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Contribution to the knowledge of carabodid oribatid mites (Acari, Oribatida, Carabodidae) of Cuba

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ABSTRACT — Two new species of oribatid mites of the family Carabodidae are described from leaf litter in forest of Cayo Santa Maria, Cuba. *Carabodes paravenezolanus* **n. sp.** is morphologically most similar to *C. venezolanus* Subías and Arillo, 2004, but it differs from the latter by the convex notogaster, bothridial setae with clear, flattened heads, notogaster without tubercles and epimere I with three pairs of setae. *Gymnobodes minimus* **n. sp.** is morphologically most similar to *G. fraterculus* (Balogh, 1963) and *G. subnudus* (Balogh, 1963), but it differs from both by the centro-dorsal part of notogaster with strong, well separated tubercles. An identification key to known species of *Gymnobodes* is given. The genus *Gymnobodes* is recorded for the first time in the Neotropical region. The genus *Kalloia* and the species *Kalloia simpliseta* Mahunka, 1985 are recorded for the first time in Cuban fauna.

KEYWORDS — oribatid mites; Carabodidae; new species; morphology; systematics; key; record; fauna; Cuba

INTRODUCTION

This work is a part of our continuing study of the Cuban fauna of oribatid mites (see Ermilov and Tolstikov 2015), and includes the data on the family Carabodidae (Acari, Oribatida).

At present, carabodid mites of Cuba are poorly known, and only relatively few representatives from the genera *Carabodes* Koch, 1935 and *Cubabodes* Balogh and Mahunka, 1974 were registered (Balogh and Mahunka 1974, 1979, 1980; Socarrás and Palacios-Vargas 1999).

During taxonomic identification of material from Cuba we found three species of Carabodidae; two are new for science, belonging to the genera *Carabodes* and *Gymnobodes* Balogh, 1965.

Carabodes is a large genus, comprising more than 130 species (see different opinions on included taxa in Mahunka 1986; Balogh and Balogh 2002; Shtanchaeva 2004; Subías 2004, online version 2015; Weigmann 2006), which have a cosmopolitan distribution (Subías 2004, online version 2015). The main generic traits were summarized by Reeves and Behan-Pelletier (1998). The identification keys to selective species of *Carabodes* were summarized by Bulanova-Zachvatkina (1975), Reeves and Behan-Pelletier (1998), Balogh and Balogh (2002), Weigmann (2006) and Bayartogtokh (2010).

Gymnobodes is a small genus, comprising three known species, which are distributed in the Ethiopian region and Borneo (Balogh 1963; Mahunka 1996). Hence, it is recorded for the first time in the Neotropical region. The main generic traits were summarized by Balogh (1965)

and Mahunka (1986). Below, we provide an identification key for all known species of *Gymnobodes*.

The main goal of the paper is to describe and illustrate two new species, to compare them with closely related species, and to present data on the new findings of carabodid taxa in Cuba.

MATERIALS AND METHODS

Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. The body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers (μm). Formulas for leg setation are given in parentheses according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulas for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus. General terminology used in this paper follows that of Grandjean (summarized by Norton and Behan-Pelletier 2009). Drawings were made with a drawing tube using a Carl Zeiss transmission light microscope "Axioskop-2 Plus". Images were obtained with an AxioCam ICc3 camera using a Carl Zeiss transmission light microscope "Axio Lab.A1". The collection locality and habitat for each species are given in the respective "Material examined" section.

Carabodes paravenezolanus n. sp. (Figures 1-4)

Diagnosis — Body size: 431 – 547 × 232 – 315. Dorsal side and anogenital part with specific cerotegument consisting from the knob-like base and strong barbs. Lamellae narrowed distally. Rostral and lamellar setae narrowly phylliform, barbed. Interlamellar, notogastral and adanal setae spoon-like, barbed. Bothridial setae long, with short, flattened, barbed head. Tutoria triangular. Epimeral setae setiform, barbed, *1c* longest. Genital and aggenital setae setiform, barbed. Adanal lyrifissures in inverse apoanal position.

Description — *Measurements*. Body length: 481 (holotype, male), 431 – 547 (23 paratypes: 11 females and 12 males); notogaster width: 265 (holotype), 232 – 315 (23 paratypes).

Integument (Figs 1A-D; 4A, B, D-F) — Body grey to brown. Dorsal side (except rostrum) and anogenital part covered by dense, specific cerotegumental structures consisting from the knob-like base (diameter up to 6) and one to six strong barbs. Rostrum covered by small cerotegumental tubercles. Lateral sides of prodorsum, subcapitular mentum, epimeral region and legs covered by dense, conical cerotegumental granules. Subcapitular mentum, genital and anal plates with foveolae (diameter up to 6).

