

CONTRIBUTION TO THE KNOWLEDGE OF THE ORIBATID MITE GENUS *GYMNOBODES* (ACARI, ORIBATIDA, CARABODIDAE), WITH DESCRIPTION OF A NEW SPECIES FROM MEXICO

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A new species of *Gymnobodes* (Oribatida, Carabodidae) – *G. paraminimus* sp. n. – is described from leaf litter of secondary semi-evergreen tropical forest in Mexico. A revised generic diagnosis, identification key and data on distribution and habitats of representatives of the genus are presented.

Key words: carabodid mites, taxonomy, generic diagnosis, morphology, identification key, distribution, habitat, Neotropical region.

INTRODUCTION

Gymnobodes Balogh, 1965 (Acari, Oribatida, Carabodidae) is a small genus of oribatid mites that was proposed by BALOGH (1965), with *Carabodes fraterculus* Balogh, 1963 as type species. At present, it comprises four species, which are distributed in the Afrotropical and Neotropical regions (BALOGH 1963, ERMILOV 2016, ERMILOV & N'DRI 2018).

During faunistic study of oribatid mite materials collected in Mexico, we found one new species of *Gymnobodes*. The main goal of our paper is to describe this new species under the names *G. paraminimus* sp. n. Earlier, one species of the genus was found in Mexico (VÁZQUEZ-GONZÁLEZ *et al.* 2016): *G. fraterculus*.

The generic traits and an identification key to some representatives of *Gymnobodes* were presented by ERMILOV and N'DRI (2018) and ERMILOV (2016), respectively. However, due to taxonomic changes (see the *Discussion* section) and new described species (ERMILOV & N'DRI 2018; data of this paper), additional goals of our paper are to revise the generic diagnosis and update the key. Also, we present data on distribution and habitats of representatives of the genus.

MATERIAL AND METHODS

Observation and documentation – For measurement and illustration, specimens were mounted in lactic acid on temporary cavity slides. All measurements are in micro-

meters (μm). Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the notogaster; other structures were oriented to avoid parallax errors. Notogastral width refers to the maximum width in dorsal aspect. Setal lengths were measured perpendicular to their long axes, accounting for curvature. Formulas for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus. Drawings were made with a camera lucida using a Leica DM 2500 light microscope.

Terminology – Morphological terminology used in this paper mostly follows that of Grandjean: see TRAVÉ & VACHON (1975) for references; NORTON (1977) for leg setal nomenclature; and NORTON & BEHAN-PELLETIER (2009) for overview.

Abbreviations – *Prodorsum*: *lam* = lamella; *tlam* = translamella; *tp* = tooth-like process of lamella; *ro*, *le*, *in*, *bs* = rostral, lamellar, interlamellar, and bothridial setae, respectively. *Notogaster*: *hp* = humeral process; *c*, *la*, *lm*, *lp*, *h*, *p* = setae; *im*, *ip* = lyrifissures; *gla* = opisthotal gland opening. *Gnathosoma*: *a*, *m*, *h* = subcapitular setae; *d*, *l*, *sup*, *inf*, *acm*, *ul*, *su*, *lt*, *vt* = palp setae; *cha*, *chb* = cheliceral setae; *Tg* = Trägårdh's organ. *Epimeral and lateral podosomal regions*: *1a*, *2a*, *3a–3c*, *4a–4c* = epimeral setae; *con* = concavity; *PdI*, *PdII* = pedotecta I, II, respectively; *dis* = discidium. *Anogenital region*: *g*, *an*, *ad* = genital, anal and adanal setae, respectively; *p.o.* = preanal organ. *Legs*: *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = trochanter, femur, genu, tibia, and tarsus, respectively; ω , φ , σ = solenidia; ε = famulus; *d*, *l*, *v*, *bv*, *ev*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv* = setae; *p.a.* = porose area.

TAXONOMY

Family Carabodidae

Genus *Gymnobodes* Balogh, 1965

Gymnobodes Balogh, 1965: 28

Type species: *Carabodes fraterculus* Balogh, 1963, by original designation

GENERIC DIAGNOSIS OF GYMNOBODES

With main traits of Carabodidae (MAHUNKA 1986, NORTON & BEHAN-PELLETIER 2009). *Size*: Small species, length about 250–350. Body ratio (length/width) ≈ 1.7 –2.3. *Integument*: Body with granulate microsculpturing; dorsal side of prodorsum with or without tubercles; lateral part of prodorsum foveolate; notogaster partially or completely tuberculate; anogenital region usually with ridges. *Prodorsum*: Rostrum rounded. Lamella located dorsolaterally, long, comparatively narrow, distally with triangular process; lamellae well separated, often connected by translamella. Interlamellar process and deep dorsosejugal concavity absent, but basal part of prodorsum sometimes depressed. Tutorium absent. Rostral, lamellar and interlamellar setae minute, simple; *ro* inserted near to rostrum, *le* and *in* on the prodorsal surface or on inner part of lamella; bothridial seta medium-sized, phylliform (dilated distally) or clavate, directed laterad. Bothridium complete or interrupted medially. *Notogaster*: Anterior notogastral margin developed, straight or concave medially. Notogaster slightly evenly convex; large notogastral apophyses and processes absent. Hu-

