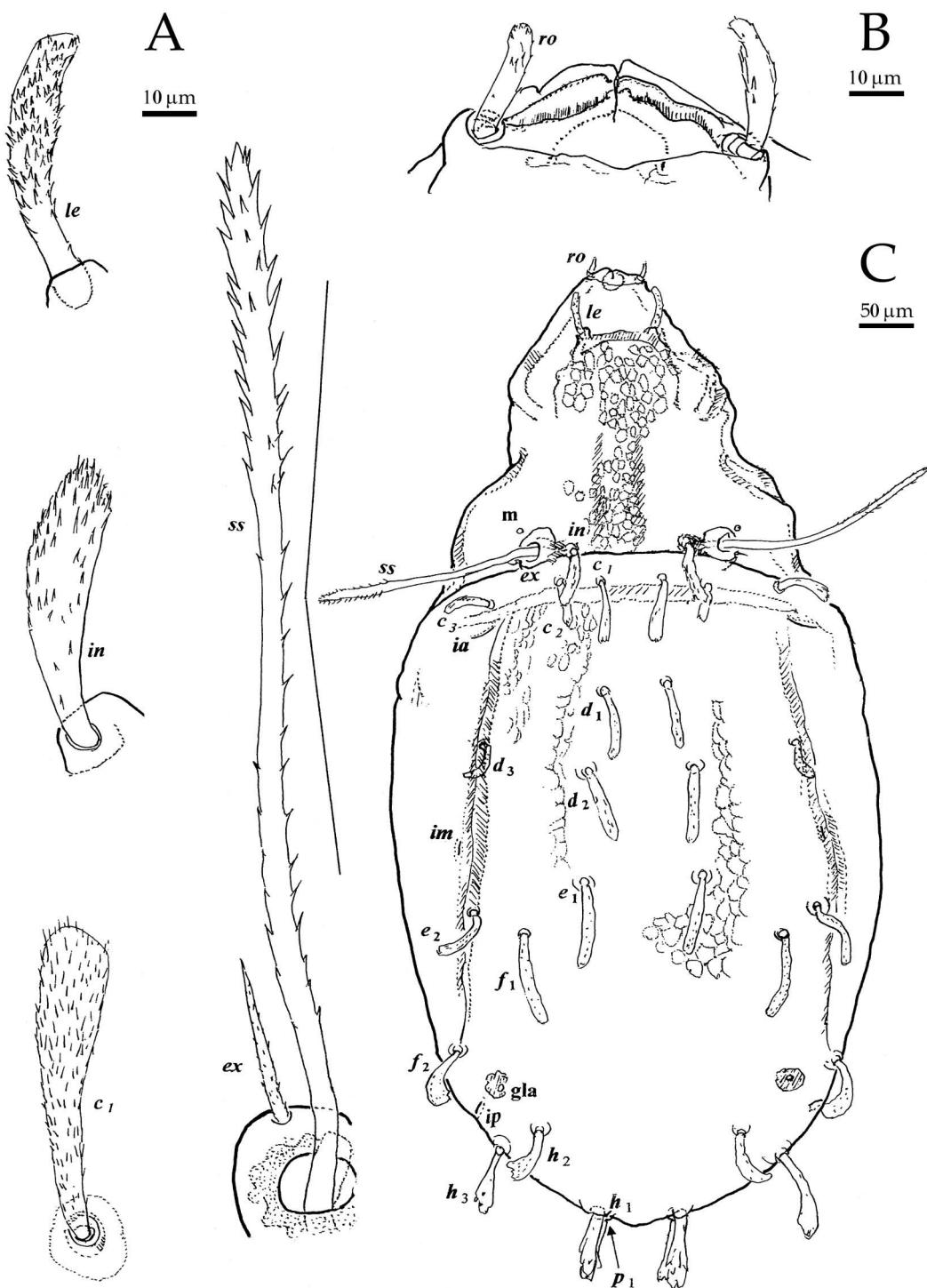


FIGURE 10: *Nothrus separatus* n.sp. (Holotype NSMT-Ac 13634): A – Principal setae: lamellar seta *le*, interlamellar seta *in*, notogastral seta *c*<sub>1</sub>, sensillus *ss*, exobothridial seta *ex*; B – Rostral region; C – Dorsal view.

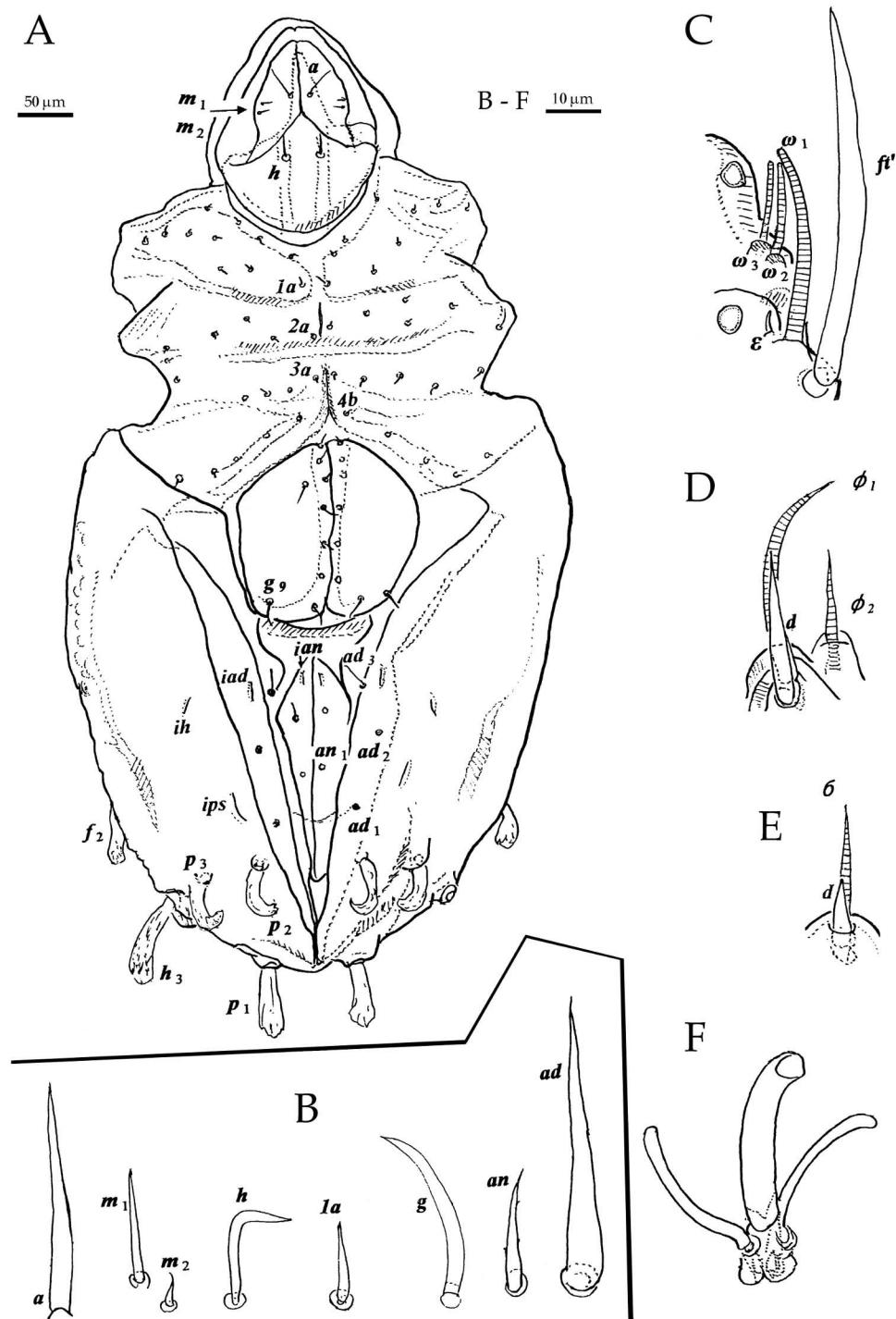


FIGURE 11: *Nothrus separatus* n.sp. (Holotype NSMT-Ac 13634): A – Ventral view; B – Principal setae: Anterior (*a*), medial (*m<sub>1-2</sub>*), posterior (*h*) setae, epimeral seta (*1a*), genital (*g*), anal (*an*), and adanal (*ad*) setae; C – Solenidial region on right tarsus I; D – Solenidial region on left tibia I; E – Solenidial region on left genu I; F – Tip of right leg III.

broad basally, situated anterior to seta  $ft'$  (67  $\mu\text{m}$ ). Solenidia  $\varphi_1$  and  $\sigma$  longer than each dorsal seta. On tibia I, solenidion  $\varphi_1$  (39  $\mu\text{m}$ ) and  $\varphi_2$  (16  $\mu\text{m}$ ) setiform, situated on every apophysis;  $\varphi_1$  contiguous to smooth spiniform seta  $d$  (26  $\mu\text{m}$ ), inserting anterior to  $d$ . On genu I,  $\sigma$  (21  $\mu\text{m}$ ) spiniform, contiguous to smooth cone-like seta  $d$  (10  $\mu\text{m}$ ) situated on a small apophysis.

Remarks — The new species is similar in shape of prodorsal and notogastral setae, and notogaster with one pair of longitudinal ridges to *Nothrus discifer* Hammer, 1961 and *T. gracilis* Hammer, 1961. However, the new species differs from those species in having the longest setae not  $h_2$  or  $p_1$ , but  $f_1$  of all notogastral setae, and longitudinal ridges not joining posteriorly.

#### TRHYPOCHTHONIIDAE WILLMANN, 1931

##### *Trhypochthonius triangulum* n.sp.

[Japanese name: Togari-montsukidani]

(Figures 12 – 14)

Diagnosis — Average body length 587  $\mu\text{m}$ ; width 348  $\mu\text{m}$ . Prodorsal surface granulate; notogastral surface postulate of hexagonal pattern. Of all notogastral setae, the longest  $h_1$ . Solenidia  $\varphi_1$  and  $\sigma$  shorter than each dorsal seta. Genito-anal setal formula: 7-0-1-3. Subcapitulum diarthric, subcapitular setae: 1-1-1. Epimeral setal formula: 3-1-3-3. Homotridactyle.

Material examined — Holotype (Adult female) (NSMT-Ac 13626) from sand, soil and humus at point C; 2 paratypes (NSMT-Ac 13625 and 13627): same data as holotype.

Etymology — After the shape of notogastral posterior region.

Measurements and body appearance — Body length (26 exs.) 464 (587) 629  $\mu\text{m}$ ; width (27 exs.): 307 (348) 407  $\mu\text{m}$ . Body colour light yellowish brown. Prodorsal surface granulate; notogastral surface postulate with hexagonal pattern. All specimens female. Percentage of gravid females 89 % in total, having 1 to 4 eggs.

Prodorsum — Triangular in dorsal view (Fig. 12A). Rostrum rounded. Setae  $ro$  (80  $\mu\text{m}$ ) thin,

barbed setiform inserting almost mid-distance between rostral anterior margin and insertion of lamellar setae. Setae  $le$  (71  $\mu\text{m}$ ) and  $in$  (95  $\mu\text{m}$ ) thick, long, densely barbed bacilliform. Sensilli (61  $\mu\text{m}$ ) with spiculate fusiform head and thin stem (Fig. 12B). Bothridia cup-shaped, opening dorso-laterally. Setae  $ex$  (4  $\mu\text{m}$ ) smooth minute cone-like, inserting at the basal portion of bothridium. Relative distances: ( $in-in$ : 100  $\mu\text{m}$ ) > ( $le-in$ : 70  $\mu\text{m}$ ) > ( $le-le$ : 50  $\mu\text{m}$ ) > ( $ro-ro$ : 43  $\mu\text{m}$ ) > ( $ro-le$ : 32  $\mu\text{m}$ ).

Notogaster — Notogaster anteriorly straight, posterior angular. Of all 16 notogastral setae including virtual  $f_1$ ; the longest  $h_1$  (77  $\mu\text{m}$ ), the shortest  $c_2$  (18  $\mu\text{m}$ ). Setae  $p$  of series inserting ventrally (Fig. 13A). Lyrifissures  $ia$  aligned longitudinally posterior to  $c_3$ ;  $im$  obliquely between  $e_1$  and  $gla$ ;  $ip$  perpendicular to notogastral outline, lateral to  $f_2$ ;  $ih$  obliquely, anterior to  $cp$ ;  $ips$  ventrally situated at the level of the insertion of setae  $ad_3$ . Relative distances: ( $d_2-d_2$ : 177  $\mu\text{m}$ ) > ( $e_1-e_1$ : 143  $\mu\text{m}$ ) > ( $e_1-h_3$ : 136  $\mu\text{m}$ ) > ( $h_3-h_3$ : 121  $\mu\text{m}$ ) > ( $e_1-f_1$ : 107  $\mu\text{m}$ ) > ( $h_1-h_3$ : 102  $\mu\text{m}$ ) > ( $d_1-d_1$ : 98  $\mu\text{m}$ ) > ( $f_1-f_1$ : 95  $\mu\text{m}$ ) > ( $h_1-h_1$ : 93  $\mu\text{m}$ ) > ( $d_1-e_1$ : 88  $\mu\text{m}$ ) > ( $p_1-p_1$ : 79  $\mu\text{m}$ ) > ( $c_1-c_1$ : 73  $\mu\text{m}$ ) > ( $c_1-d_1$ : 54  $\mu\text{m}$ ).