Prodorsum (Figs 1A, C, D; 4C) — Rostrum rounded. Lamellae narrowed distally. Translamella not developed. Rostral setae (*ro*, 24 – 36) hardly narrowly phylliform, barbed, inserted on prodorsum, nearly to distal parts of lamellae. Lamellar setae (*le*, 32 – 36) well narrowly phylliform, barbed, inserted on lamellae. Interlamellar setae (*in*, 32 – 41) spoon-like, barbed, inserted on prodorsum. Bothridial setae (*bs*, 65 – 69) with long, slightly barbed stalk and small, flattened head covered by barbs and ribs, directed laterally. Exobothridial setae and their alveoli absent. Tutoria (*tu*) long, with triangular tip.

Notogaster (Figs 1A, B, D; 4D) — Prodorsum and notogaster separated by slightly developed, narrow hollow. Anterior notogastral margin slightly convex medially. Humeral shoulders distinctly visible, rounded anteriorly. Ten pairs of notogastral setae similar in length (24 – 28), spoon-like, barbed. Lyrifissures and opisthonotal gland openings not found under the cerotegumental layer.

Gnathosoma (Figs 2A-C) — Subcapitulum longer than wide (102 – 118 × 90 – 102). Subcapitular setae *a* (20) thickened, sparse barbed, with attenuate tip; *h* (12) setiform, barbed; *m* (12) thinnest, setiform, barbed. Postpalpal setae *e* (6) spiniform. Adoral setae absent. Palps (61 – 65) with setation 0-2-1-3-8(+ω). Solenidion of palptarsi thickened, blunt-ended, pressed to their surface. Chelicerae (110 – 118) with two setiform, barbed setae; *cha* (41) longer than *chb* (16). Trägårdh's organ (Tg) tapered, rounded distally.

