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NEW SPECIES OF *MONOSCHELOBATES* BALOGH ET MAHUNKA 1969 AND *MULTORIBATES* HAMMER 1961 (ACARI, ORIBATIDA, SCHELORIBATIDAE), PHORETIC ON PASSALID BEETLES FROM THE NEOTROPICAL REGION

© 2021 г. S. G. Ermilov[a], *, B. M. OConnor[b], **

[a] *Institute of Environmental and Agricultural Biology (X-BIO), Tyumen State University, Tyumen, 625003 Russia*

[b] *Department of Ecology and Evolutionary Biology (Museum of Zoology), University of Michigan, Ann Arbor, Michigan, 48109 USA*

**e-mail: ermilovacari@yandex.ru*

***e-mail: bmoc@umich.edu*

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Two new species of oribatid mites (Oribatida) of the genera *Monoschelobates* Balogh et Mahunka 1969 and *Multoribates* Hammer 1961 (family Scheloribatidae), phoretic on the passalid beetles (Passalidae), *Verres longicornis* and *Ptichopus angulatus,* are described from Costa Rica and Mexico, respectively. *Monoschelobates paramasani* sp. n. differs from *Monoschelobates masani* Ermilov 2016 by the presence of a widely triangular rostrum, bothridial setae with unilaterally dilated heads and comparatively shorter interlamellar setae. *Multoribates mexicanus* sp. n. differs from *Multoribates heterotrichus* (Mahunka 1984) by the presence of cilia on the bothridial heads, 13 pairs of short notogastral setae and a pointed rostrum.

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Phoresy by oribatid mites (Acari, Oribatida) on insects is poorly studied (e.g., Oudemans, 1911; Woolley, 1969; Norton, 1980; see summarized data in Ermilov, 2019; Ermilov, Frolov 2019, 2019a). During taxonomic identification of mites phoretic on passalid beetles (Coleoptera, Passalidae), from the Neotropical region, we found two new species, belonging to the genera *Monoschelobates* Balogh et Mahunka 1969 and *Multoribates* Hammer 1961 (family Scheloribatidae). The goal of the paper is to describe and illustrate these new species.

Monoschelobates includes five species, which are distributed in the Ethiopian, Neotropical and Oriental regions, and Polynesia (Subías, 2019). *Multoribates* includes two species, which are distributed in the Neotropical region, Tanzania, and the Caucasus region (Subías, 2019).

This work is part of our continuing study of the oribatid mite fauna of Costa Rica and Mexico (e.g., Ermilov et al., 2014, 2015; Niedbała, Ermilov, 2017), and phoretic relationship between Oribatida and Insecta (Ermilov, 2019; Ermilov, Frolov 2019, 2019a).

METHODS

Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the notogaster. Notogastral width refers to the maximum width of the notogaster in dorsal view. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers. 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.

Drawings were made with a camera lucida using a Leica transmission light microscope “Leica DM 2500”.

Morphological terminology used in this paper follows that of F. Grandjean: see Travé and Vachon (1975) for references, Norton (1977) for leg setal nomenclature, and Norton and Behan-Pelletier (2009), for overview.

The following abbreviations are used (including text, figures and table): *lam* = lamella; *slam* = sublamella; *Al* = sublamellar porose area; *tlam* = transla-

mella; *kf* = lateral keel-shaped ridge; *ro*, *le*, *in*, *bs*, *ex* = = rostral, lamellar, interlamellar, bothridial and exobothridial setae, respectively; *exv* = alveolar vestige of second exobothridial seta; *D* = dorsophragma; *P* = = pleurophragma; *c*, *la*, *lm*, *lp*, *da*, *dm*, *dp*, *h*, *p* = notogastral setae; *Sa*, *S1*, *S2*, *S3* = notogastral sacculi; *ia*, *im*, *ip*, *ih*, *ips* = notogastral lyrifissures; *gla* = opisthonotal gland opening; *a*, *m*, *h* = subcapitular setae; *or* = adoral seta; ω = palp and leg solenidion; *cha*, *chb* = cheliceral setae; *Tg* = Trägårdh's organ; *I*, *II* = = pedotecta I, II, respectively; *1a*, *1b*, *1c*, *2a*, *3a*, *3b*, *3c*, *4a*, *4b*, *4c* = epimeral setae; *dis* = discidium; *cp* = circumpedal carina; *g*, *ag*, *an*, *ad* = genital, aggenital, anal and adanal setae, respectively; *iad* = adanal lyrifissure; *Amar* = marginal porose area; *po* = preanal organ; *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = leg trochanter, femur, genu, tibia, tarsus, respectively; *pa* = leg porose area; σ, φ = leg solenidia; ε = leg famulus.