Ventral region — Genito-anal setal formula: 7-0-1-3; all setae thin setiform; genital setae (32  $\mu\text{m}$ ) densely barbed; anal (29  $\mu\text{m}$ ) and adanal setae (30 – 36  $\mu\text{m}$ ) sparsely barbed (Fig. 13A). All adanal setae aligned in adanal. Lyrifissures  $ian$  and  $iad$  aligned obliquely at the level of anal anterior margin. Subcapitulum stenarthric, subcapitular setae: 1-1-1; setae  $h$  (13  $\mu\text{m}$ ),  $A$  (32  $\mu\text{m}$ ) sparsely roughened;  $m$  (3  $\mu\text{m}$ ) smooth, minute cone-like (Fig. 13E). Epimeral setal formula: 3-1-3-3; all setae (16 – 32  $\mu\text{m}$ ) thin, short, smooth setiform; 1  $c$  the longest; 1  $A$  = 2  $A$  the shortest. Epimeral borders distinct. Cheliceral setae  $cha$  (42  $\mu\text{m}$ ) long, barbed setiform;  $chb$  (17  $\mu\text{m}$ ) short, smooth, spiniform. Trägårdh's organ (29  $\mu\text{m}$ ) thin.

Legs — Homotridactylous; claws (43  $\mu\text{m}$ ) dentate dorsally (Fig. 13B). Setal formula: I (1-5-5-5-19), II (1-5-5-5-17), III (2-4-3-4-12), IV (1-2-3-3-10). Solenidiotaxy: I (1-2-3), II (1-1-2), III (1-1-0), IV (0-1-0). Measurements ( $\mu\text{m}$ ) of segments according to holotype: [Right-left]  
I([50-?]-[86-?]-[41-?]-[27-?]-[66-?]),  
II([?-?]-[73-?]-[41-?]-[27-?]-[63-?]),

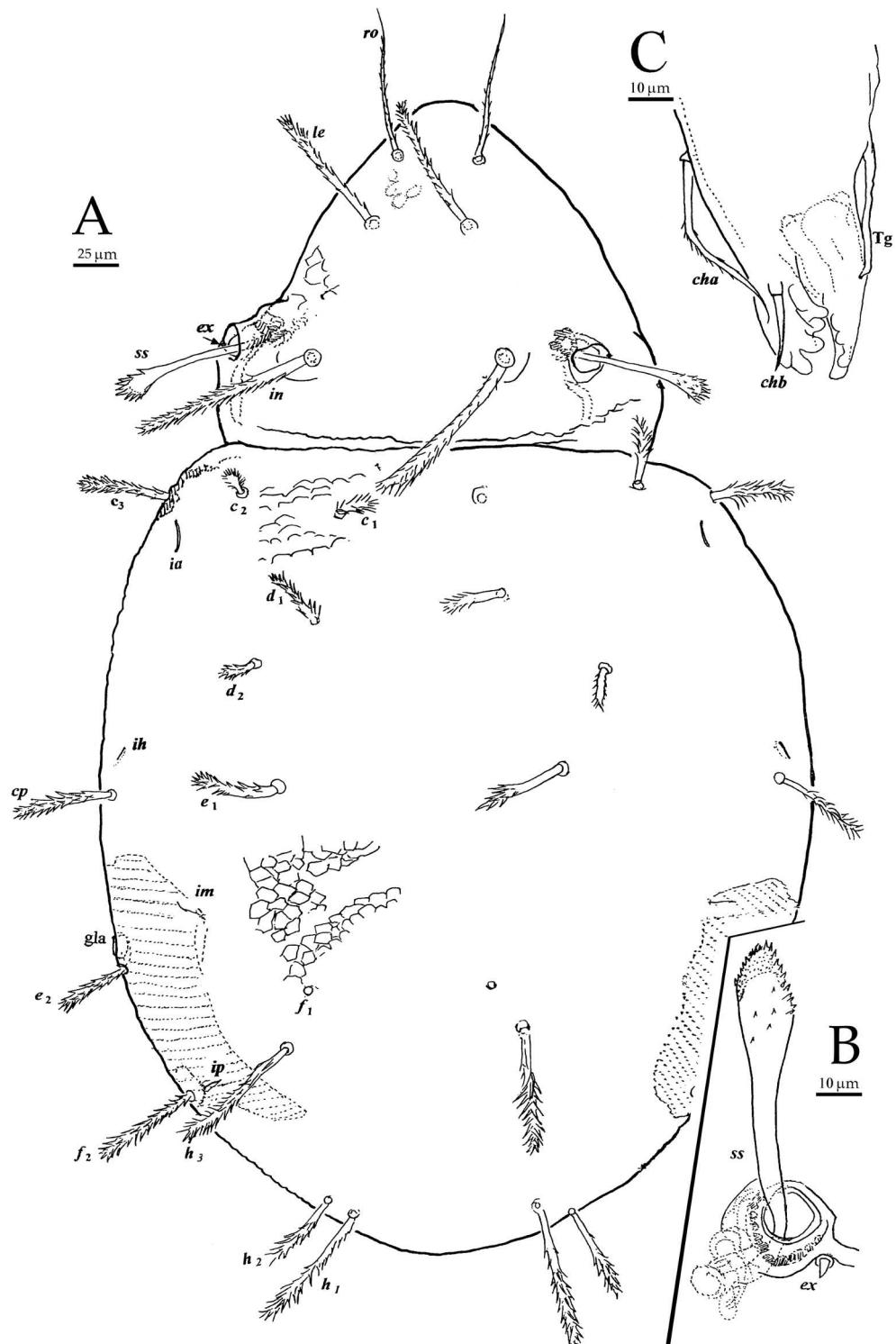


FIGURE 12: *Trhypochthonius triangulum* n.sp.: A – Dorsal view; B – Right bothridial region; C – Part of chelisera (A, C: Holotype NSMT-Ac 13626; B, Paratype NSMT-Ac 13625).

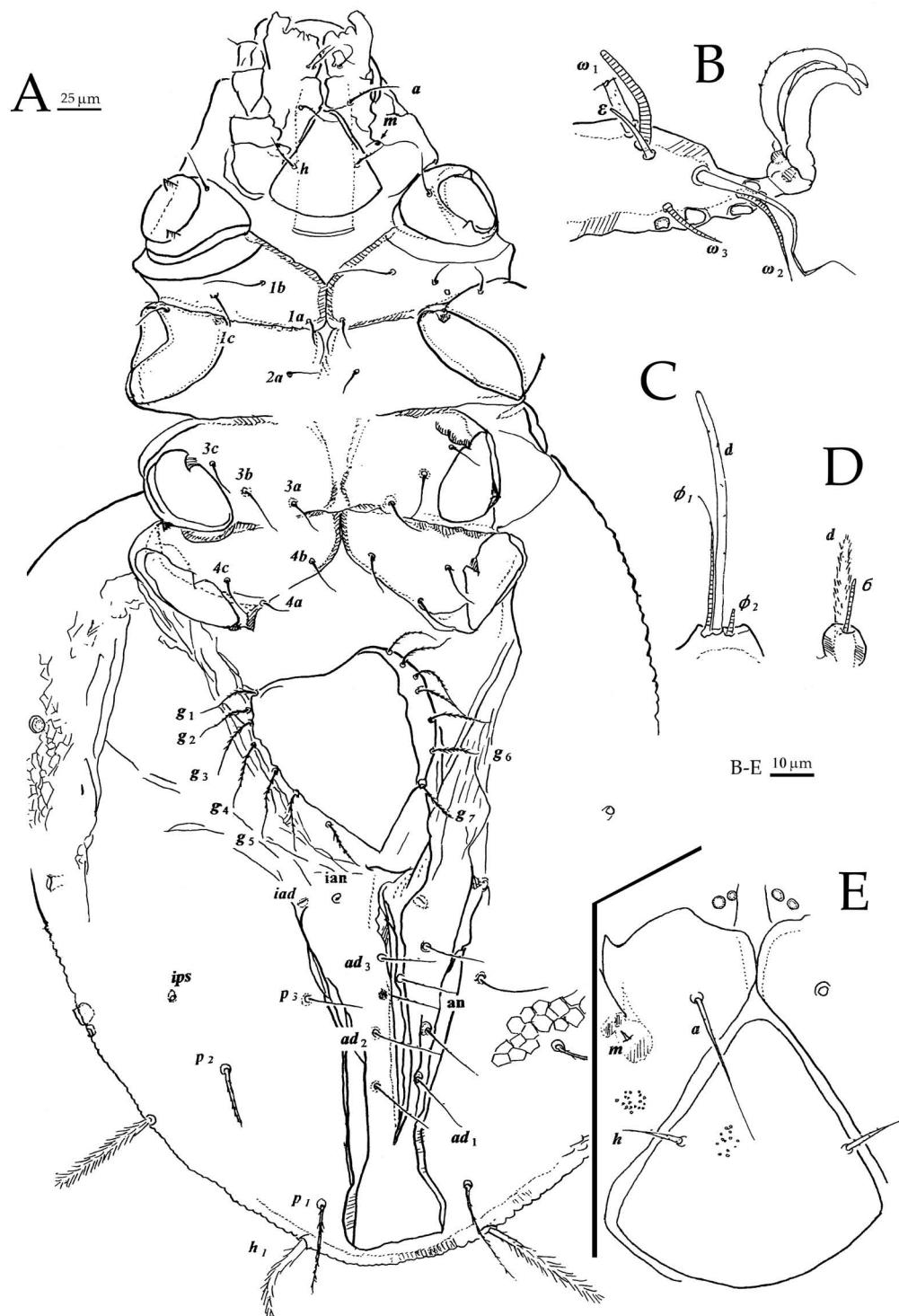


FIGURE 13: *Trhypochthonius triangulum* n.sp.: A – Ventral view; B – Solenidial region on right tarsus I; C – Solenidial region on left tibia I; D – Solenidial region on genu I; E – Gnathosoma (A: Holotype NSMT-Ac 13626; B-E: Paratype NSMT-Ac 13625).

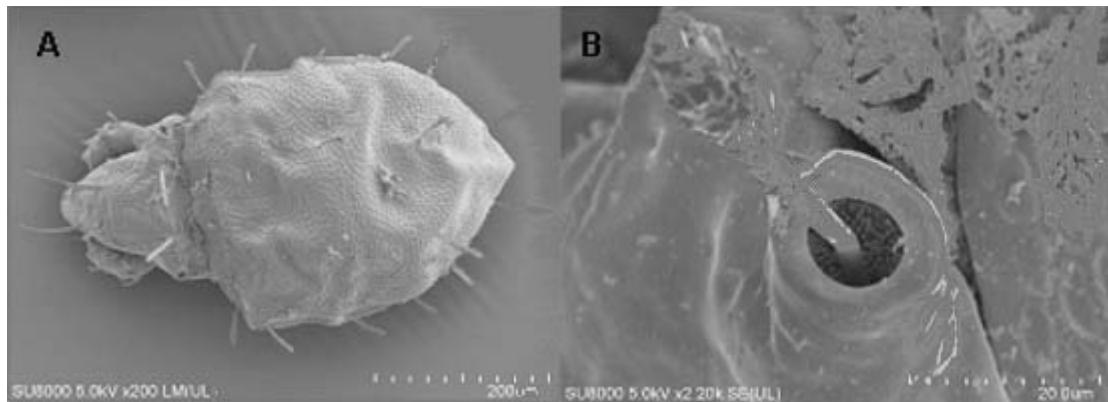


FIGURE 14: *Trhypochthonius triangulum* n.sp. by the scanning electron microscopy (photos by Nakamura Y.-N., Ohgi Y. and Shiroasaki T.):  
A – Dorsal view; B – Right bothridium.

III([46-?]-[63-?]-[36-36]-[27-29]-[63-61], IV([54-50]-[68-63]-[43-41]-[38-39]-[84-80]). Measurements (average value:  $\mu\text{m}$ ) of segments according to depressed paratypes: [Right-left] I([47-47]-[79-73]-[46-47]-[31-31]-[54-59]), II([47-39]-[70-71]-[34-43]-[29-36]-[58-54]), III([57-59]-[59-55]-[36-30]-[29-30]-[50-54]), IV([54-54]-[63-63]-[36-36]-[32-38]-[71-84]).

All legs bearing one solenidia of all tibiae and genua contiguous to dorsal seta (Figs. 13C-D). On tarsus I, famulus  $\varepsilon$  (14  $\mu\text{m}$ ) obtuse situated laterally to  $\omega_1$ ;  $\omega_1$  (25  $\mu\text{m}$ ) thick bacilliform;  $\omega_2$  (25  $\mu\text{m}$ ) thin setiform inserting near the base of claws;  $\omega_3$  (14  $\mu\text{m}$ ) situated lateral to famulus and posterior to  $\omega_2$ . Solenidia  $\varphi_1$  and  $\sigma$  shorter than each dorsal seta. On tibia I, solenidion  $\varphi_1$  (31  $\mu\text{m}$ ) setiform and  $\varphi_2$  (6  $\mu\text{m}$ ) spiniform, situated on either side of seta  $d$  (55  $\mu\text{m}$ ) on common apophysis (Fig. 13C). On genu I,  $\sigma$  (12  $\mu\text{m}$ ) bacilliform, contiguous to barbed ensiform seta  $d$  (21  $\mu\text{m}$ ) situated on a small apophysis (Fig. 13D).