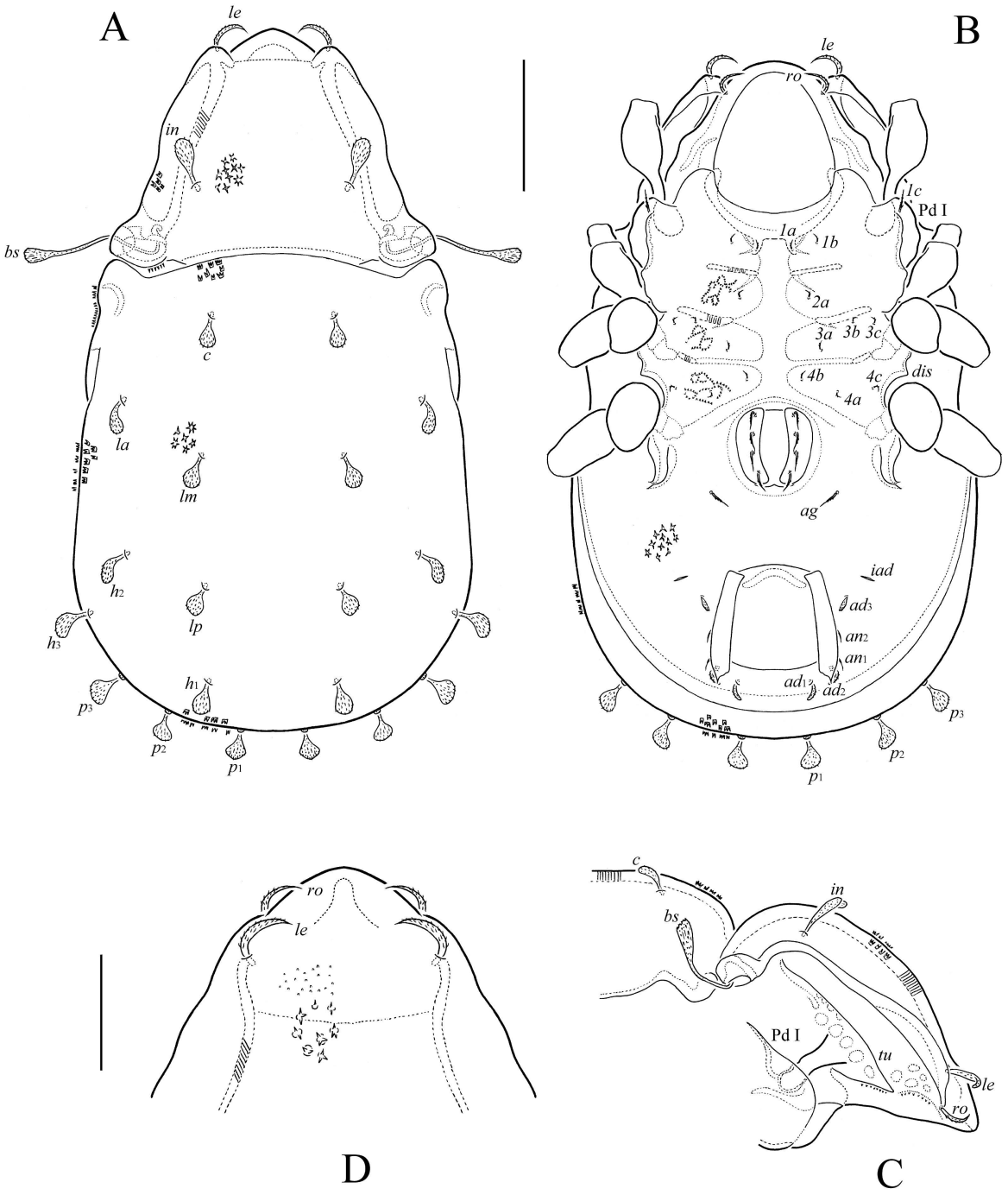

FIGURE 1: *Carabodes paravenezolanus* **n. sp.**: A – dorsal view; B – ventral view (gnathosoma and legs except basal parts not illustrated); C – anterior part of body, lateral view (gnathosoma and leg I except basal part not illustrated); D – rostrum, dorso-frontal view. Scale bar (A-C) 100 μm, scale bar (D) 50 μm.

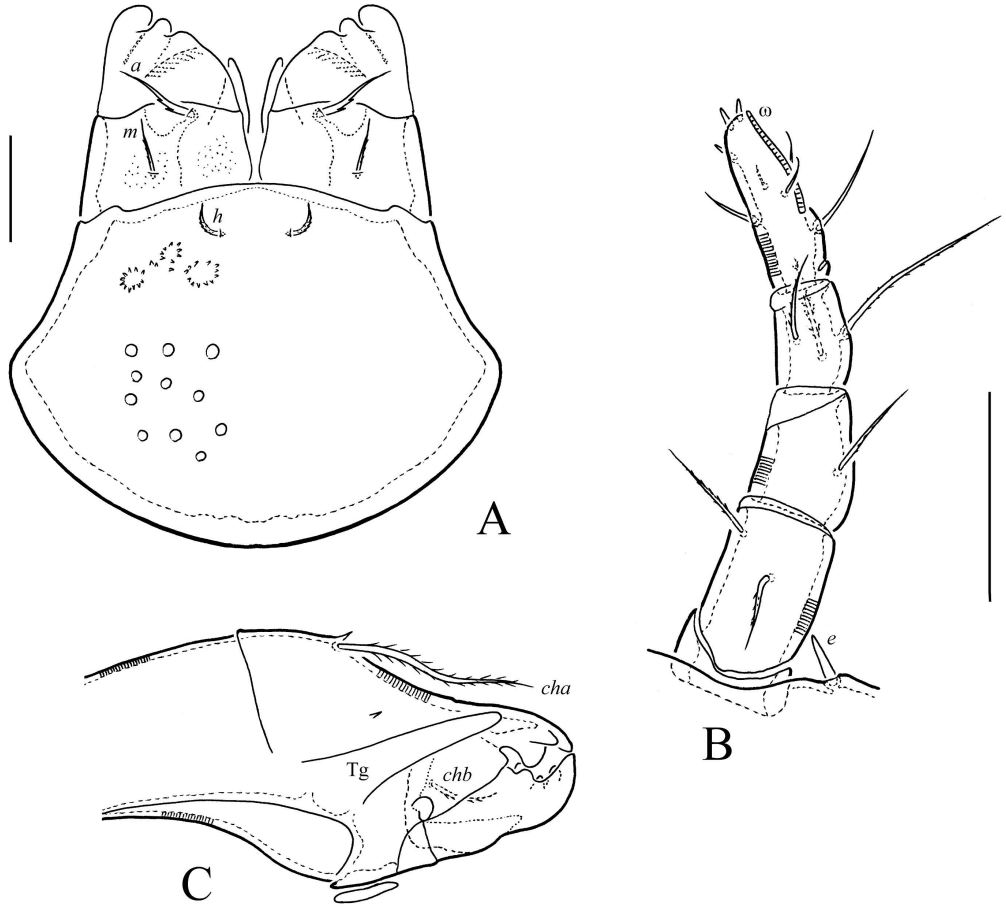

FIGURE 2: *Carabodes paravenezolanus* **n. sp.**: A – subcapitulum, ventral view; B – palp, left, antiaxial view; C – chelicera, left, paraxial view. Scale bars (A, B) 20 μm.

Epimeral and lateral podosomal regions (Fig. 1B) — Epimeral setal formula 3-1-3-3. Epimeral setae setiform, barbed; *1c* (20 – 24) thicker and longer than others (10 – 12). Pedotecta I (Pd I) large, broadly scale-like (in lateral view); pedotecta II slightly developed. Discidia (*dis*) small, triangular, blunt distally.

Anogenital region (Figs 1B; 4E, F) — Four pairs of genital (g_1-g_4) and one pair of aggenital (*ag*) setae similar in length (20), setiform, barbed. Two pairs of anal setae (an_1, an_2, 10 – 12) setiform, smooth. Three pairs of adanal setae (ad_1-ad_3, 14 – 16) spoon-like, barbed. Adanal lyrifissures (*iad*) clearly visible, located in inverse apoanal position.