meral process small, anteriorly usually triangular. Ten pairs of notogastral setae widely spaced, all minute, simple; humeral process without seta; posterior part of notogaster with four pairs of setae (h_3, p_1-p_3). *Gnathosoma*. Subcapitular setae short, simple. Palp setation: 0–2–1–2[or 3]–8(+ ω). Chelicera chelate-dentate. *Epimeral and lateral podosomal regions*: Epimeral formula: 1[or 2]–1–3–3. Pedotectum I represented by large lamina. Discidium well developed. *Anogenital region*: Four pairs of genital, two pairs of anal and three pairs of adanal setae minute, simple; aggenital setae absent or present. Adanal lyrifissure distanced from anal aperture. *Legs*: Tarsus IV with complete setation (12 setae).

***Gymnobodes paraminimus* sp. n.**

<http://zoobank.org/1793D22B-3F5F-4FC5-8112-C631060019F3>

(Figs 1–3)

Material examined – Holotype (female) and six paratypes (six females): Mexico, 20°33'N, 87°13'W, Quintana Roo, Municipio de Solidaridad, vicinities of Playa del Carmen, leaf litter under trees and bushes in secondary semi-evergreen tropical forest (date and collector unknown; collection of the Tyumen State University Museum of Zoology, Tyumen, Russia; see GASHEV *et al.* 2005).

Type deposition – The holotype is deposited in the collection of the Senckenberg Museum of Natural History, Görlitz, Germany; six paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are preserved in 70% solution of ethanol with a drop of glycerol.

Etymology – The species name *paraminimus* refers to the similarity between the new species and *Gymnobodes minimus* Ermilov, 2016.

Diagnosis – Body length: 255–285. Dorsal side of prodorsum with tubercles and strong tuberculate-like ridges; notogaster with sparse tubercles; genital and anal plates with sparse foveolae; anogenital region with thin, curved ridges. Translamella present. Bothridial seta with phylliform (dilated distally) head. Humeral process anteriorly triangularly pointed. Epimeral setal formula: 1–1–3–3. Aggenital setae absent.

Description of adult – *Measurements*. Body length: 255 (holotype), 255–285 (paratypes); notogaster width: 150 (holotype), 150–165 (paratypes).

Integument (Figs 1A, C, D; 2A–C; 3A–D). Body color light brown. Body with dense, granulate microsculpturing. Dorsal side of prodorsum (between lamellae) with tubercles (diameter up to 9) and strong tuberculate-like ridges; lateral side of prodorsum with foveolae (diameter up to 7). Notogaster with sparse tubercles (diameter up to 9). Subcapitular mentum with slight foveolae (diameter up to 5). Genital and anal plates with sparse foveolae (diameter up to 2). Anogenital region with thin, curved ridges. Marginal part of ventral plate slightly longitudinally striate. Antiaxial side of leg femora I–IV and trochanters III, IV with foveolae (diameter/length up to 7).

Prodorsum (Figs 1A, B, D; 2B). Rostral margin broadly rounded. Lamella with strong distal tooth-like process; translamella present, well visible in dorsal view. Rostral (9–11),

lamellar (9–11) and interlamellar (4–6) setae setiform, thin, smooth; bothridial seta (34–37) with well developed, phylliform (dilated distally) head, having slight ribs and indistinct barbs; opening of bothridium complete, not interrupted ventrally; exobothridial seta absent.



Fig. 1. *Gymnobodes paraminimus* sp. n., adult: A = dorsal view; B = bothridial seta; C = ventral view (gnathosoma and legs not shown); D = right lateral view (gnathosoma and legs not shown). Scale bars 50 μ m (A, C, D), 10 μ m (B)

Table 1. Leg setation and solenidia of adult *Gymnobodes paraminimus* sp. n.