**Remarks** — The new species is similar in shape of notogaster, insertion of rostral setae, namely, almost mid-distance between rostral anterior margin and insertion of lamellar setae, and length of notogastral setae to *Trhypothoios tectorum* (Berlese, 1896), *T. septentrionalis* Fujikawa, 1995 and *T. fujinitensis* Fujikawa, 2000. The chelicerae of the new species are similar in appearance to those of *T. semovitussi* Szywilewska, 2004 and *T. sphagnicola* Weigmann, 1997. However, the new species differs from its congeners in having smaller body size,

solenidion  $\omega_1$  located between famulus and seta  $ft'$  on tarsus I, setiform solenidion  $\omega_2$  on tarsus I, and sparsely barbed bacilliform dorsal seta on tibia I.

COHORT BRACHYPYLINA HULL, 1918  
TECTOCEPHEIDAE GRANDJEAN,  
1953[1954]

*Tectocepheus elegans* Ohkubo, 1981  
[Japanese name: Kakoi-kuwagatadani]

*Tectocepheus elegans* Ohkubo, 1981, Annot. Zool. Japon., 54(1), pp.42-52, figs. 1-3; Fujikawa et al., 1993, J. Acarol. Soc. Jpn., 2(Suppl. 1), p. 57; Subías, 2004, Graellsia, 60, p.154; Nakamura et al., 2006, Mem. Fac. Agr., Ehime Univ., p. 41.

**Diagnosis** — Rostrum with fence-like sclerotic ridge. Sensilli consisting clavate verrucose head and thin, smooth stem. Notogaster with four pairs of large hollows medially.

**Material examined** — One female (NSMT-Ac 13632): from point B; holotype slide NSMT-Ac 9204 bearing the label "*Tectocepheus elegans* OHOKUBO, 1980" in the National Museum of Nature and Science, Tokyo.

**Measurements** — Body length 314  $\mu\text{m}$ ; width 214  $\mu\text{m}$ . Body colour light brown.

**Supplementary description** — Notogastral surface covered with cerotegument of irregularly granulate. Measurements ( $\mu\text{m}$ ) of segments of legs:

[Right-left]:  
I ([29-?]-[23-23]-[18-?]-[25-?]),  
II([36-?]-[50-?]-[18-18]-[34-25]-[29-26]),  
III([29-30]-[36-36]-[16-18]-[34-?]-[29-?]),  
IV([48-?]-[39-39]-[18-21]-[39-40]-[36-36]).

Distribution — Oriental region.

Remarks — The present specimen differs from the holotype in shape of granules of cerotegument on notogastral surface.

***Tectocephalus velatus velatus*(Michael, 1880)**

[Japanese name: Kuwagatadani]  
**(Figure 15A)**

*Tegeocranus velatus* Michael, 1880, Journ. R. micr. Soc. Trans. Soc., III(5), pp. 190 & 191, pl. 6, figs. 6-9.

*Tectocephalus velatus*: Berlese, 1895, Acari, Myriapoda et Scorpiones hucusque in Italia reperta, Padova. Ordo Cryptostigmata (Oribatidae). fasc., 77(2), tav. 72; Oudemans, 1900, p. 151; Haarlov, 1942, Medd. Grønland, 28, p. 37, figs. 22b & e; Hammen, van der, 1952, Zool. Verh., 17, p. 70; Hammer, 1952, Acta Arctica, 4, p. 41, fig. 58; Abd-El-Hamid, 1965, Zool. Anz., 175, pp. 426-436, figs. 1-15; Knülle, 1954, Zool. Anz., 152, p. 286, figs. 6-8; Chistyakov, 1972, Zool. Journ., 51(4), pp. 604-607, fig. 1; Fujikawa, 1988, Acarologia, 29(2), pp. 206-207, fig. 1-5; 29(3), pp. 308-311, figs. 1-8; Nübel-Reidelbach, 1994, andrias, 12, pp. 51-52, figs. 4, 6, 7a, 8-13, 15-20, 23, 24, 26-29, 31-35 & 41-44; Subías, 2004, Graellsia, 60, p.154; Fujikawa, 1995, Edaphologia, (55), pp. 1-82, figs. 2-4, 8-18, 21, 26, 28-31, 35-39; Fujikawa, 1999, Edaphologia, (62), pp. 16-23, figs. 5-13, 20, 24-28; Fujita and Fujiyama, 2001, Pedobiologia, 45, pp. 36-45; Weigmann, 2002, in : Bernini et al. (eds.): Acarid phylogeny and evolution. Adaptations in mites and ticks, Kluwer Academic Publishers, printed in Netherlands, pp. 141-152, figs. 1-8; Laumann et al., 2007, Pedobiologia, 51, figs. 1-2.

Diagnosis — Rostral anterior margin without incision. Lamellar cuspis without dent. Setae *in* short. Sensilli with verrucose globular head. Bothridia with deep incision, without swelling or projection. Depressions and dorsosejugal scissure ab-

sent. Humeral region with small triangular projection. Ten pairs of notogastral setae. Genito-anal setal formula: 6-1-2-3. Lyrifissures *iad* located along, near anterior margin of anal aperture. Epimeral setal formula: 3-1-3-3. Trochantera III and IV bearing carina without sharply pointed apex. Monodactylous.

Material examined — One female (NSMT-Ac 13633): from point B; 11 exs. and 2 parts of body, slides Nos. 596-604 bearing the label "*Tegeocranus velatus*" in the Michael collection.

Measurements — Body length 336 µm; width 229 µm. Body colour light brown.

Supplementary description — Morphological variation in shape of lamellar cuspis, sensillus, and situation of adanal lyrifissure *iad*, type B, B, and A used in figs 6 and 7 by Fujikawa (1999), respectively, that is, the present specimen has narrow cuspis, elongate sensillus, and enclosed angle of the adanae lyrifissure pair *iad*, 170°. Genital plates bearing *g*<sub>1</sub> and *g*<sub>2</sub> inserting at the same level. Measurements (µm) of segments of legs: [Right-left]:

I([?-16]-[66-50]-[24-23]-[38-34]-[39-38]),  
II([?-31]-[71-57]-[20-27]-[34-36]-[31-31]),  
III([43-43]-[43-46]-[18-19]-[37-32]-[32-31]),  
IV([50-53]-[50-54]-[21-23]-[46-43]-[37-36]).

Distribution — Cosmopolitan.

Remarks — Three specimens from Matsushima-cho belonging to the genus *Tectocephalus* have a body surface ornamented "as with a veil" (Michael, 1880), and the ornamentation has densely, dark, large granules (Fig. 15A). Lyrifissure *im* of the present specimen aligned transversely anterior to opisthonotal gland *gla*.

***Tectocephalus acutus* n.sp.**

[Japanese name: Togari-kuwagatadani]  
**(Figures 15B-G – 16)**

Diagnosis — Average body length 282 µm; width 171 µm. Rostral anterior margin without incision, broadly rounded with rostral trowel. Lamellar cuspis with dents bilaterally to lamellar seta, not extending to level of rostral anterior margin. Setae *in* roughened rod-like. Sensilli with spinose, clavate head and smooth, thin stem. Bothridia with deep

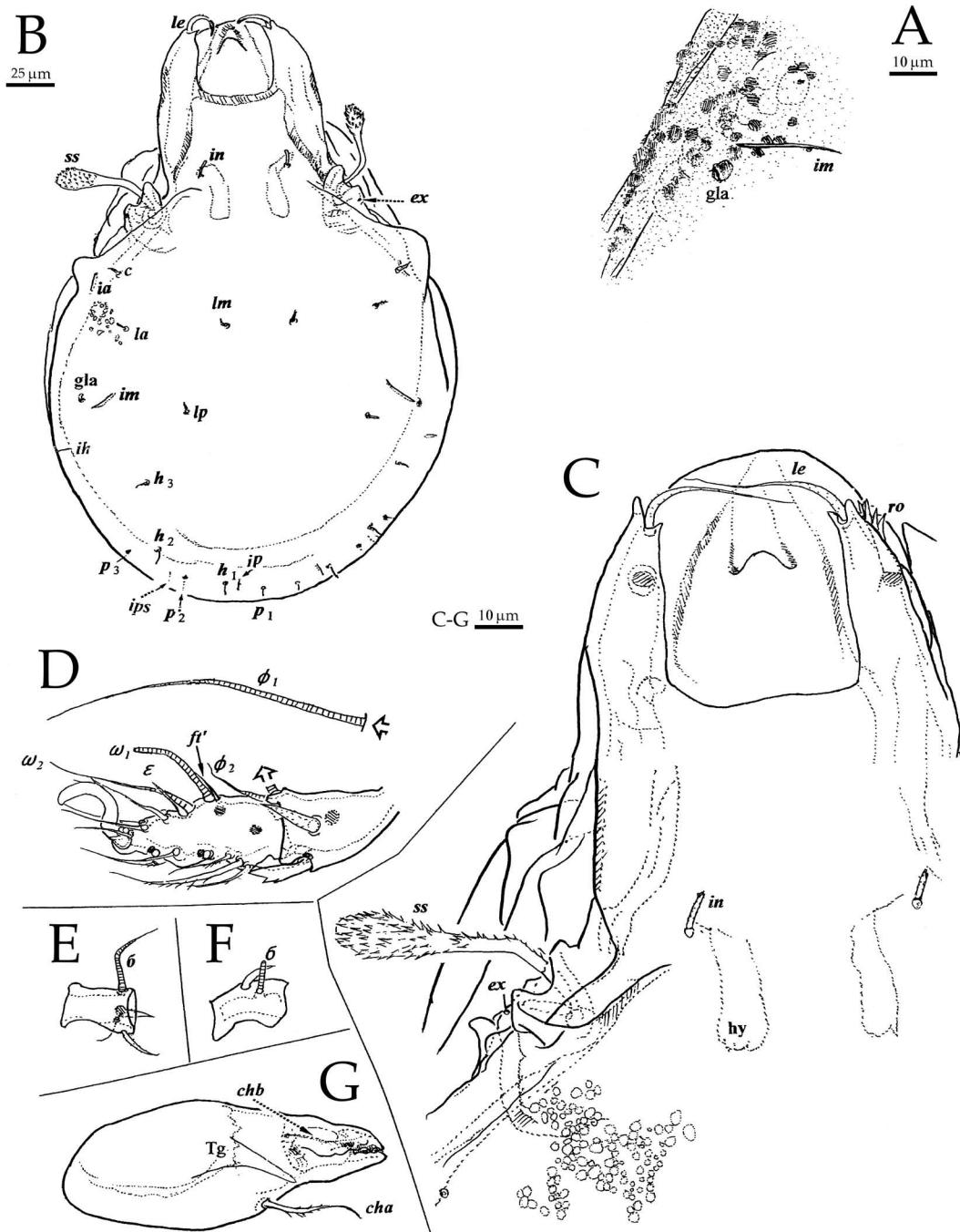


FIGURE 15: A – Left of lyrifissure *im* region of *Tectocephus velatus velatus* (Michael, 1880) (NSMT-Ac 13633); B-G: *Tectocephus acutus* sp. nov. B – Dorsal view; C – Prodorsum; D – Solenidial region on left tarsus I and tibia I; E – Solenidial region on left genu I; F – Solenidial region on right genu III; G – Chelicera (B, F: Holotype NSMT-Ac 13630; C, E, G: Paratype NSMT-Ac 13631).