Legs (Figs 3A-D; 4G) — Claw of each leg serrate dorsally and with ventral barb. Porose areas of femora and trochanters III, IV present, but visible only in dissected specimens. Formulas of leg setation and solenidia: I (1-4-3-4-15) [1-2-2], II (1-4-3-3-15) [1-1-2], III (2-3-1-2-15) [1-1-0], IV (1-2-2-2-11) [0-1-0]; homology of setae and solenidia indicated in Table 1. Famuli short, straight, blunt-ended. Solenidia φ_1 on tibiae I very long, setiform; ω_1 on tarsi I of medium size, directed forward, ω_1 and ω_2 on tarsi II short, all thickened, blunt-ended; σ on genua III, φ on tibiae II-IV, short, finger-like, often dilated in

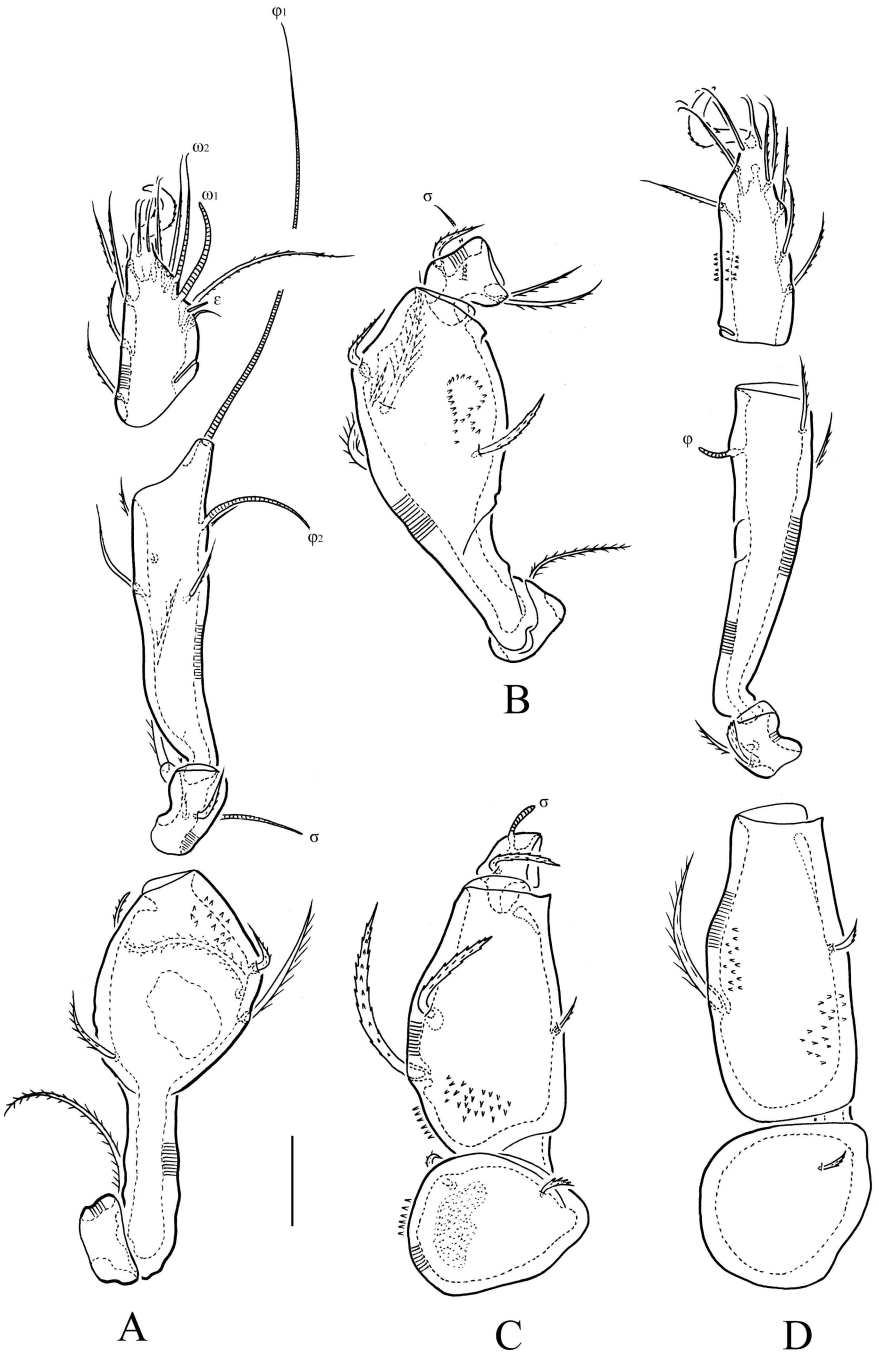

FIGURE 3: *Carabodes paravenezolanus* **n. sp.**: A – leg I, left, antiaxial view; B – trochanter, femur and genu of leg II, right, antiaxial view; C – trochanter, femur and genu of leg III, left, antiaxial view; D – leg IV, left, antiaxial view. Scale bar 20 μm.