SYSTEMATICS

Family Scheloribatidae

Genus ***Monoschelobates*** Balogh et Mahunka 1969

Type species *Monoschelobates parvus* Balogh et Mahunka 1969.

Monoschelobates paramasani Ermilov et OConnor sp. n. (Figs 1, 2)

M a t e r i a l. Holotype (♂) and six paratypes (4♀♀, 2♂♂): Costa Rica, Cartago, Turrialba, FICA Station, 9°53′29″ N, 83°39′58″ W, 600 m a.s.l., phoretic on specimen of *Verres longicornis* (Coleoptera, Passalidae), 13 July 1965 (D.W. Alsop) (BMOC 77-1214-001 – as *Metaleius* sp. A. in Norton (1980)). The host specimen is in the Cornell University Insect Collection and bears the voucher label, "Mites removed B.M. OConnor #77-1214-1". Mites were located on the ventral metathorax of the host.

The holotype and one paratype are deposited in the Cornell University Insect Collection (CUIC), Ithaca, NY, USA; two paratypes are deposited in the collection of the University of Michigan Museum of Zoology (UMMZ), Ann Arbor, MI, USA; three paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are stored in ethanol with a drop of glycerol.

D i a g n o s i s. Body size: 365–381 × 232–249. Rostrum pointed. Prolamella and sublamellar porose area absent. Translamella represented by one pair of short, poorly developed rudimentary parts near lamellae. Rostral, lamellar and interlamellar setae long, setiform, barbed; *ro* shortest, *in* longest. Exobothridial seta comparatively long. Bothridial seta long, with elongate, unilaterally dilated, pointed apically head, barbed. Lateral keel-shaped ridge present. Notogastral seta short, setiform, roughened. Epimeral and anogenital setae short, setiform, slightly barbed.

D e s c r i p t i o n. *Measurements*. Body length: 365 (holotype), 365–381 (paratypes); notogaster width: 249 (holotype), 232–249 (paratypes). No difference between females and males in body size.

Integument. Body color light brown. Body surface punctate (visible under high magnification in dissected specimens). Lateral part of prodorsum slightly microgranulate.

Prodorsum (Figs 1*a*, 1*d*). Rostrum pointed. Lamella located dorsolaterally, about half of prodorsum (measured in lateral view). Sublamella thin, similar to lamella in length. Sublamellar porose area and prolamella absent. Translamella well separated medially (represented by one pair of rudimentary parts near lamellae) and usually poorly visible. Rostral (57–61), lamellar (65–69) and interlamellar (82–94) setae setiform, barbed. Bothridial seta (82–94) long, slightly barbed, with narrowly elongate, dilated unilaterally, pointed apically head. Exobothridial seta (20–24) setiform, thin, slightly barbed. Alveolar vestige of second exobothridial seta and lateral keel-shaped ridge present. Sejugal porose area elongate oval, poorly visible. Dorsophragma semi-oval.

Notogaster (Figs 1*a*–1*d*). Anterior notogastral margin slightly convex medially. Ten pairs of notogastral setae (10–12) setiform, thin, roughened. Four pairs of sacculi with small opening and drop-like chamber. Distance *S1–S1* equal *S2–S2*. Opisthonotal gland opening and lyrifissures *ia*, *im*, *ip*, *ih*, and *ips* distinct. Circumgastric sigillar band visible. Circumgastric scissure not observed.

Gnathosoma (Figs 1*e*–1*g*). Subcapitulum longer than wide (82–86 × 69–73). Subcapitular seta setiform, barbed; *h* (20) longer than *a* (16–18) and *m* (16). Adoral seta (10–12) setiform, barbed. Palp (61–65) with typical setation 0-2-1-3-9(+ω). Postpalpal seta (6) spiniform. Chelicera (86–94) with two setiform, barbed setae, *cha* (28) longer than *chb* (16). Trägårdh's organ narrowly triangular.