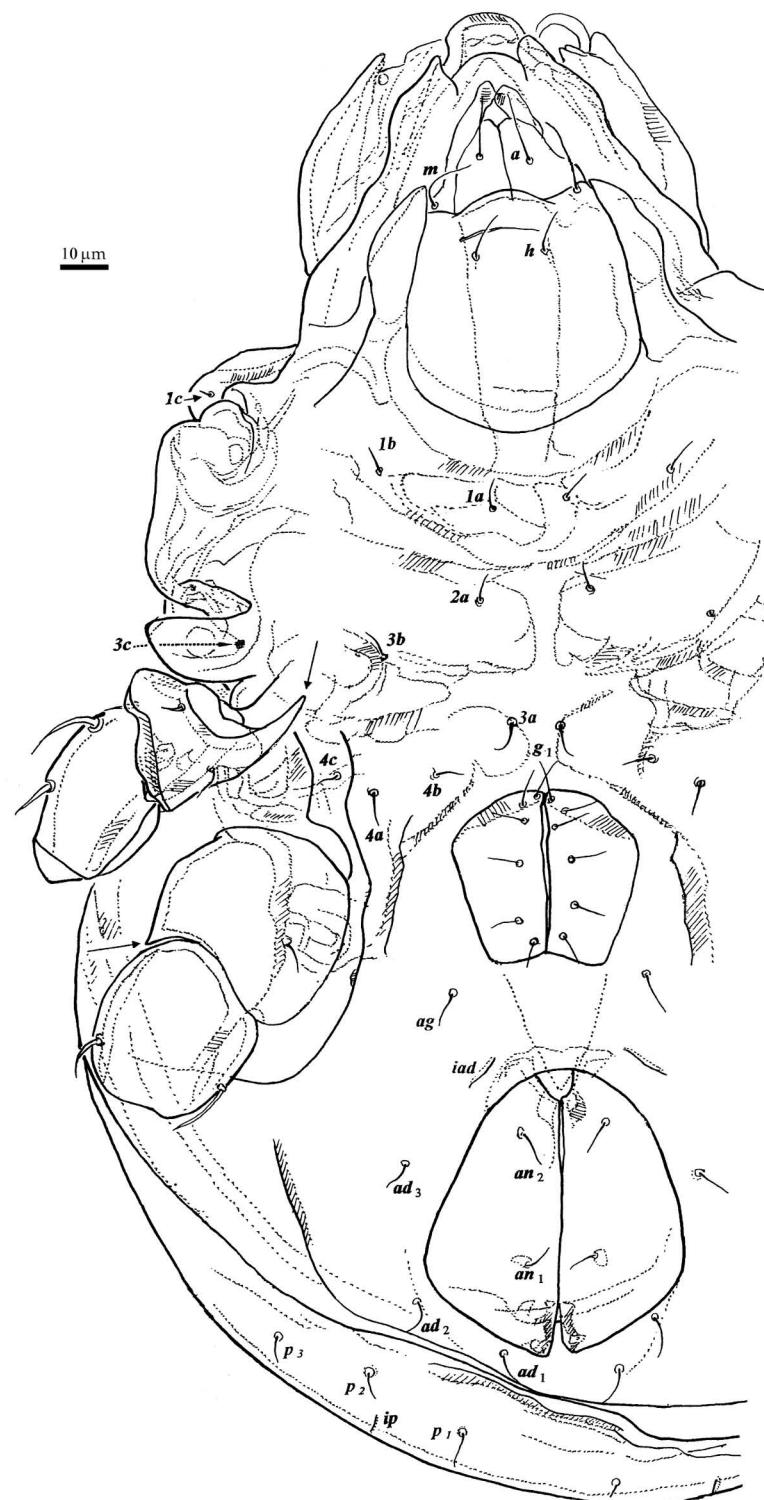


FIGURE 16: *Tectocepheus acutus* n.sp.: Ventral view (Paratype NSMT-Ac 13631).

incision, without swelling or projection. Depressions and dorsosejugal scissure absent. Humeral region with small triangular projection. Ten pairs of notogastral setae. Genito-anal setal formula: 6-1-2-3. Lyrifissures *iad* located along, near anterior margin of anal aperture. Epimeral setal formula: 3-1-3-3. Trochantera III and IV bearing carina with sharply pointed apex. Monodactylous.

**Material examined** — Holotype (Female) (NSMT-Ac 13630) from point B; 1 paratype (NSMT-AC 13631): same data as holotype.

**Etymology** — After long, sharply pointed apex on trochanter III.

**Measurements and body appearance** — Body length 279 – 286 µm; width 164 – 179 µm. Body colour light brown. Whole body surface covered with cerotegument; cerotegument irregularly dark granulate.

**Prodorsum** — Rostral anterior margin without incision, broadly rounded with rostral trowel (Fig. 15C). Rostral setae (16 µm) consisting of unilaterally spinose head and thick, smooth stem, inserting dorsally under lamellar cuspis. Lamellar cuspis with dents bilaterally to lamellar seta, not extending to level of rostral anterior margin; outer dent longer than inner dent. Inner sides of cuspides straight. Setae *le* (33 µm) setiform minutely roughened, strongly curved inside. Setae *in* (7 µm) minutely roughened rod-like. Sensilli (46 µm) composed of thin, roughened stem and globular head bearing dark coloured spines. Setae *ex* (4 µm) smooth, short bacilliform. Bothridia opening antero-laterally, with deep incision, without swelling or projection.

**Notogaster** — Depressions and dorsosejugal scissure absent. Dorsophragmatic apophysis (*hy*) conspicuously long. Humeral region with small triangular projection (Fig. 15B). Ten pairs of notogastral setae short (4 – 7 µm) setiform, roughened throughout length. Lyrifissures *ia* aligned longitudinally or obliquely, lateral to setae *c*; *im* obliquely, lateral to *gla*; *ih*, *ip* and *psi* perpendicular to notogastral outline. Relative distances: (*h<sub>3</sub>-h<sub>3</sub>*: 120 µm) > (*h<sub>2</sub>-h<sub>2</sub>*: 95 µm) > (*lp-lp*: 88 µm) > (*h<sub>1</sub>-h<sub>1</sub>*: 43 µm) > (*lm-lm*: 34 µm) > (*p<sub>1</sub>-p<sub>1</sub>*: 18 µm).

**Ventral region** — Genital (31 µm) and anal (55 µm) apertures almost pentagonal in shape; distance (23 µm) between them appreciably shorter than half length of anal aperture. Genito-anal setal formula: 6-1-2-3; all setae smooth setiform (Fig. 16). Setae *g<sub>1</sub>* and *g<sub>2</sub>* (9 µm) not inserting at the same level at anterior margin of plates. Setae *ag* (8 µm) inserting latero-posterior to genital aperture. Setae *ad<sub>1</sub>* and *ad<sub>2</sub>* (10 µm) aligned in postanal position, *ad<sub>3</sub>* (7 µm) in adanal; *ad<sub>3</sub>* inserting almost at mid-distance between *an<sub>1</sub>* and *an<sub>2</sub>* (7 µm). Lyrifissures *iad* located along, near anterior margin of anal aperture with enclosed angle 120-140°. Sternal ridge indistinct. Epimeral borders 1-4, *sj* distinct. Epimeral setal formula: 3-1-3-3; setae smooth, short setiform (3 – 7 µm). Subcapitulum diarthric, subcapitular setae 3 pairs, *A* (14 µm), *m* (14 µm), and *h* (11 µm); setae thin smooth setiform. Cheliceral setae *cha* (23 µm), *chb* (16 µm) thin, barbed setiform. Trägårdh's organ short (14 µm), with a blunt apex (Fig. 15G).

**Legs** — Monodactylous; claw (21 µm) sparsely dentate dorsally. Setal formula: I (1-5-3-4-18), II (1-5-3-4-14), III (2-4-1-3-14), IV (1-2-2-3-10). Measurements (µm) of right segments according to depressed paratype: I (25-40-16-31-35), II (21-46-14-25-28), III (50-36-14-26-23), IV (51-43-21-?-?). Trochantera III – IV and femora III-IV bearing carina; trochantera III with long, sharply pointed apex (21 µm) bending to rostral side (Fig. 16). On tarsus I, famulus *ε* (9 µm) consisting of a fine tip and expanded basal portion, situated antero-laterally contiguous to *ω<sub>2</sub>*; *ω<sub>2</sub>* (31 µm) terminating in fine tip; *ω<sub>1</sub>* (21 µm) bacilliform situated posterior to *ω<sub>2</sub>*; *ft'* (8 µm), inserting posterior contiguous to *ω<sub>1</sub>* (Fig. 15D). Solenidion *φ<sub>2</sub>* (15 µm) originating from a small apophysis on the tip of tibia I; *φ<sub>1</sub>* (65 µm) situated at the base of apophysis. On genu I, solenidion *σ* (18 µm) terminating in a fine tip, longer than seta *d* (8 µm) (Fig. 15E). All solenidia on tarsus II, tibiae II-IV and genua II-III short rod-like (*σ<sub>III</sub>*: 7 µm), shorter than each dorsal seta (*d<sub>III</sub>*: 11 µm) (Fig. 15F).

**Remarks** — The new species is similar to *Tectoccephalus minor* Berlese, 1903 in shape of dentate cuspis and small enclosed angle of lyrifissure pair *iad*, however, the former is different from the latter in shape of bothridial ventral extension, long sharply

pointed carina on trochantera III, arrangement of genital setae, and solenidia of legs (Laumann *et al.*, 2007; Nübel-Reidelbach, 1994). The new species is similar in shape of long sharply pointed carina on trochantera III, and shape, length and situation of solenidia, famulus and seta *ft'* on tarsus I to *T. kumayaensis* Nakamura *et al.*, 2010. However, the new species differs from the latter in having a round rostrum, dentate cuspides, lyrifissures *im* located laterally to opisthonotal gland *gla* and genital setae aligned almost in a line. The new species is distinguished from its congeners by shape of rostral region, cuspides, dorsosejugal region with long dorsophragmatic apophysis, humeral region, carina on trochantera III and IV, and solenidia of legs.

## PHENOPELOPIDAE PETRUNKEVITCH, 1955

### *Eupelops* sp.

(Figures 17 – 19)

**Diagnosis** — Prodorsal surface granulate; notogastral integument bearing irregular broken angular insular lumps; other body surface punctulate. Tutorium with sharply pointed apex, without dens. Anterior notogastral tectum broadly concave. Notogastral setae spinose bacilliform. Genito-anal setal formula: 6-1-2-2. Epimeral setal formula: 3-1-3-3. Pedipalpal setal formula: 2-1-3-9[1]. Chelicerae bearing two Trägårdh's organs. Heterotridactylous.

**Material examined** — Female (NSMT-Ac 13610) from point A. The present specimen was the other half of only two specimens collected from the point A. Some conspicuous features were remarkable to be justified as a new species, however, the specimen is described only as *Eupelops* sp. in the present work, because of being rather damaged by preparing for study (body broken..).

**Measurements and body appearance** — Body colour dark reddish-brown. Prodorsal surface granulate; granules dark, large, closely. Notogastral integument including pteromorphae covered with ornament of irregular broken angular insular lumps. Other surface, namely, lamellae, cuspidis, genital-anal plates, subcapitulum, ventral plate and legs punctulate.

**Prodorsum** — Setae *ro* (63 µm) ciliate ensiform with narrow basal portion, inserting on lateral rostral margins at base of free tip of tutorium, extending for short distance anterior of rostral margin. Tutorium with sharply pointed apex, without dens (Fig. 17C). Tips of lamellar cuspis terminating in a sharp point, anteroventrally arising lamellar setae (Fig. 17A). Setae *le* (41 µm), thick setiform with sparsely, unilaterally barbed distal portion, reaching anterior margin of rostrum. Setae *in* (157 µm) narrow phylliform, sparsely spiculate throughout length on dorsal side, smooth on ventral side (Fig. 17F). Bothridia opening dorsally. Sensilli (*ss*) (72 µm) rod-like without narrow apex, spiculate distally, smooth basally (Fig. 17D). Setae *ex* (3 µm) minute, smooth spiniform.

**Notogaster** — Anterior notogastral tectum broadly concave, projecting further anteriorly than anterior margin of movable pteromorphs, covering basal part of prodorsum (Fig. 17B). Notogastral setae bacilliform, spinose throughout their length, smooth basely, variable in length; the shortest *c* (29 – 30 µm) (Fig. 17E).

**Ventral region** — Genital (64 µm) and anal apertures (62 µm) roughly pentagonal in shape; distance (70 µm) slightly longer than length of each aperture (Fig. 18A). Genito-anal setal formula: 6-1-2-2; all setae short, smooth setiform. Setae *g<sub>1</sub>*, *g<sub>2</sub>* (9 µm) inserting at the anterior margins of plates. Setae *ag* (11 µm) inserted latero-posteriorly to genital aperture, near one tenth-distance between genital and anal apertures. Setae *an<sub>1</sub>* (7 µm) and *an<sub>2</sub>* (9 µm) inserting near posterior inner and anterior outer margin of plates, respectively. Setae *ad<sub>1</sub>* (8 µm) aligned in postanal position; *ad<sub>2</sub>* (6 µm) latero-posteriorly; *ad<sub>3</sub>* absent. Lyrifissures *iad* located along outline of aperture, posterior to the level of setae *an<sub>2</sub>*. Epimeral setal formula: 3-1-3-3; setae (9–19 µm) short, smooth setiform; *3c* the longest (Fig. 18C). Pedipalpal setal formula: 0-2-1-3-9[1]. Subcapitulum suctorial, subcapitular setae 3 pairs, *a* (24 µm), *m* (11 µm), and *h* (14 µm); all setae smooth, spiniform, terminating a fine tip (Fig. 18B). Chelicerae bearing two Trägårdh's organs (69 µm) (Fig. 18D). Setae *cha* (17 µm) thin setiform; *chb* (4 µm) smooth cone-like.