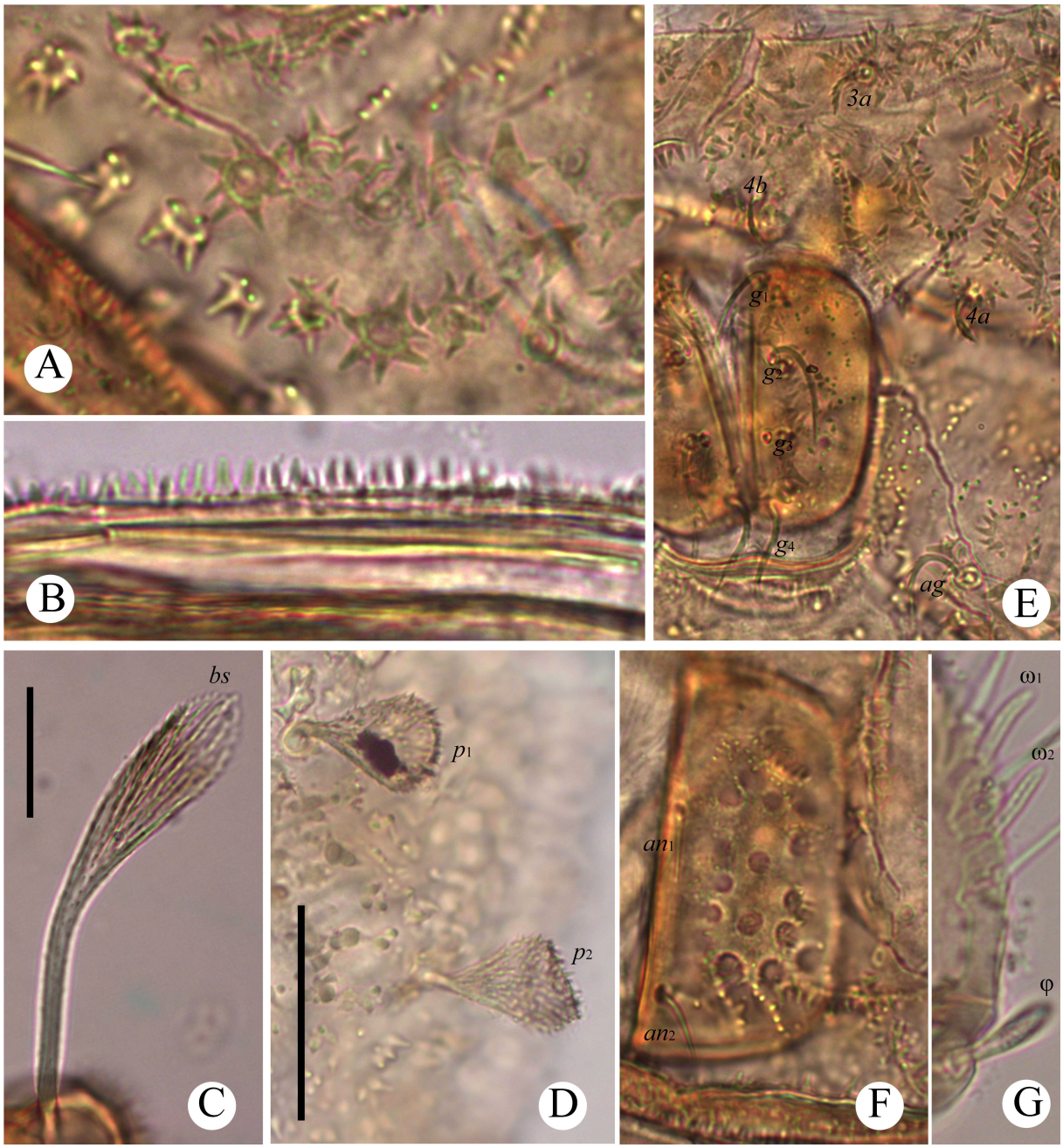

FIGURE 4: *Carabodes paravenezolanus* **n. sp.**, microscope images in dissected specimen: A – cerotegument in adanal region, dorsal view; B – cerotegument of notogaster, lateral view; C – bothridial seta; D – notogastral setae p_1 and p_2; E – left genital plate and part of epimeral region; F – left anal plate; G – solenidia on tibia and tarsus of leg II. Scale bars (A, B, G and C-F) 20 μm(A, B, G) 100 μm, scale bar (D) 50 μm.

TABLE 1: Leg setation and solenidia of *Carabodes paravenezolanus* **n. sp.** (same data for *Gymnobodes minimus* **n. sp.**)

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	*v′*	*d, (l), bv′′*	*(l), v′,* σ	*(l), (v),* φ_1, φ_2	*(ft), (tc)*, (it), (p), (u), (a), s, (pv),* ε, ω_1, ω_2
II	*v′*	*d, (l), bv′′*	*(l), v′,* σ	*l′, (v),* φ	*(ft), (tc), (it), (p), (u), (a), s, (pv),* ω_1, ω_2
III	*l′, v′*	*d, l′, ev′*	*l′,* σ	*(v),* φ	*(ft), (tc), (it), (p), (u), (a), s, (pv)*
IV	*v′*	*d, ev′*	*d, l′*	*(v),* φ	*ft′′, (tc), (p), (u), (a), s, (pv)*

Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus). Single prime (′) marks setae on anterior and double prime (′′) setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.
* *tc′* absent in *Carabodes paravenezolanus* **n. sp**.

median part; other solenidia setiform, blunt-ended.