Epimeral and lateral podosomal regions (Figs 1*d*, 2*a*). Epimeral setal formula 3-1-3-3. Setae setiform, slightly barbed; *1b* and *3b* (24–28) longer than *1c*, *3c*, *4a*, *4b*, *4c* (12–16) and *1a*, *2a*, *3a* (10–12). Setae *1c* inserted laterally on pedotectum I. Pedotectum II rounded in ventral view. Discidium elongate rounded. Circumpedal carina of medium size, reaching to discidium.

Anogenital region (Figs 1*b*–1*d*, 2*a*). Four pairs of genital (10–12), one pair of aggenital (16), two pairs of anal (16) and three pairs of adanal (16) setae setiform, slightly barbed. Adanal lyrifissure located close and parallel to anal plate. Marginal porose area complete,

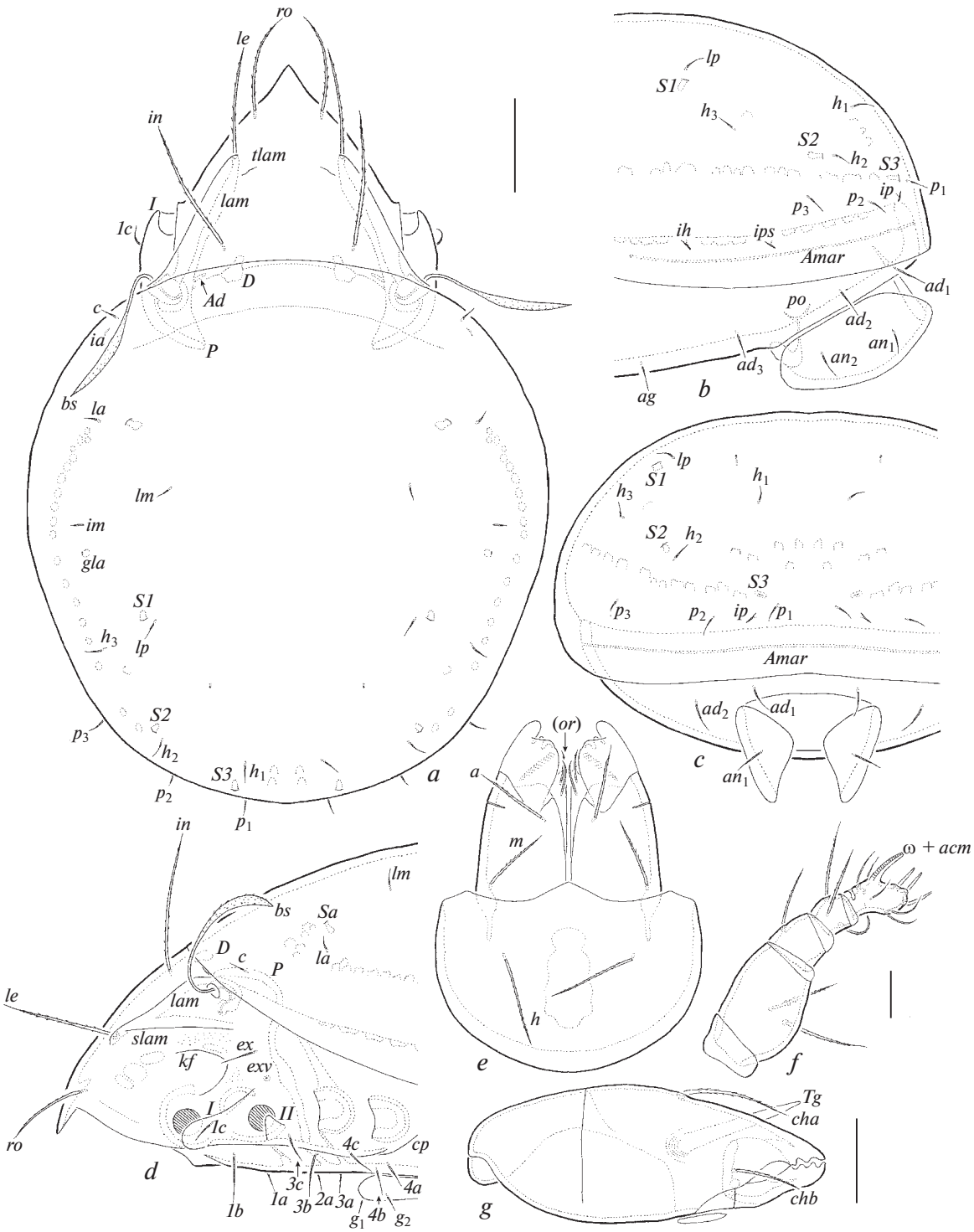

Fig. 1. *Monoschelobates paramasani* sp. n., adult: *a* – dorsal view (legs not illustrated); *b* – posterior part of body, lateral view; *c* – posterior view; *d* – anterior part of body, lateral view (gnathosoma and legs not illustrated); *e* – subcapitulum, ventral view; *f* – palp, left, paraxial view; *g* – chelicera, right, antiaxial view. Scale bar (μm): *a*–*d* – 50; *e*, *g* – 20; *f* – 10.

band-like, poorly visible. Preanal organ of typical, goblet-like form. Ovipositor elongated (118 × 45), blade (49) shorter than length of distal section (beyond middle fold; 69). Each of the three blades with four smooth setae, $\psi_1 \approx \tau_1$ (28) setiform, $\psi_2 \approx \tau_a \approx \tau_b \approx \tau_c$ (16) thorn-like. Coronal seta not observed.

Legs (Figs 2*b*–2*e*). Claw of leg pretarsus sparsely barbed on dorsal side. Porose area on femora I–IV