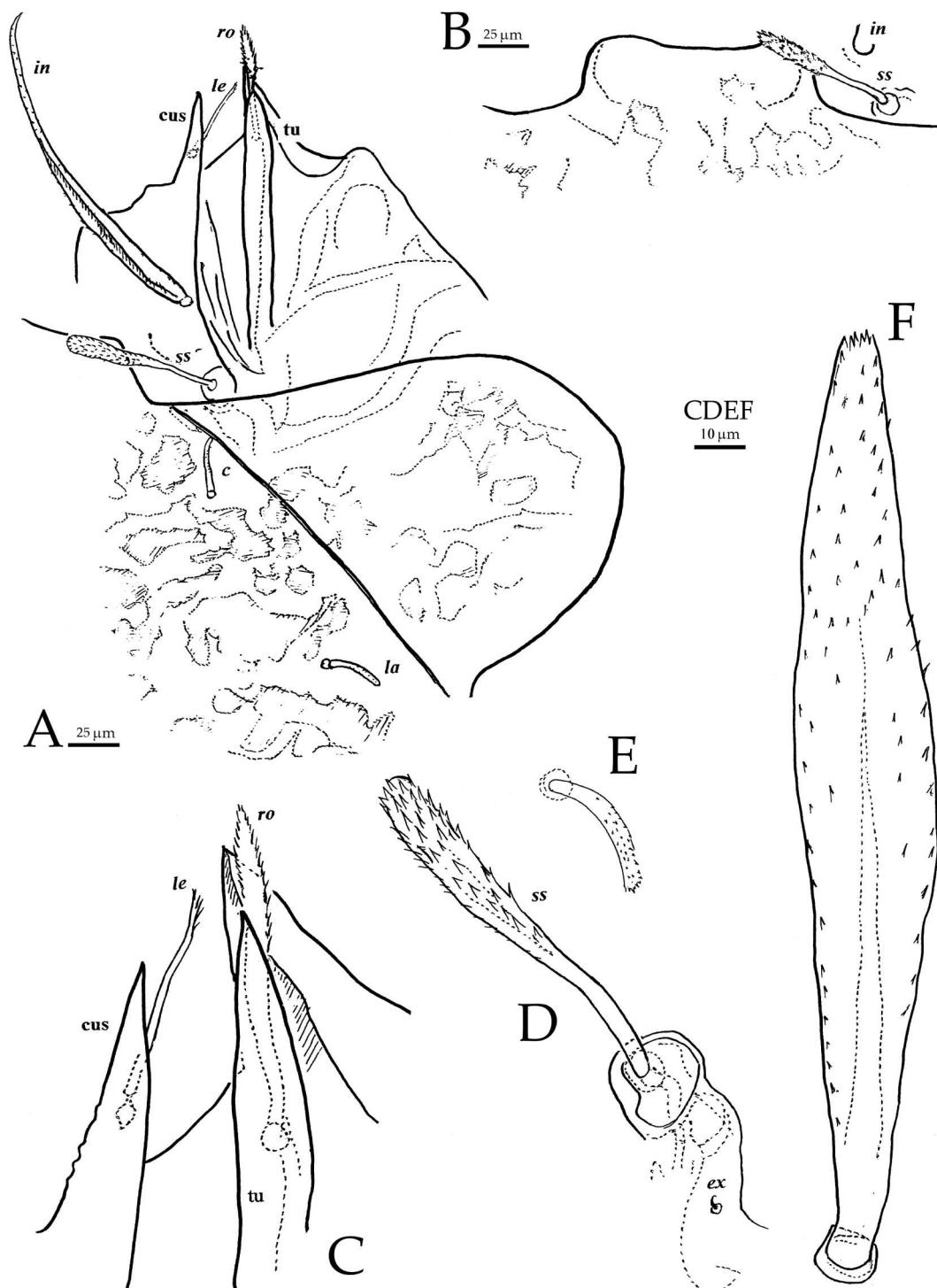


FIGURE 17: *Eupelops* sp. (NSMT-Ac 13610): A – Right pteromorphal region; B – Anterior notogastral tectum; C – Right rostral region; D – Right bothridial region; E – Notogastral seta c; F – Interlamellar seta.

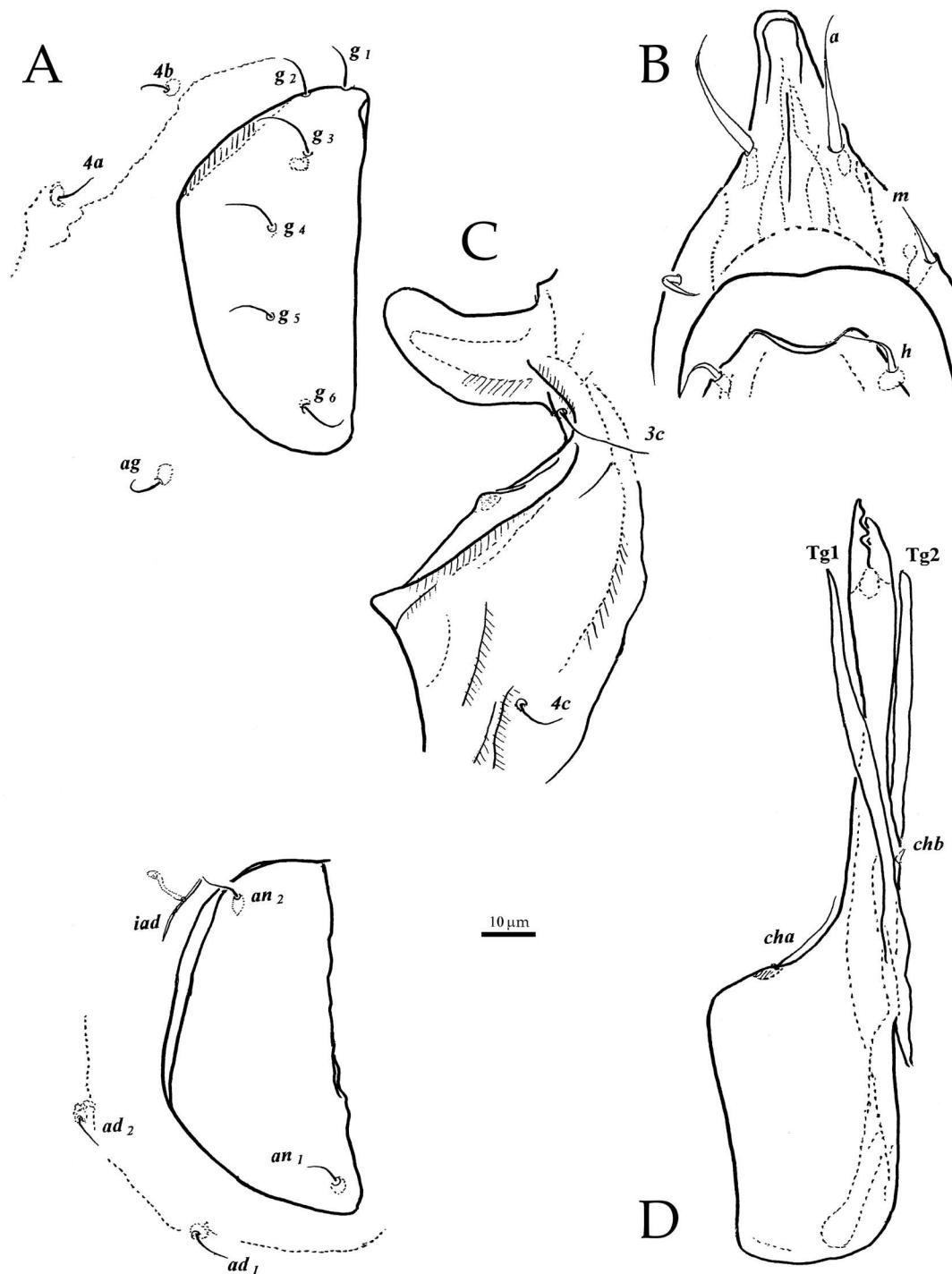


FIGURE 18: *Eupelops* sp. (NSMT-Ac 13610): A – Right genital-anal region; B – Anterior region of subcapitulum; C – Right discidium region; D – Chelicera.

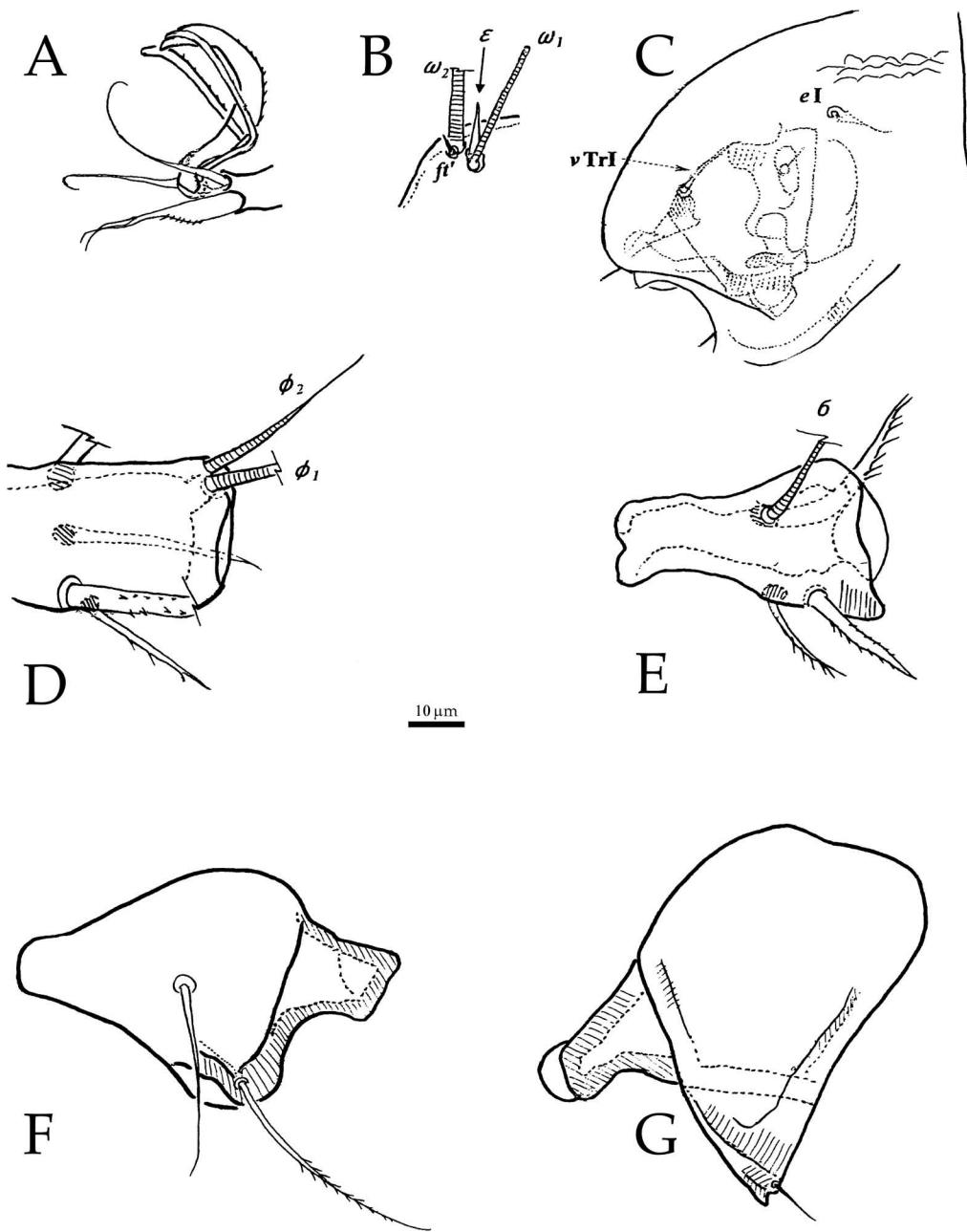


FIGURE 19: *Eupelops* sp. (NSMT-Ac 13610): A – Tip of right tarsus I; B – Solenidial region on left tarsus I; C – Suprocoxal setal region; D – Solenidial region on right tibia I; E – Right genu I; F – Right trochanter III; G – Left trochanter IV.

Legs — Heterotridactylous; claws (51  $\mu\text{m}$ ) dentate dorsally (Fig. 19A) Setal formula: I (1-5-3-4-20), II lost, III (2-3-1-3-14), IV (1-2-2-4-12). Measurements ( $\mu\text{m}$ ) of right segments: I (51-116-44-55-66), II lost, III (54-73-25-59-62), IV (56-71-43-86-71). Genu I, femur IV and trochantera III-IV bearing protrusion (Figs. 19E-G). Solenidiotaxy; I (1-2-2), II lost, III (1-1-0), IV (0-0-0), solenidion absent on tibiae IV. On tarsus I, famulus  $\varepsilon$  (15  $\mu\text{m}$ ) spiniform, contiguous to  $\omega_1$  situated anteriorly between solenidia  $\omega_1$  and  $\omega_2$ ;  $\omega_1$  (23  $\mu\text{m}$ ) bacilliform;  $\omega_2$  (45  $\mu\text{m}$ ) setiform; seta  $ft'$  (3  $\mu\text{m}$ ) minute setiform inserting posteriorly, contiguous to  $\omega_2$  (Fig. 19B). On tibia I solenidion  $\varphi_2$  (33  $\mu\text{m}$ ) situated laterally to  $\varphi_1$  (broken) at the tip (Fig. 19D). Supracoxal setae recognizable (Fig. 19C).

Remarks — The present specimen has rod-like sensilli and concave anterior tectum of the notogaster such as found in *Eupelops kumayaensis* Nakamura et al., 2010, and shape of ornament on notogastral integument such as found in *E. kumaensis* Fujikawa, 2009. However, this specimen is different from congeners in (1) shape of rostral, lamellar and chelicerae setae, (2) shape of tip of tutorium, (3) length of notogastral setae and Trägårdh's organs, (4) number of adanal setae, and (5) situation, length and shape of famulus and solenidia of legs.