Material examined — Holotype (male) and 23 paratypes (11 females and 12 males): Cuba, Cayo Santa Maria, 22°66′21″N, 78°96′88″W, leaf litter in forest (unknown date and collector, mites were previously deposited in the Museum of Zoology of Tyumen State University, Russia).

Type deposition — The holotype (alcohol) is deposited in the collection of the Senckenberg Institute, Görlitz, Germany; 23 paratypes (alcohol) are in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Etymology — The specific name *paravenezolanus* refers to the morphological similarity of the new species to *Carabodes venezolanus* Subías and Arillo, 2004.

Remarks — *Carabodes paravenezolanus* n. sp. is similar to *Carabodes venezolanus* Subías and Arillo, 2004 from Venezuela (see Subías and Arillo 2004) in having spoon-like interlamellar and notogastral setae and long bothridial setae. However, the new species differs from the latter by the convex notogaster (vs. posterior part flattened), bothridial setae with short, clear, flattened head (vs. elongate, slightly developed, barbed unilaterally), notogaster without tubercles (vs. with tubercles) and epimere I with three pairs of setae (vs. with one pair).

Gymnobodes minimus **n. sp.**
(Figures 5-6)

Diagnosis — Body size: 270 – 282 × 135 – 143. Notogaster tuberculate. Anogenital region with ribs. Rostral and lamellar setae similar short, thin, smooth. Interlamellar, notogastral and ventral setae minute. Bothridial setae with flattened head covered by barbs and ribs. Tutoria absent.

Description — Measurements — Body length: 270 (holotype, male), 282 (one paratype: female); notogaster width: 143 (holotype), 135 (one paratype).

Integument (Figs 5A-C; 6A-D) — Body yellow-brownish. Notogaster with clearly separated tubercles (diameter up to 8). Anogenital region with ribs. Lateral sides of prodorsum and genital and anal plates with foveolae (diameter up to 2).

Prodorsum (Figs 5A, C, D; 6E, F) — Rostrum rounded. Translamella not developed. Rostral and lamellar setae similar in length (10 – 12), thin, smooth, interlamellar setae minute (4), all inserted on prodorsum. Bothridial setae (32) with longer, smooth stalk and shorter, flattened head covered by barbs and ribs, directed laterally. Exobothridial setae and their alveoli absent. Small concavity located anteriorly to interlamellar setae. Tutoria absent.

Notogaster (Figs 5A, C) — Anterior notogastral margin slightly convex medially. Humeral shoulders distinctly visible, pointed anteriorly. Ten pairs of notogastral setae similar in length, minute (4). Lyrifissures and opisthonotal gland openings not found under tuberculate layer.

Gnathosoma — Subcapitulum longer than wide (57 × 41). Subcapitular setae setiform, thin, indistinctly barbed, similar in thickness, *a* and *m* (both 6 – 8) longer than *h* (4). Adoral setae absent. Postpalpal setae *e* (8) straight, strong, barbed. Palps (36) with setation 0-2-1-3-8(+ω). Solenidion of palptarsi thickened, blunt-ended, pressed to their surface. Chelicerae (69) with two setiform, barbed se-