Leg	Tr	Fe	Ge	Ti	Ta
I	<i>v'</i>	<i>d</i> , (<i>l</i>), <i>bv''</i>	(<i>l</i>), <i>v'</i> , σ	(<i>l</i>), (<i>v</i>), φ_1 , φ_2	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>pv</i>), ε , ω_1 , ω_2
II	<i>v'</i>	<i>d</i> , (<i>l</i>), <i>bv''</i>	(<i>l</i>), <i>v'</i> , σ	<i>l'</i> , (<i>v</i>), φ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>pv</i>), ω_1 , ω_2
III	<i>l'</i> , <i>v'</i>	<i>d</i> , <i>l'</i> , <i>ev'</i>	<i>l'</i> , σ	(<i>v</i>), φ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>pv</i>)
IV	<i>v'</i>	<i>d</i> , <i>ev'</i>	<i>d</i> , <i>l'</i>	(<i>v</i>), φ	<i>ft''</i> , (<i>tc</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>pv</i>)

Note: Roman letters refer to normal setae; Greek letters to solenidia (except ε = famulus). Single quotation mark (') designates seta on the anterior and double quotation mark (") seta on the posterior side of a given leg segment. Parentheses refer to a pair of setae.

Notogaster (Figs 1A, D; 2A). Anterior notogastral margin straight; posterior notogastral margin broadly rounded. Humeral process distinctly developed, anteriorly triangularly pointed. Notogastral setae (4–6) setiform, thin, smooth. Lyrifissures *im* and *ip* distinct, others (*ia*, *ih*, *ips*) not observed; opisthonotal gland opening poorly visible.

Gnathosoma (Figs 2C–E). Subcapitulum size: 64–67 × 49–52; subcapitular setae (*a*: 7; *m*: 5; *h*: 4) setiform, thin, smooth. Palp length: 32–34; setation: 0–2–1–2–8(+ ω); postpalpal seta (5) spiniform. Chelicera length: 71–75; setae (*cha*: 19–22; *chb*: 9–11) setiform, barbed.

Epimeral and lateral podosomal regions (Figs 1C, D). Epimeral setal formula: 1–1–3–3; setae (4–6) setiform, thin, smooth. Slight concavity present between sejugal apodemes. Discidium distinct.

Anogenital region (Figs 1C, D; 2A). Genital, anal and adanal setae (4–6), setiform, thin, smooth; aggenital seta absent. Adanal lyrifissure not visible.

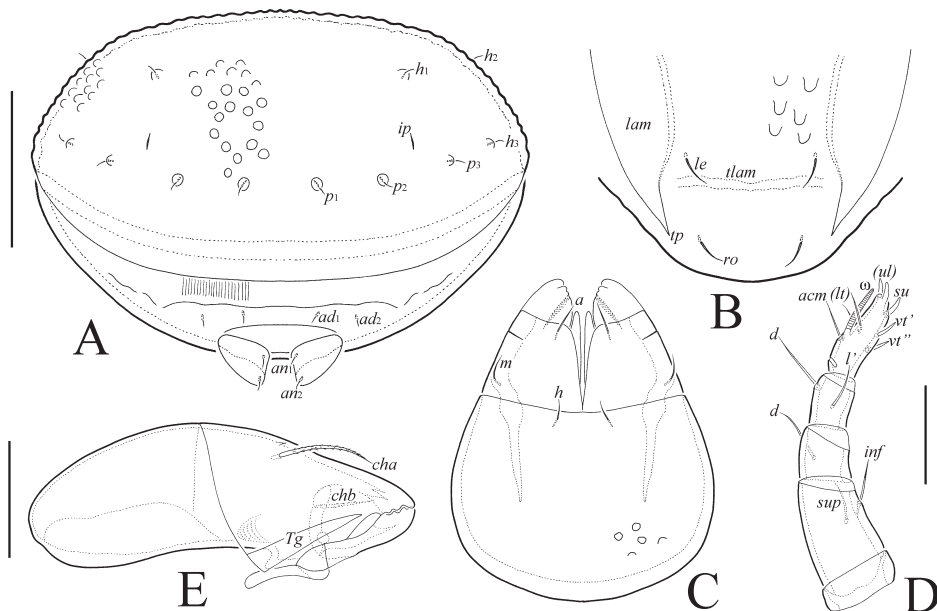


Fig. 2. *Gymnobodes paraminimus* sp. n., adult: A = posterior view; B = anterior part of prodorsum, dorsoanterior view; C = subcapitulum, ventral view; D = palp, left, paraxial view; E = chelicera, left, paraxial view. Scale bars 50 μ m (A), 20 μ m (B, C, E), 10 μ m (D)

Legs (Figs 3A–D). Claw of each leg strong, smooth. Porose area on femora I–IV distinct; porose area on trochanters III, IV not observed. Formulas of leg setation and solenidia: I (1–4–3–4–16) [1–2–2], II (1–4–3–3–15) [1–1–2], III (2–3–1–2–15) [1–1–0], IV (1–2–2–2–12) [0–1–0]; homology of setae and solenidia indicated in Table 1.