## SCHELORIBATIDAE GRANDJEAN, 1933

### *Scheloribates (Scheloribates) processus* n.sp.

[Japanese name: Nobe-otohimedani]

(Figures 20 – 21)

Diagnosis — Body length 464  $\mu\text{m}$ ; width 343  $\mu\text{m}$ . Rostral tip rounded, weakly extended bending to ventral side. Prolamellae developed. Sensilli consisting of sparsely spinose, fusiform head and smooth, thin stem. Four pairs of sacculi, ten pairs of notogastral setae, five pairs of lyrifissures present on notogaster. Porose areas Ah and dosophragmata hy distinct.

Material examined — Holotype (Female) (NSMT-Ac 13629); from litter and humus at point C.

Etymology — After prolamella.

Measurements and body appearance — Body length 464  $\mu\text{m}$ ; width 343  $\mu\text{m}$ . Body colour light yellowish brown. Whole integument smooth.

Prodorsum — Rostral tip rounded, weakly extended bending to ventral side (Fig. 20B). Rostral setae (ro) (69  $\mu\text{m}$ ) inserting at lateral margins of rostrum (Fig. 20A). Lamellae convergent, extending from bothridia to about two third-way along length of prodorsum without cuspis nor translamella; setae le (84  $\mu\text{m}$ ) arising at the ending of lamellae; prolamella (14  $\mu\text{m}$ ) distinct between insertions of le and ro. Setae ro, le extending anterior of rostrum for distance equal to half of their length. Transverse ridge absent in rostral and lamellar region. Setae in (118  $\mu\text{m}$ ) extending for a short distance in front of anterior rostral margin. Setae ro, le, in, ex thin setiform, sparsely, minutely barbed throughout the length, terminating in fine tips. Sensilli (91  $\mu\text{m}$ ) consisting of sparsely spinose fusiform head and smooth thin stem. Bothridia opening dorsal-laterally; setae ex (41  $\mu\text{m}$ ) inserting laterally. Porose areae Ah large, posterior to bothridia. Relative distances, (le-in: 66  $\mu\text{m}$ ) > (le-le) = (in-in) (63  $\mu\text{m}$ ) > (ro-ro: 59  $\mu\text{m}$ ) > (anterior margin of straighten rostrum-le) (54  $\mu\text{m}$ ) > (anterior margin of straighten rostrum-ro) (45  $\mu\text{m}$ ).

Notogaster — Length as long as width; broadly triarched anteriorly, semicircular posteriorly. Dosophragmata distinct. Ten pairs of notogastral setae present; setae thin smooth, minute;  $p_1$  the longest (11  $\mu\text{m}$ ), other setae 9  $\mu\text{m}$ . Four pairs of opening minute pores of sacculi present; Sa located longitudinally laterally to la, antero-laterally to lm; S1 obliquely lateral to gla, antero-laterally to  $h_3$ ; S2 obliquely laterally to  $h_1$ ; S3 longitudinally between  $p_1$  and  $p_2$ . Lyrifissures ia aligned obliquely antero-laterally to c; im transversely or obliquely antero-laterally to gla; ih perpendicular to notogastral outline; ip and ips situated ventrally. A number of light spots arranged peripherally on notogaster.

Ventral region — Genital (59  $\mu\text{m}$  in length) and anal (91  $\mu\text{m}$  in length) apertures with distance (107  $\mu\text{m}$ ) between them, roughly circular and square, respectively (Fig. 21A). Genito-anal setal formula 4-1-2-3; all setae thin, smooth, setiform except for genital setae thin, smooth, and setiform: genital setae (21  $\mu\text{m}$ ) sparsely minutely barbed (Fig. 20C). Se-

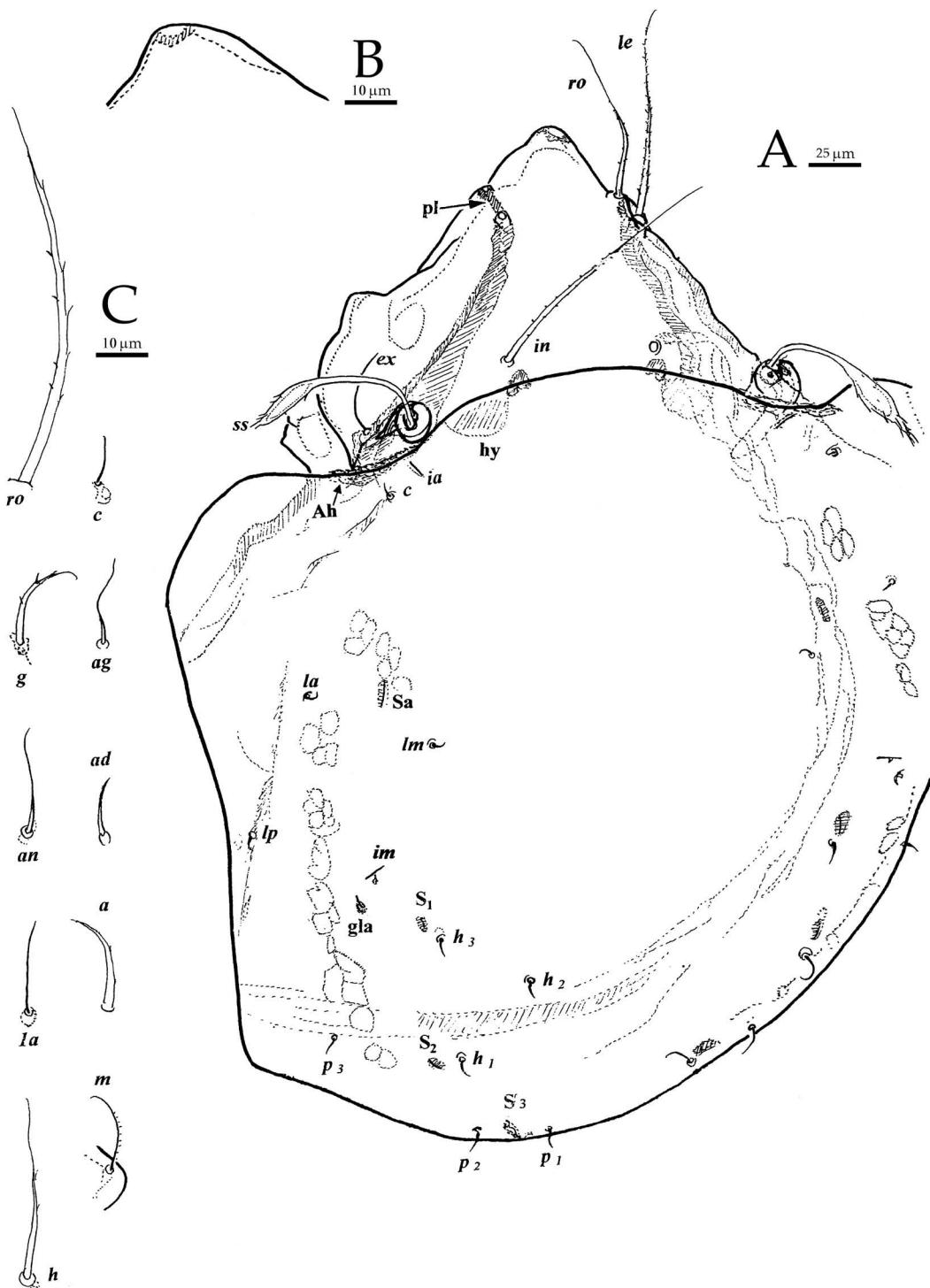


FIGURE 20: *Scheloribates (Scheloribates) processus* n.sp. (Holotype NSMT-Ac 13629): A – Dorsal view; B – Tip of rostral region; C – Principal setae: rostral seta *ro*, notogastral seta *c*, genital seta *g*, aggenital seta *ag*, anal seta *an*, adanal seta *ad*, epimeral seta *1a*, anterior *a*, medial *m*, posterior *h* subcapitular setae.

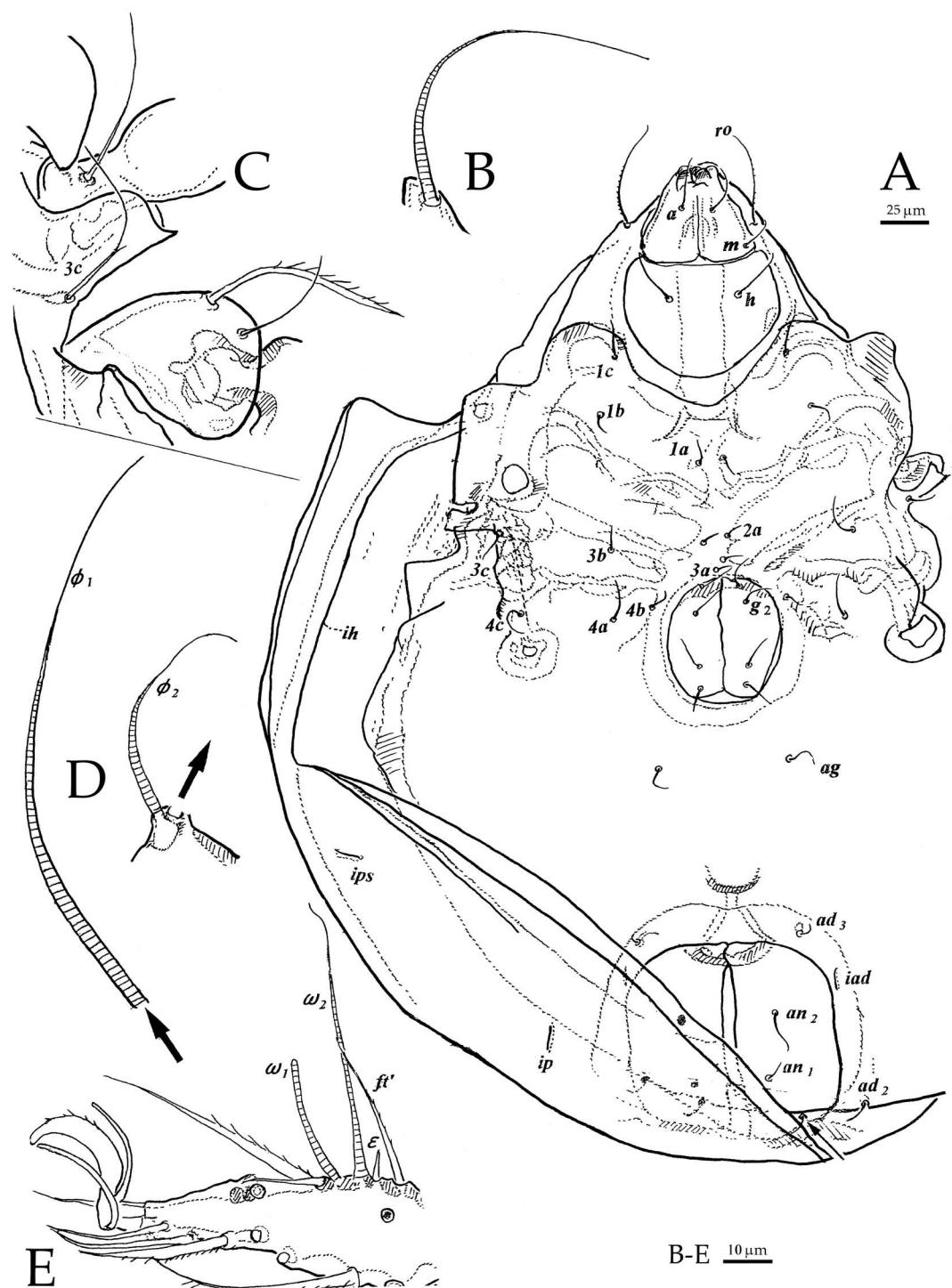


FIGURE 21: *Scheloribates (Scheloribates) processus* n.sp. (Holotype NSMT-Ac 13629): A – Ventral view; B – Solenidion on left genu I; C – Left trochanter III region; D – Solenidia on left tibia I; E – Solenidial region on right tarsus I.

tae  $g_1$  inserting at anterior margin of plates; setae  $g_4$  at posterior margins. Setae  $ag$  (17 µm) inserting latero-posteriorly to genital aperture, near one third-distance between genital and anal apertures. Setae  $an_1$  and  $an_2$  (21 µm) inserting far from posterior and anterior margins of plates, respectively. Adanal setae (12 µm)  $ad_1$  aligned in postanal position;  $ad_2$  latero-posteriorly to the aperture;  $ad_3$  in preanal. Lyrifissures  $iad$  located longitudinally at the level of mid-distance between  $an_2$  and anterior anal margin. Posterial anal locking-pieces indistinct. All epimeral borders distinct. Epimeral setal formula: 3-1-3-3; setae thin, smooth and setiform except for  $3c$ ;  $3c$  the longest (35 µm) bearing a few barbs;  $1A$  the shortest (16 µm) (Fig. 21C). Subcapitulum diarthric, subcapitular setae 3 pairs:  $a$  (21 µm) unilaterally sparsely minutely barbed;  $m$  (15 µm) and  $h$  (31 µm) minutely barbed throughout the length.

Legs — Heterotridactylous; claws (39 µm) minutely dentate dorsally. Setal formula: I (1-5-3-4-19), II (1-5-3-4-16), III (2-3-1-3-14), IV (1-2-2-2-10). Measurements (µm) of segments of legs: [Right-left]:

I([38-39]-[86-84]-[25-32]-[63-48]-[63-63]),  
II([36-32]-[86-80]-[18-21]-[48-41]-[54-52]),  
III([?-48]-[59-59]-[21-21]-[54-52]-[56-59]),  
IV([?-50]-[61-59]-[36-36]-[61-68]-[64-71]).