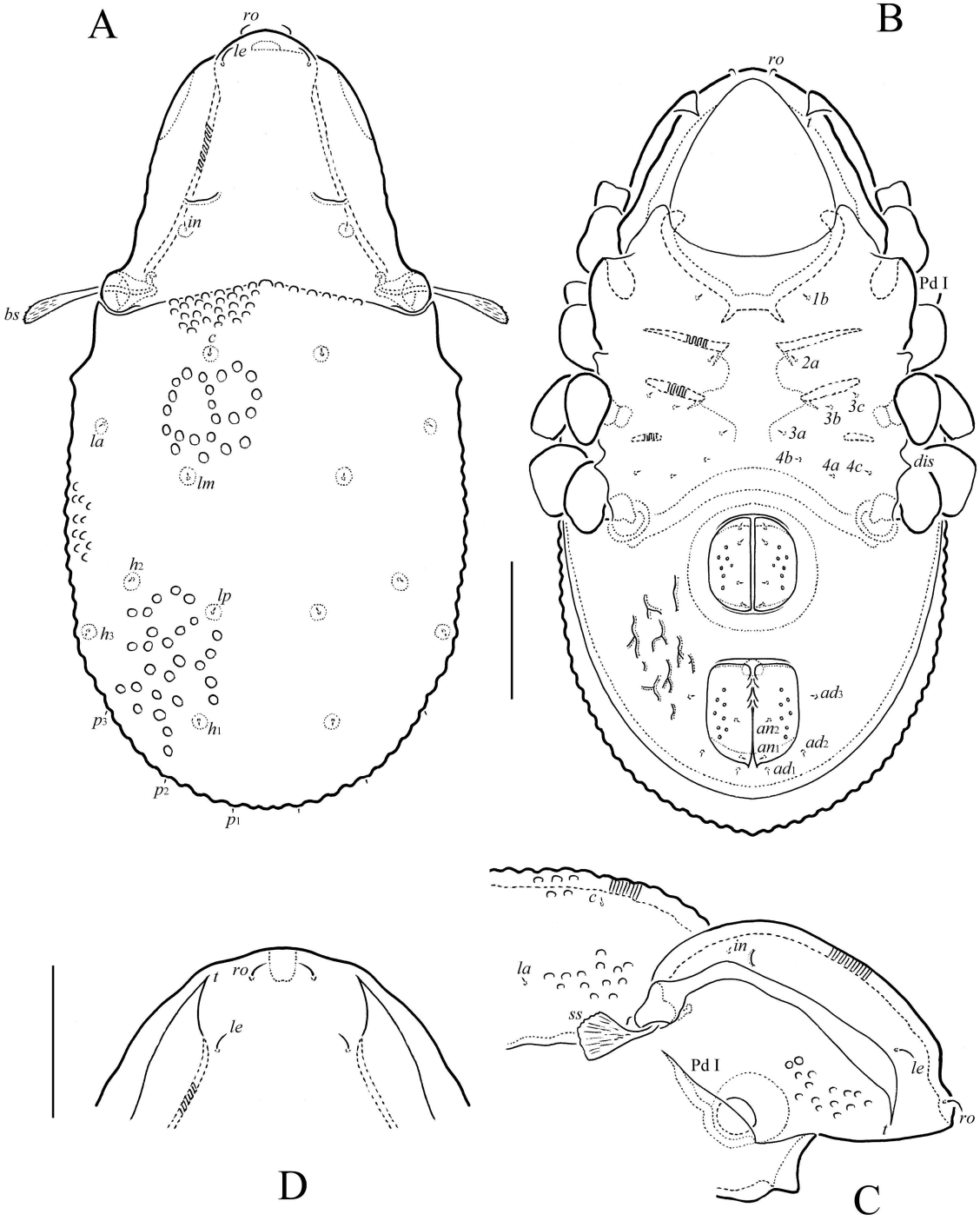

FIGURE 5: . *Gymnobodes minimus* **n. sp.**: A – dorsal view; B – ventral view (gnathosoma and legs except basal parts not illustrated); C – anterior part of body, lateral view (gnathosoma and leg I except basal part not illustrated); D – rostrum, dorso-frontal view. Scale bars 50 μm.