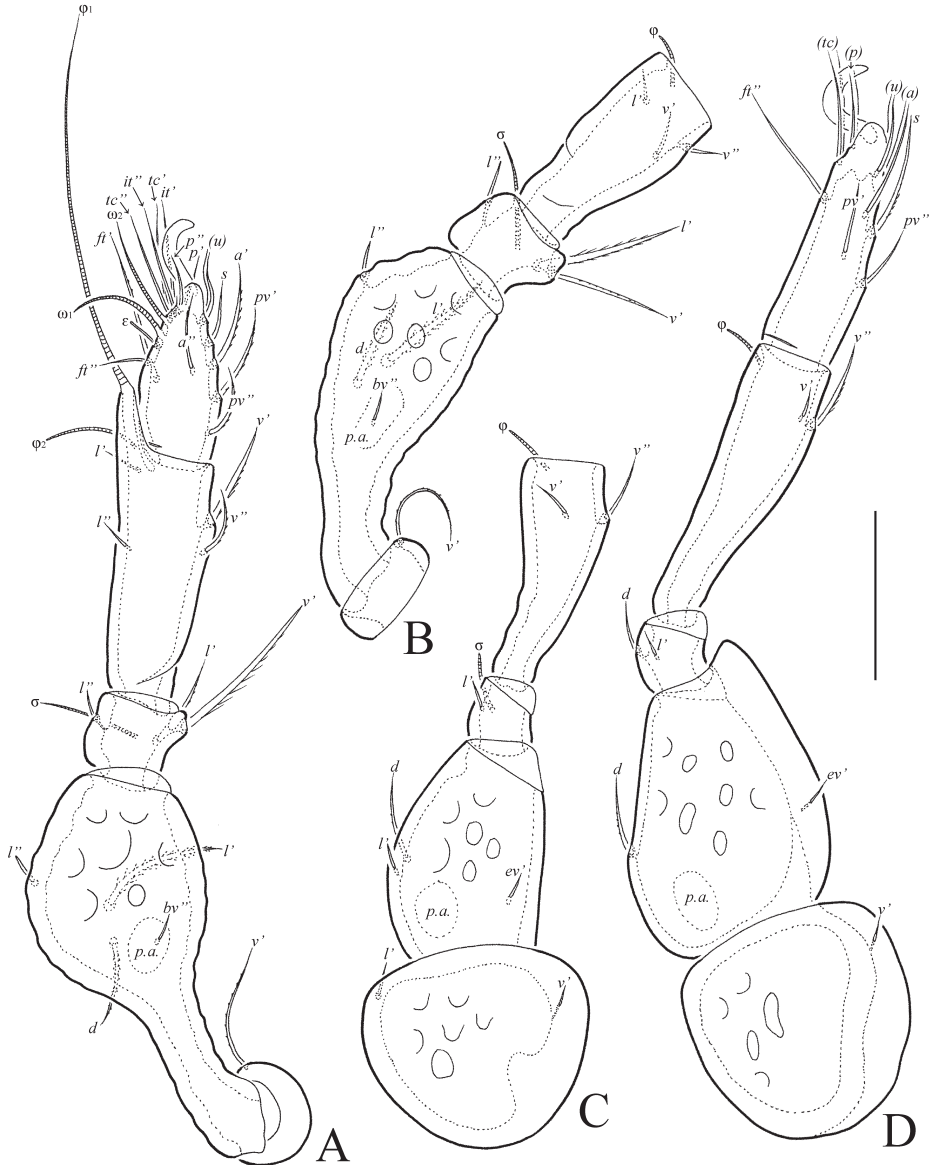


Fig. 3. *Gymnobodes paraminimus* sp. n., adult: A = leg I, right, antiaxial view; B = leg II, without tarsus, right, antiaxial view; C = leg III, without tarsus, left, antiaxial view; D = leg IV, left, antiaxial view. Scale bar 20 μ m

Remarks – *Gymnobodes paraminimus* sp. n. is morphologically similar to *G. minimus* from Cuba in having sparse small tubercles on the notogaster and minute foveolae on genital and anal plates, however, it differs from the latter by the: smaller elongation of body (length/width of body \approx 1.7 versus 2.0); presence (versus absence) of translamella; presence of tubercles and strong tuberculate-like ridges on the prodorsum; absence of a pair of depressions anteriorly to interlamellar setae.