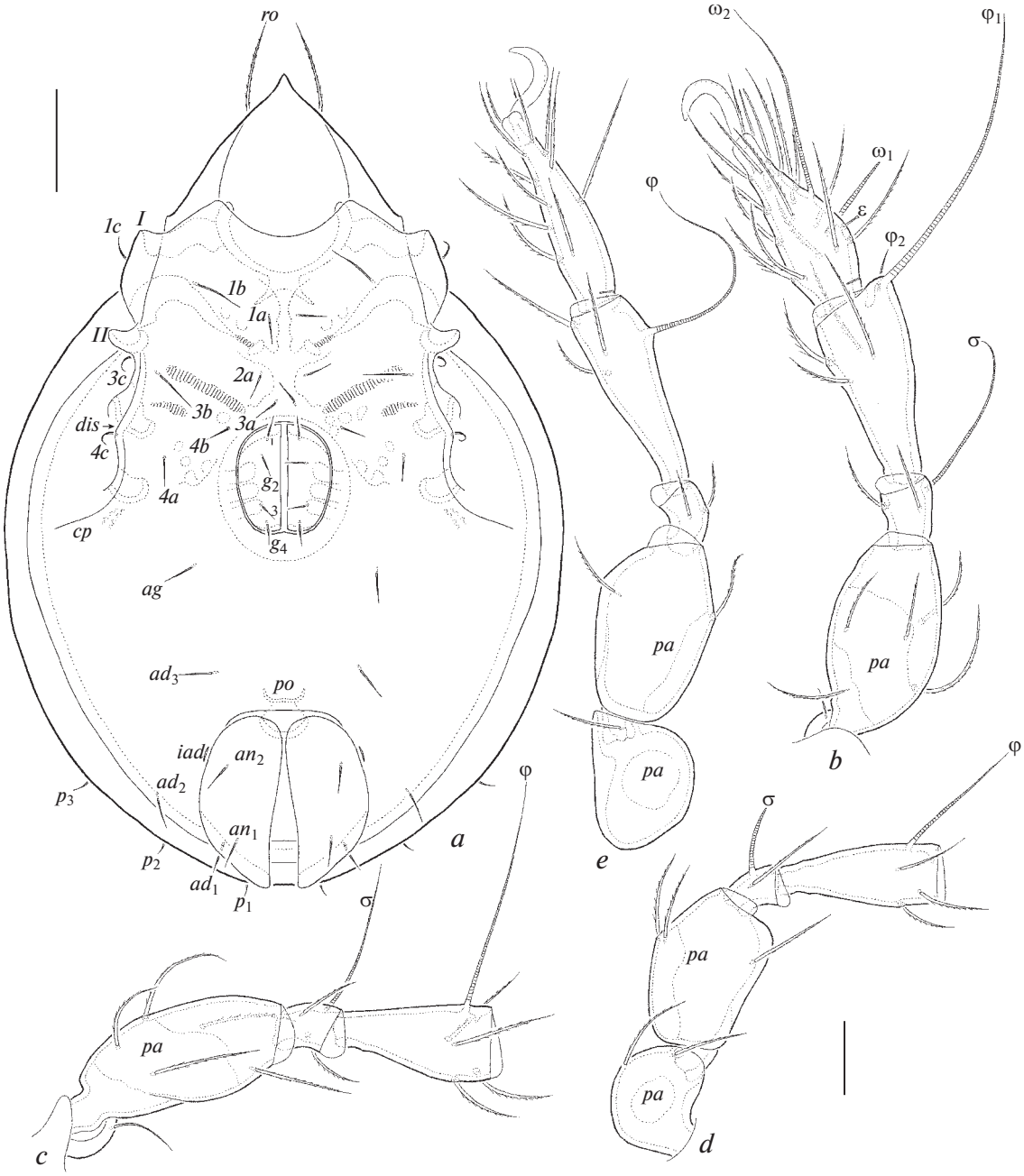

Fig. 2. *Monoschelobates paramasani* sp. n., adult: *a* – ventral view (gnathosoma and legs not illustrated); *b* – leg I, left, antiaxial view; *c* – leg II, without tarsus, right, antiaxial view; *d* – leg III, without tarsus, left, antiaxial view; *e* – leg IV, right, antiaxial view. Scale bar (μm): *a* – 50; *b*–*e* – 20.

and on trochanters III, IV slightly visible; ventral porose area in basal part of tarsus and distal part of tibia not observed. Formulas of leg setation and solenidia: I (1-5-2-4-18) [1-2-2], II (1-5-2-4-15) [1-1-2], III (2-3-1-3-15) [1-1-0], IV (1-2-2-3-12) [0-1-0]; homology of setae and solenidia indicated in Table 1. Famulus of tarsus I short, erect, slightly swollen distally, inserted between solenidion ω_1 and seta *ft*". Solenidion ω_1 on tarsus I, ω_1 and ω_2 on tarsus II and σ on genu III bacilliform, φ_2 on tibia I slightly thickened, blunt-ended, other solenidia setiform. Solenidion ω_2 and seta *tc*" on tarsus I connected mediodistally.