Femora II-IV and trochantera III-IV bearing a small rounded carina. On tarsus I, famulus  $\varepsilon$  (6 µm) spiniform, situated contiguously posterior to solenidion  $\omega_2$ ;  $\omega_2$  (54 µm) setiform posterior to  $\omega_1$ ; solenidion  $\omega_1$  (25 µm) bacilliform. Seta  $ft'$  (30 µm) unilaterally sparsely barbed setiform, inserting posterior to  $\varepsilon$  (Fig. 21E). Solenidion  $\varphi_1$  (107 µm) on tibia I situated contiguous to  $\varphi_2$  (45 µm) originating from a small apophysis (Fig. 21D). Solenidion  $\sigma$  (63 µm) originating from a small apophysis (Fig. 21B)

Remarks — The new species differs from members of the genus *Scheloribates* (*Scheloribates*) Berlese, 1908 by having weakly protruding and bending rostral tip, fusiform sensilli, prolamella, long interlamellar setae extending in front of rostral anterior margin, and famulus contiguous, posterior to setiform solenidion  $\omega_2$  and anterior to seta  $ft'$  on tarsi I. The new species resembles in the shape of rostral

tip, shape of sensilli, presence of prolamella and arrangement of famulus and solenidia such as found in *S. (S.) azumaensis* Enami *et al.*, 1996, however, the former is different from the latter in shape of rostral extension, length of interlamellar setae, and distance of famulus and  $\omega_2$ . The new species is similar to *S. (S.) shigeruus* Fujikawa, 2011 in shape of prolamella and length of interlamellar setae, however, the former is different from the latter in shape of tip of rostrum, shape of sensilli, and arrangement of solenidia and famulus on tarsi I.

## GALUMNIDAE JACOT, 1925

### *Trichogalumna trowella* n.sp.

[Japanese name: Hana-furisodedani]

(Figures 22 – 23)

Diagnosis — Body length 321 µm; width 250 µm. Pteromorphae lineate; other integument of body smooth. Rostrum broadly rounded with rostral trowel. Setae  $ro$ ,  $le$  and  $in$  short. Sensilli fusiform, composed barbed head and thin, smooth stem. Ten pairs of short notogastral setae, four pairs of porose areas, five pairs of lyrifissures present. Movable pteromorphs bearing short furrow,  $c$  and  $ia$ . Pteromorphae notch distinct. Dorsophragmatic apophysis ( $hy$ ) small circular in shape. Genito-anal setal formula: 6-1-2-3. Epimeral setal formula: 3-0-3-3. Heterotridactyl Subcapitulum diarthric, subcapitular setae.

Material examined — Holotype (Female) (NSMT-Ac 13628) from litter and humus at the point C.

Etymology — After rostral trowel.

Measurements and body appearance — Body length 321 µm; width 250 µm. Body colour light brown. Integument on pteromorphae lineate; other body surface punctulate.

Prodorsum — Rostral tip broadly rounded with rostral trowel (Fig. 22A). Setae  $ro$  (21 µm) thin, short, smooth setiform, inserting on lateral margins of rostrum, not reaching rostral tip. Lamellar and sublamellar lines near each other actuate, parallel. Setae  $le$  (39 µm) short, setiform, minutely barbed through the length, inserting between lines L and L,

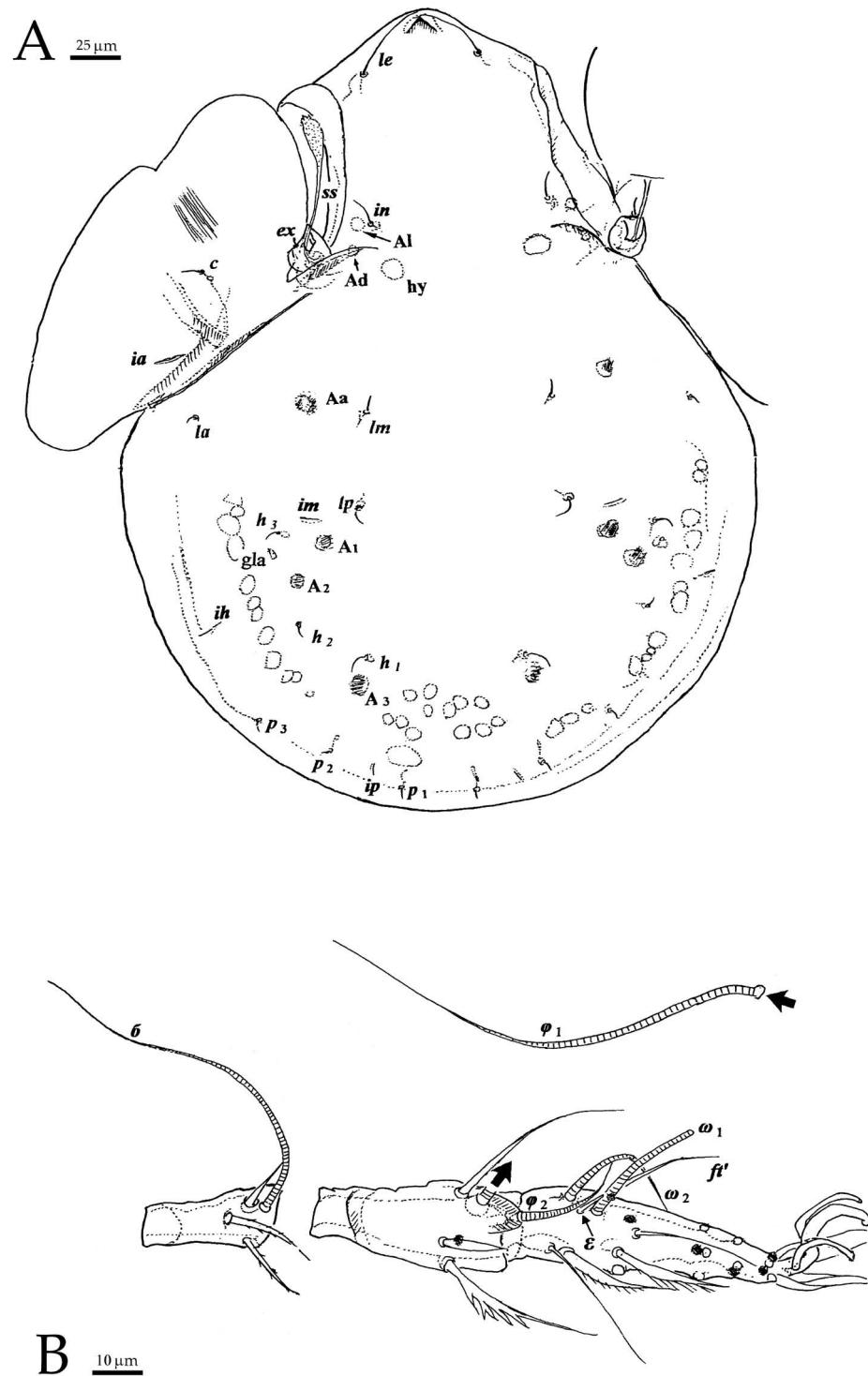


FIGURE 22: *Trichogalumna trowella* n.sp. (Holotype NSMT-Ac 13628): A – Dorsal view; B – Solenidial region of left leg I.

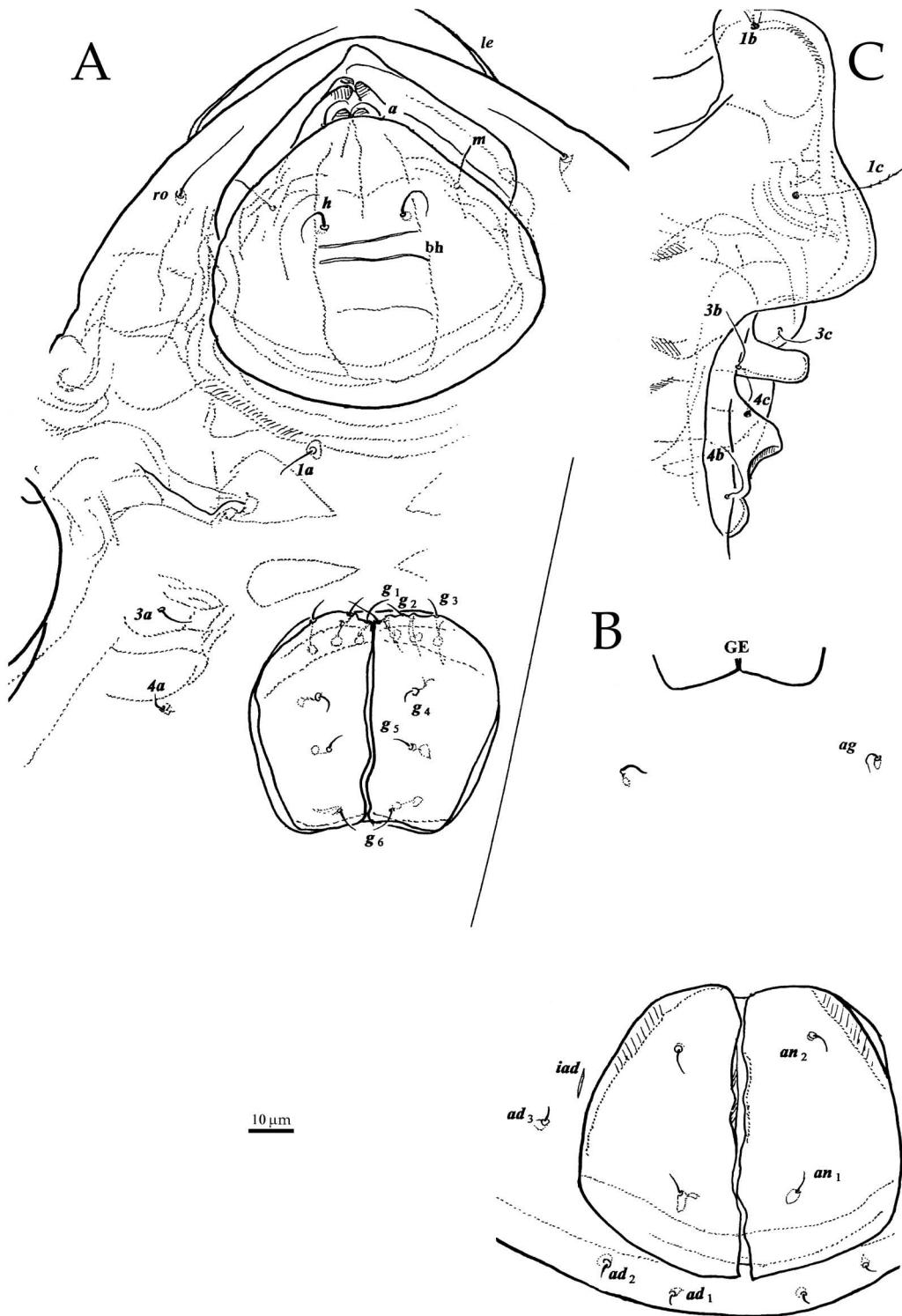


FIGURE 23: *Trichogalumna trowella* n.sp. (Holotype NSMT-Ac 13628): A – Anterior region of ventral side; B – Posterior region of ventral side; C – Left lateral side of epimerata.

extending for a short distance in front of rostral tip. Setae *in* (12  $\mu\text{m}$ ) short, thin, smooth setiform. Bothridia opening dorso-laterally. Sensilli (*ss*) (66  $\mu\text{m}$ ) composed of thin, long, smooth stem and expanded fusiform head bearing sparsely spicules. Setae *ex* (4  $\mu\text{m}$ ) short, smooth, setiform.

**Notogaster** — Ten pairs of short notogastral setae (4  $\mu\text{m}$ ), six pairs of porose areas, five pairs of lyrifissures present. Anterior notogastral margin absent. Movable pteromorphs bearing short furrow, *c* and *ia*; pteromorphal notch distinct. Dorsophragmatic apophysis (*hy*) small circle. Porose areas (major axis, minor axis:  $\mu\text{m}$ ) *A1* (9,8) located outer lateral to insertion of *in*; *Ad* (9,6) posterior to *A1*; *Aa* (9,6) outer lateral to *lm*; *A1* (6,5) latero-posteriorly to *lp* or *im*; *A2* (7,6) latero-posteriorly to *A1* or *gla*; *A3* (9,6) posterior to *h<sub>1</sub>*. Distance between *A1* and *A2* about one-third as long as that between *A2* and *A3*. Lyrifissures *ia* on pteromorphae aligned almost parallel to the joint line between pteromorpha and notogaster; *im* transversely latero-posteriorly to *lp*; *ih*, *ip* perpendicular to notogastral outline; *ip* between *p1* and *p2*; *?ips* between *p2* and *p3*. Opening *gla* situated posterior to *h<sub>3</sub>*. Relative distances: (*lp-lp*: 38  $\mu\text{m}$ ) > (*lm-lm*: 34  $\mu\text{m}$ ) > (*h<sub>1</sub>-h<sub>1</sub>*: 29  $\mu\text{m}$ ) > (*p<sub>1</sub>-p<sub>1</sub>*: 14  $\mu\text{m}$ ).