DISCUSSION

MAHUNKA (1996) described *Gymnobodes semengok* from Borneo. However, some morphological traits clearly do not correspond to the generic diagnosis of *Gymnobodes*, for example, it has comparatively long, barbed rostral, lamellar, interlamellar, notogastral and anoanal setae (versus setae minute, simple), well developed tutorium (versus tutorium absent), and has no distal tooth-like process of the lamella (versus process present). Therefore, we support Subías's opinion (SUBÍAS 2022), who included *G. semengok* in *Carabodes* (*Klapperiches*) Mahunka, 1978.

Based on presence of minute, simple body setae and tuberculate notogaster, SUBÍAS (2022) included three species of *Carabodes* (*Klapperiches*) in *Gymnobodes*: *C. atrichosus* Mahunka, 1984 and *C. depilatus* Balogh et Mahunka, 1969 from the Neotropical region; *C. mikhaetandreorum* Ermilov et Anichkin, 2013 from Vietnam. However, *C. atrichosus* and *C. mikhaetandreorum* have a different localization of lamellar and interlamellar setae (on lamella versus on the prodorsal surface or on inner part of lamella) and have no distal tooth-like process of the lamella (versus process present). Therefore, we support the placement of these species in *Carabodes* (*Klapperiches*).

Taxonomic placement of *C. depilatus* is difficult. It is described briefly and only one figure (dorsal side) is presented (BALOGH & MAHUNKA 1969), therefore, the morphology of the distal part of the lamella, the localization of lamellar seta, and the integument of the ventral side of the body are unclear. Thus, preliminary we continue to consider *C. depilatus* as a representative of *Carabodes* (*Klapperiches*) until the study of the type material.

Key to known species of *Gymnobodes*

1. Bothridial seta clavate; notogaster with four longitudinal ridges and one pair of posterolateral concavities; aggenital seta present; body length: 298–348 *G. cotedivoirensis* Ermilov, 2018 (described in ERMILOV & N'DRI 2018)
- Bothridial seta flattened, phylliform; notogaster without longitudinal ridges and posterolateral concavities; aggenital setae absent 2

2. Centrodorsal part of notogaster with dense large tubercles, forming polygonate ornamentation; inner part of lamella and the posterior part of ventral plate foveolate 3
 - Centrodorsal part of notogaster with sparse small tubercles, not forming polygonate ornamentation; inner part of lamella and the posterior part of ventral plate not foveolate 4
3. Anterior margin of notogaster concave medially; distance between genital and anal apertures more than length of genital plate; length/width of body ≈ 2.3 ; body length: 300–322 *G. subnudus* (Balogh, 1963).
 - Anterior margin of notogaster straight; distance between genital and anal apertures less than length of genital plate; length/width of body ≈ 2.0 ; body length: 248–288 *G. fraterculus* (Balogh, 1963) (see also MAHUNKA 1986).
4. Translamella present; prodorsum with tubercles and strong tuberculate-like ridges; depression anteriorly to interlamellar seta absent; length/width of body ≈ 1.7 ; body length: 255–285 *G. paraminimus* sp. n.
 - Translamella absent; prodorsum without tubercles and tuberculate-like ridges; depression anteriorly to interlamellar seta present; length/width of body ≈ 2.0 ; body length: 270–282 *G. minimus* Ermilov, 2016.

Distribution and habitats of representatives of *Gymnobodes*

Species of *Gymnobodes* are known only from the Afrotropical and Neotropical regions. Except *G. fraterculus*, the other four species have a highly circumscribed geographic distribution, i.e., are endemic to a single country.

Gymnobodes cotedivoirensis was found from plant litter of 7-year-old rubber plantations in Côte d'Ivoire (ERMILOV & N'DRI 2018, 2020). *Gymnobodes fraterculus* was described from equatorial forest in Congo (BALOGH 1963); also, this species was reported from tropical ecosystems in Mexico (VÁZQUEZ-GONZÁLEZ *et al.* 2016). *Gymnobodes minimus* was recorded from leaf litter from forest in Cuba (ERMILOV 2016). *G. paraminimus* sp. n. is known from leaf litter of secondary semi-evergreen tropical forest in Mexico. *Gymnobodes subnudus* was registered from equatorial forest in Congo (BALOGH 1963).

According to the summarized data, representatives of *Gymnobodes* prefer mainly the litter in forest ecosystems.

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