R e m a r k s. The new species is morphologically most similar to *Monoschelobates masani* Ermilov 2016 from Peru (see Ermilov, Friedrich, 2016) in the small body size and presence of well-developed exobothrid-

Table 1. Leg setation and solenidia of adult *Monoschelobates paramasani* sp. n. and *Multoribates mexicanus* sp. n.

Leg	*Tr*	*Fe*	*Ge*	*Ti*	*Ta*
I	*v'*	*d*, (*l*), *bv"*, *v"*	(*l*), σ	(*l*), (*v*), φ_1, φ_2	(*ft*), (*tc*), (*it*), (*p*), (*u*), (*a*), *s*, (*pv*), (*pl*), ε, ω_1, ω_2
II	*v'*	*d*, (*l*), *bv"*, *v"*	(*l*), σ	(*l*), (*v*), φ	(*ft*), (*tc*), (*it*), (*p*), (*u*), (*a*), *s*, (*pv*), ω_1, ω_2
III	*l'*, *v'*	*d*, *l'*, *ev'*	*l'*, σ	*l'*, (*v*), φ	(*ft*), (*tc*), (*it*), (*p*), (*u*), (*a*), *s*, (*pv*)
IV	*v'*	*d*, *ev'*	*d*, *l'*	*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 the anterior and double prime (") – setae on the posterior side of a given leg segment. Parentheses refer to a pair of setae.

ial setae, and in the absence of sublamellar porose areas. It differs from the latter by the presence of a widely triangular rostrum (versus rostrum narrowly protruding), bothridial setae with unilaterally dilated heads (versus lanceolate) and comparatively shorter interlamellar setae.