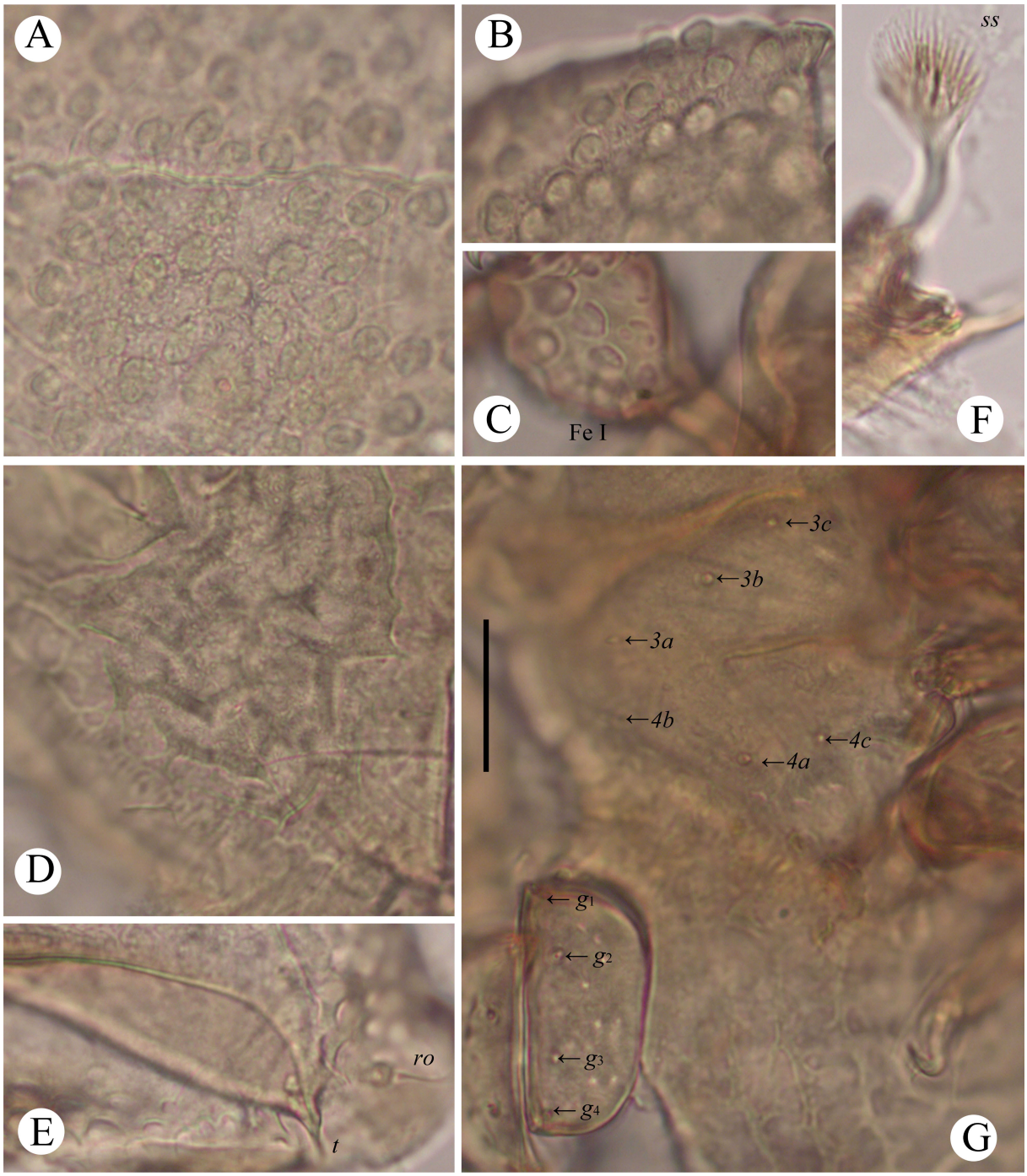

FIGURE 6: *Gymnobodes minimus* **n. sp.**, microscope images in dissected specimen: A, B – tubercles in centrodorsal part of notogaster; C – foveolae on femora I; D – ornamentation in adanal region; E – lamella and rostral seta; F – bothridial seta; G – left genital plate and part of epimeral region. Scale bar 20 μm.

tae; *cha* (20) longer than *chb* (8). Trägårdh's organ tapered, rounded distally.

Epimeral and lateral podosomal regions (Figs 5B; 6G) — Epimeral setal formula 1-1-3-3. Epimeral setae minute (4). Pedotecta I large, scale-like (in lateral view); pedotecta II slightly developed. Discidia small, triangular, blunt distally.

Anogenital region (Figs 5B; 6G) — Four pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae similar in length, minute (4). Adanal lyrifissures not visible.

Legs (Fig. 6C) — Generally, similar to *Carabodes paravenezolanus* **n. sp.**, but *tc'* present and solenidion ω_1 on tarsi I curved backwards distally. Homology of setae and solenidia indicated in Table 1.

Material examined — Holotype (male) and one paratype (female): Cuba, Cayo Santa Maria, 22°66'21"N, 78°96'88"W, leaf litter in forest (unknown date and collector, mites were previously deposited in the Museum of Zoology of Tyumen State University, Russia).

Type deposition — The holotype (alcohol) is deposited in the collection of the Senckenberg Institute, Görlitz, Germany; one paratype (alcohol) is in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Etymology — The specific name *minimus* refers to the small body size.

Remarks — The known species of the genus *Gymnobodes* can be distinguished by the key which is presented below.

Key to known species *Gymnobodes*

1. Interlamellar, notogastral and adanal setae of medium size, setiform, densely barbed; body size: 263 × 129 ..... *G. semengok* Mahunka, 1996 (see Mahunka 1996). Distribution: Borneo.
— Interlamellar, notogastral and adanal setae minute, slightly visible 2

2. Centro-dorsal part of notogaster with strong, well separated tubercles; body size: 270 – 282 × 135 – 143 ..... *G. minimus* n. sp. Distribution: Cuba.
— Centro-dorsal part of notogaster with indistinctly developed, dense tubercles, forming reticulate pattern 3

3. Anterior notogastral margin concave medially; body distinctly elongated, length / width ≈ 2.3; body size: 300 – 322 × 124 – 140 ..... *G. subnudus* (Balogh, 1963) (see Balogh 1963). Distribution: Congo.
— Anterior notogastral margin straight; body of normal size length / width ≈ 2.0; body size: 248 – 288 × 120 – 148 ..... *G. fraterculus* (Balogh, 1963) (see Balogh 1963; Mahunka 1986). Distribution: Ethiopian region.

New record

Kalloia simpliseta Mahunka, 1985 (see Mahunka 1985). Distribution: Neotropical region. First record of the genus and species in Cuba.

Material examined — 11 specimens: Cuba, Parque Nacional Alejandro de Humboldt, 20°30'N, 74°40'W, leaf litter in forest (unknown date and collector, mites were previously deposited in the Museum of Zoology of Tyumen State University, Russia).

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