**Ventral region** — Genital (45  $\mu\text{m}$  in length) and anal (62  $\mu\text{m}$  in length) apertures almost trapezoid length of anal aperture slightly shorter than distance (66  $\mu\text{m}$ ) between genital and anal apertures (Figs. 23A-B). Genito-anal setal formula: 6-1-2-3; all setae short, thin, smooth setiform. Setae *g<sub>1</sub>* - *g<sub>3</sub>* (9  $\mu\text{m}$ ) aligned at the anterior margin of the plates; other setae longitudinally in a row at the medial portion of the plates. Setae *ag* (7  $\mu\text{m}$ ) inserting posterior-lateral to genital aperture. Anal setae (5  $\mu\text{m}$ ) inserting far from anterior margin of anal plates. Setae *ad<sub>1</sub>* and *ad<sub>2</sub>* (4  $\mu\text{m}$ ) aligned in postanal position; *ad<sub>3</sub>* in adanal, at the level of almost mid-distance along the anal aperture. Lyrifissures *iad* located longitudinally, antero-laterally to *ad<sub>3</sub>*. Epimeral borders short. Epimeral setal formula: 3-0-3-3; setae short, thin, smooth setiform; *1b* (4  $\mu\text{m}$ ) the shortest, *1c* (24  $\mu\text{m}$ ) the longest (Fig. 23C). Subcapitulum bearing 3 pairs of setae; setae short, setiform; *a* (0.7  $\mu\text{m}$ ), *m* (11  $\mu\text{m}$ ) sparsely, minutely

barbed; *h* (14  $\mu\text{m}$ ) roughened.

**Legs** — Heterotridactyl; claws (23  $\mu\text{m}$ ) minutely dentate. Setal formula: I (1-5-3-4-19), II (1-4-3-4-16), III (2-3-1-3-15), IV (1-2-2-3-12). Measurements ( $\mu\text{m}$ ) of segments of left legs: I (25-46-25-39-55), II (31-75-21-25-36), III (49-45-16-36-39), IV (54-43-17-43-46). On tarsus I (Fig. 22B), famulus *ε* (6  $\mu\text{m}$ ) obtuse, situated posterior to solenidia *ω<sub>1</sub>*; *ω<sub>1</sub>* (24  $\mu\text{m}$ ) bacilliform; *ω<sub>2</sub>* (29  $\mu\text{m}$ ) setiform, situated latero-posterior to *ω<sub>1</sub>*; *ft'* (31  $\mu\text{m}$ ) smooth, setiform, inserting just lateral to *ω<sub>1</sub>*. On tibia I, solenidia *φ<sub>1</sub>* (86  $\mu\text{m}$ ), *φ<sub>2</sub>* (23  $\mu\text{m}$ ) setiform situated at anterior portion of the segment; *φ<sub>2</sub>* originating from a small apophysis; dorsal seta (34  $\mu\text{m}$ ) smooth setiform, inserting contiguous to *φ<sub>1</sub>*. On genu I, *σ* (69  $\mu\text{m}$ ) longer than seta *d* (11  $\mu\text{m}$ ).

**Remarks** — The new species is very similar to *Trichogalumna chimaera* Ohkubo, 1984 in ornamentation of the pteromorphal integument, length of rostral and interlamellar setae, shape of sensilli and insertion of genital-anal setae. However, the former is different from the latter in having a round rostrum with rostral trowel, and the body surface is punctulate except for pteromorphae.

#### ACKNOWLEDGEMENTS

The authors wish to acknowledge their indebtedness to Mr. Rokuro Ebeshu of Matsushima-cho who kindly gave one of the authors the story of his experiences on Tsunami on March 11, 2011, and valuable suggestion to add to geographical and botanical knowledge, and kindness in allowing her the sampling. The authors wish to express their sincere thanks to Dr. Yoshiro Ohgi and Dr. Tomohiro Shiroasaki of Kumamoto Industrial Research Institute for making the photographs of the Scanning Electronic Microscope; to Miyagi Meteorological Observatory, Japan Meteorological Agency, and Geospatial Information Authority of Japan for their valuable suggestion about meteorological and geographical information. They are greatly indebted to Dr. A. S. Baker, Dr. B. E. Brewster and Dr. K. H. Hyatt of the British Museum (Nat. His.), London who kindly allowed one of authors the study of type specimens in the Michael's collection, and

to Dr. H. Ono allowed her the study of type specimens in the National Museum of Nature and Science, Tokyo's collection, and to Emeritus Prof. Dr. Yoshio Nakamura of his kindly help and encouragement for sampling and making photographs.

## REFERENCES

- Al-Assiuty A.I., Bayoumi B.M., Abdel-Hamid M.E., Khalil M.A. 1988 — Three new oribatid mite species from soils at Sinai and Quena-Egypt — *Delta J. Sci.*, 12(4): 1744-1760.
- Aoki J. 1980 — Cryptostigmata. In: S. Ehara S., ed.: Illustrations of the mites and ticks of Japan: 398-489 — Zenkoku Nōson Kyōiku Kyōkai. (In Japanese)
- Badejo M.A., Woas S., Beck L. 2002 — Redescription of *Archegozetes magnus* (Sellnick, 1925) (Trhypochthonioidea) from Brazil and description of two new species of nanhermanniid mites: *Bicyrthermannia nigeriana* and *Masthermannia seropedica* (Nanhermannioidea) (Acari: Oribatida) — *Genus*, 14(1): 125-149.
- Balogh J. 1958 — Oribatides nouvelles de l'Afrique tropicale — *Rev. Zool. Bot. Afr.*, 58(1-2): 1-34.
- Balogh J. 1961 — Identification keys of world oribatid (Acari) families and genera. — *Acta Zoologica Academiae Scientiarum Hungaricae*, 7 (3-4): 243-344.
- Balogh J., Mahunka S. 1983 — Primitive oribatid genera of the Palaearctic region — Elsevier Science Publishers B. Amsterdam, The Netherlands and Akadémiai Kiado, The Publishing House of the Hungarian Academy of Sciences, Budapest. Hungary. pp. 372.
- Berlese A. 1896 — Acari, Myriapoda et Scorpiones hucusque in Italia reperta, Padova. Ordo Cryptostigmata (Oribatidae). fasc., 78(6), tav. 25 — Portici Sumptibus Auctoris (Annis 1882-1896).
- Berlese A. 1903(1904) — Spicilegia Zoologica. Acari Nuovi — *Redia*, 1: 235-252.
- Berlese A. 1904 — Acari Nuovi. Manipulus II — *Redia*, 1: 258-280.
- Berlese A. 1913 — Acari nuovi. Manipoli VII-VIII — *Redia*, 9: 77-111, pls.1-8.
- Enami Y., Nakamura Y., Katsumata H. 1996 — A new species of the genus *Scheloribates* (Acari: Oribatei) from a crop field in Fukushima, North of Japan — *Edaphologia*, No. 56: 11-16.
- Franklin E.N., Guimarães R.L., Adis J., Schubart H.O.R. 2001 — Resistência à submersão de Ácaros (Acari: Oribatida) terrestres de florestas inundáveis e de terra firme na Amazônia Central em condições experimentais de laboratório — *Acta Amazonica*, 31(2): 285-298.
- Fujikawa T. 1995 — Oribatid mites from *Picea glehnii* forest at Mo-Ashoro, Hokkaido. (11) A new species of the family Trhypochthoniidae — *Edaphologia*, (53): 1-6.
- Fujikawa T. 1999 — Individual variations of two reared oribatid species, *Tectocepeheus velatus* (Michael, 1880) and *Oppiella nova* (Oudemans, 1902) — *Edaphologia*, (62): 11-46.
- Fujikawa T. 2000 — Five new species of the genera *Trhypochthoniellus* and *Trhypochthonius* — *Edaphologia*, (65): 35-53.
- Fujikawa T. 2006 — Oribatid mites (Acari, Oribatida) from World Cultural Heritage Area in Miyajima, Japan — *Edaphologia*, (80): 1-24.
- Fujikawa T. 2009 — A new species of Phenopelopidae (Acari, Oribatida) from South Japan — *Edaphologia*, (85): 1-6.
- Fujikawa T. 2011 — Three new species of oribatid mites (Acari, Oribatida) from Itsuki Village, South Japan — *Edaphologia*, (89): 1-12.
- Grandjean F. 1940 — Observations sur les Oribates (13<sup>e</sup> série) — *Bull. Mus. nat. Hist. natur.* (2)12: 62-69.
- Grandjean F. 1954a — Étude sur les Palaeacaroïdes (Acariens, Oribates) — *Mém. Mus. Nat. Hist. Natur. Sér. A, Zool.*, 7(3): 179-272.
- Grandjean F. 1954b — *Posthermannia nematophora* n.g., n.sp, [Acarien, Oribate] — *Rev. franç. Ent.*, 21: 298-311.
- Halbert, J.N. 1915 — Clare Island Survey Part 39. Acarinida. Section II. Terrestrial and marine Acarina. *Proc. R. Irish Acad.* 39(2): 45-136.
- Halbert J.N. 1920 — VII. The Acarina of the seashore — *Proc. R. Irish Acad.*, 31: 106-152, pls. XXI-XXIII.
- Hammen L. van der 1980 — Glossary of acarological terminology (Glossaire de la terminologie acarologique) Vol. 1 General terminology — Rijksmuseum van Natuurlijke Historie, Leiden. Dr. W. Junk B. V. Publishers, The Hague. pp. 244.
- Hammen L. van der 1989 — An introduction to comparative Arachnology — SPB Academic Publishing bv, pp. 576.
- Hammer M. 1961 — Investigations on the oribatid fauna of the Andes Mountains II. Peru — *Biol. Skr. Dan. Vid. Selsk.*, 13 (1): 1-157, pls. I-XLIII.
- Hartman A.G. 1949 — A new species of *Nanhermannia* with notes on the genus (Acarina, Oribatoidea, Nanhermanniidae) — *Proc. Ent. Soc. Wash.*, 51(4): 169-171.
- Laumann M., Norton R.A., Weigmann G., Scheu S., Maraun M., Heethoff M. 2007 — Speciation in the parthenogenetic oribatid mite genus *Tectocepeheus* (Acari, Oribatida) as indicated by molecular phylogeny — *Pedobiologia*, 51: 111-122.  
[doi:10.1016/j.pedobi.2007.02.001](https://doi.org/10.1016/j.pedobi.2007.02.001)

Mahunka S. 2009 — Oribatids from Madagascar IV (Acari: Oribatida) — Rev. Suisse Zool., 116 (3-4): 337-352.

Mahunka S., Zombori L. 1985 — The variability of some morphological features in Oribatid mites — Folia Entomologica Hungarica Rovartani Közlemények, 46(1): 115-128.

Michael A.D. 1880 — A further contribution to the knowledge of British Oribatidae. (Part II.) — Journ.R. Micr. Soc. Trans. Soc., III (5): 177-201, pls. 5 & 6.

Nakamura Y.-N., Fukumori S., Fujikawa T. 2010 — Oribatid fauna (Acari, Oribatida) from the Kumaya Cave of Iheya village in Central Ryukyu Arc, South Japan, with a description of several new species — Acarologia, 50 (4): 439-477. doi:[10.1051/acarologia/20101988](https://doi.org/10.1051/acarologia/20101988)

Norton R.A., Behan-Pelletier V. M. 2009 — Suborder Oribatida. In Krantz G. W., Walter D. E. (Eds.) (2009): A manual of Acarology -3rd edition. —Texas Tech. University Press: 430-564.

Nübel-Reidelbach E. 1994 — Taxonomie und Systematik der Gattung *Tectocepheus* Berlese, 1895 (Acari, Oribatei) — Aandrias, Staatliches Museum für Naturkunde Karlsruhe, 12: 3-94.

Ohkubo N. 1984 — Several species of *Trichogalumna* (Acarina, Oribatida) from Japan — Acarologia, 25 (3): 293-306.

Pérez-Iñigo C., Baggio D. 1988 — Oribates édaphiques du Brésil (IV) Oribates de l'état de São Paulo (Première partie) — Acarologia, 29 (2): 189-204.

Sellnick M. 1959 — Acarina from Southeastern Polynesia-II (Oribatidae) — Occasional Papers Bernice P. Bishop Museum Honolulu, Hawaii, 22(9): 109-152.

Subías L.S. 2004 — Listado Sistemático, sinonímico y Biogeográfico de los Ácaros Oribatidos (Acariformes, Oribátida) del Mundo (1758-2002) — Graellsia, 60 (número extraordinario): 3-305.

[10.3989/graellsia.2004.v60.iExtra](https://doi.org/10.3989/graellsia.2004.v60.iExtra)

Szywilewska A. 2004 — *Trhypochthonius semovitus* sp. nov. (Acari: Oribatida: Malacothroidea) from Central Europe — Annales Zoologici (Warszawa), 54(4): 803-806.

Weigmann G. 1997 — New and old species of Malacothroidea from Europe — Spixiana, 20(3): 199-218.

Weigmann G. 2006 — Hornmilben (Oribatida) — Die Tierwelt Deutschlands Begründet 1925 von Friedrich Dahl 76. Teil Goecke & Evers, Keltern, pp. 520.

## COPYRIGHT

 Nakamura K. et al. Acarologia is under free license. This open-access article is distributed under the terms of the Creative Commons-BY-NC-ND which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.