Etymology. The species name *paramasani* refers to the similarity between the new species and *Monoschelobates masani* Ermilov 2016.

Genus ***Multoribates*** Hammer 1961

Type species: *Multoribates chavinensis* Hammer 1961.

Multoribates mexicanus Ermilov et OConnor sp. n. (Figs 3, 4)

Material. Holotype (♂) and four paratypes (2♀♀, 2♂♂): Mexico, Jalisco, Ajijic, 20°18′ N 103°17′ W, phoretic on specimen of *Ptichopus angulatus* (Coleoptera, Passalidae), 28 June 1956 (J. Hendrichs) (BMOC 04-0513-009). The host is in the UNAM collection, and bears the voucher label, "Mites removed B.M. OConnor #04-0513-009". Mites were located on the venter of the abdomen.

The holotype is deposited in the collection of the Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico; two paratypes are deposited in the collection of the University of Michigan Museum of Zoology, Ann Arbor, MI, USA; two paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are stored in ethanol with a drop of glycerol.

Diagnosis. Body size: 232–249 × 116–132. Rostrum pointed. Prolamella and translamella absent. Rostral, lamellar and interlamellar setae long, setiform, barbed; *ro* longest. Bothridial seta long, clavate, ciliate. Lateral keel-shaped ridge present. Thirteen pairs of short, setiform, roughened notogastral setae. Epimeral and anogenital setae short, setiform, roughened. Leg pretarsus with one claw.

Description. *Measurements*. Body length: 232 (holotype), 232–249 (paratypes); notogaster width: 116 (holotype), 116–132 (paratypes). No difference between females and males in body size.

Integument. Body color light brown. Body surface punctate (visible under high magnification in dissected specimens). Lateral part of prodorsum slightly microgranulate. Region between lamella and sublamella slightly striate.

Prodorsum (Figs 3*a*, 3*d*). Rostrum pointed. Lamella located dorsolaterally, about half of prodorsum (measured in lateral view). Sublamella thin, similar to lamella in length. Sublamellar porose area (6–8) rounded. Translamella and prolamella absent. Rostral (32–36), lamellar (24–28) and interlamellar (24–28) setae setiform, barbed. Bothridial seta (24–28) long, clavate, rounded apically, shortly ciliate. Exobothridial seta (16) setiform, thin, slightly barbed. Alveolar vestige of second exobothridial seta and lateral keel-shaped ridge present. Sejugal porose area elongate oval, poorly visible. Dorsophragma slightly elongate.

Notogaster (Figs 3*a*–3*d*). Anterior notogastral margin convex medially. Thirteen pairs of notogastral setae (8–10) setiform, thin, roughened. Four pairs of sacculi with small opening and drop-like chamber. Distance *S1*–*S1* slightly longer than *S2*–*S2*. Opisthonotal gland opening and lyrifissures *ia*, *im*, *ip*, *ih*, and *ips* distinct. Circumgastric sigillar band visible. Circumgastric scissure not observed.

Gnathosoma (Figs 3*e*–3*g*). Subcapitulum longer than wide (65–69 × 49–53). Subcapitular seta setiform, barbed; *h* (14–16) and *a* (14–16) longer and thicker than *m* (8–10). Adoral seta (10–12) setiform, barbed. Palp (45–49) with typical setation 0-2-1-3-9(+ω). Postpalpal seta (4) spiniform. Chelicera (69–73) with two setiform, barbed setae, *cha* (28–32) longer than *chb* (16–20). Trägårdh's organ narrowly triangular.

Epimeral and lateral podosomal regions (Figs 3*d*, 4*a*). Epimeral setal formula 3-1-3-3. Setae setiform, roughened; *1b*, *1c* and *3b* (14–16) longer than *3c* (10–12) and *1a*, *2a*, *3a*, *4a*, *4b*, *4c* (8–10). Setae *1c* inserted ventrally on pedotectum I. Pedotectum II rounded in ventral view. Discidium elongate rounded. Cir-

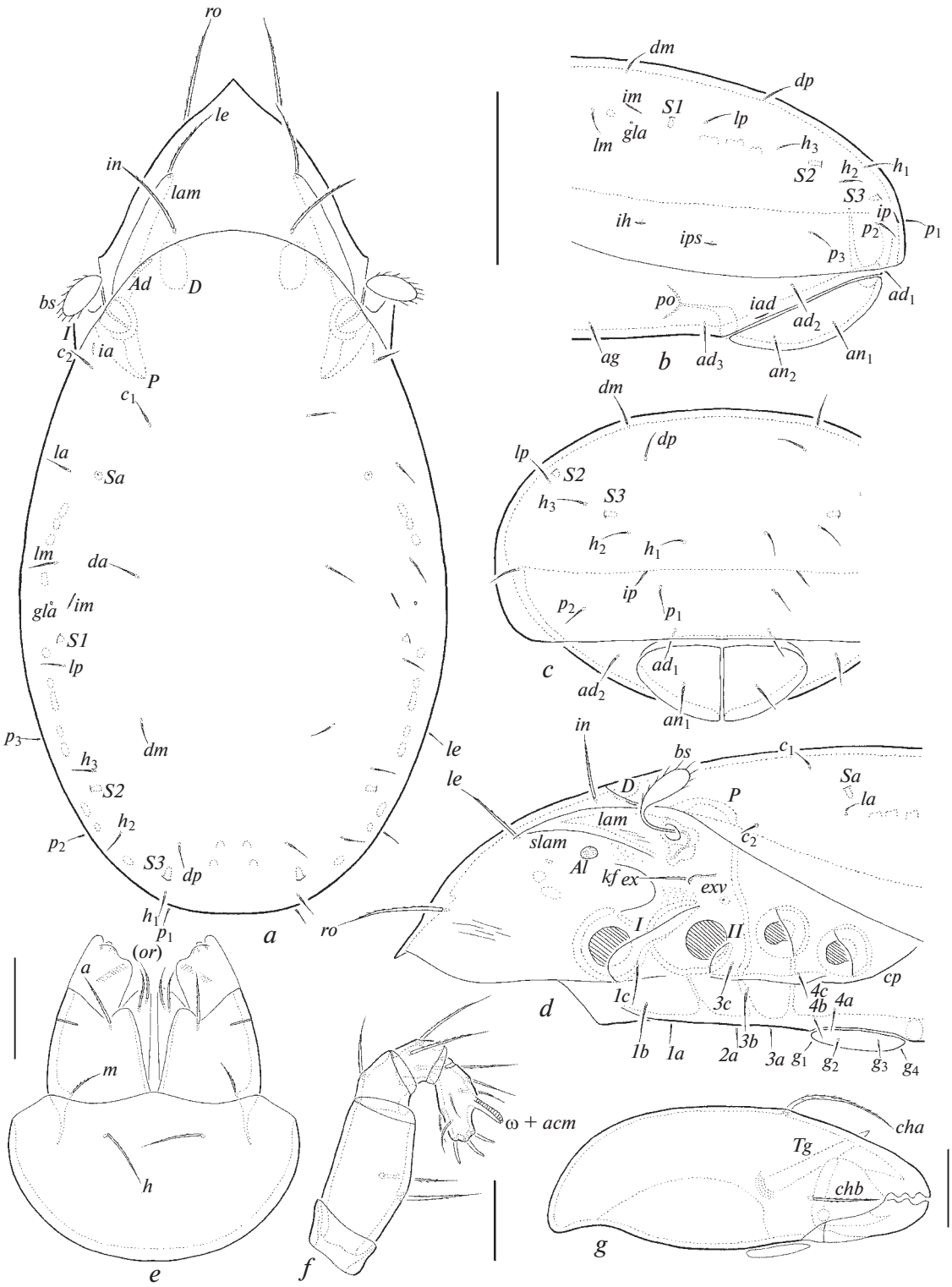

Fig. 3. *Multoribates mexicanus* sp. n., adult: *a* – dorsal view (legs not illustrated); *b* – posterior part of body, lateral view; *c* – posterior view; *d* – anterior part of body, lateral view (gnathosoma and legs not illustrated); *e* – subcapitulum, ventral view; *f* – palp, left, paraxial view; *g* – chelicera, right, antiaxial view. Scale bar (μm): *a*–*d* – 50; *e*, *g* – 20; *f* – 10.

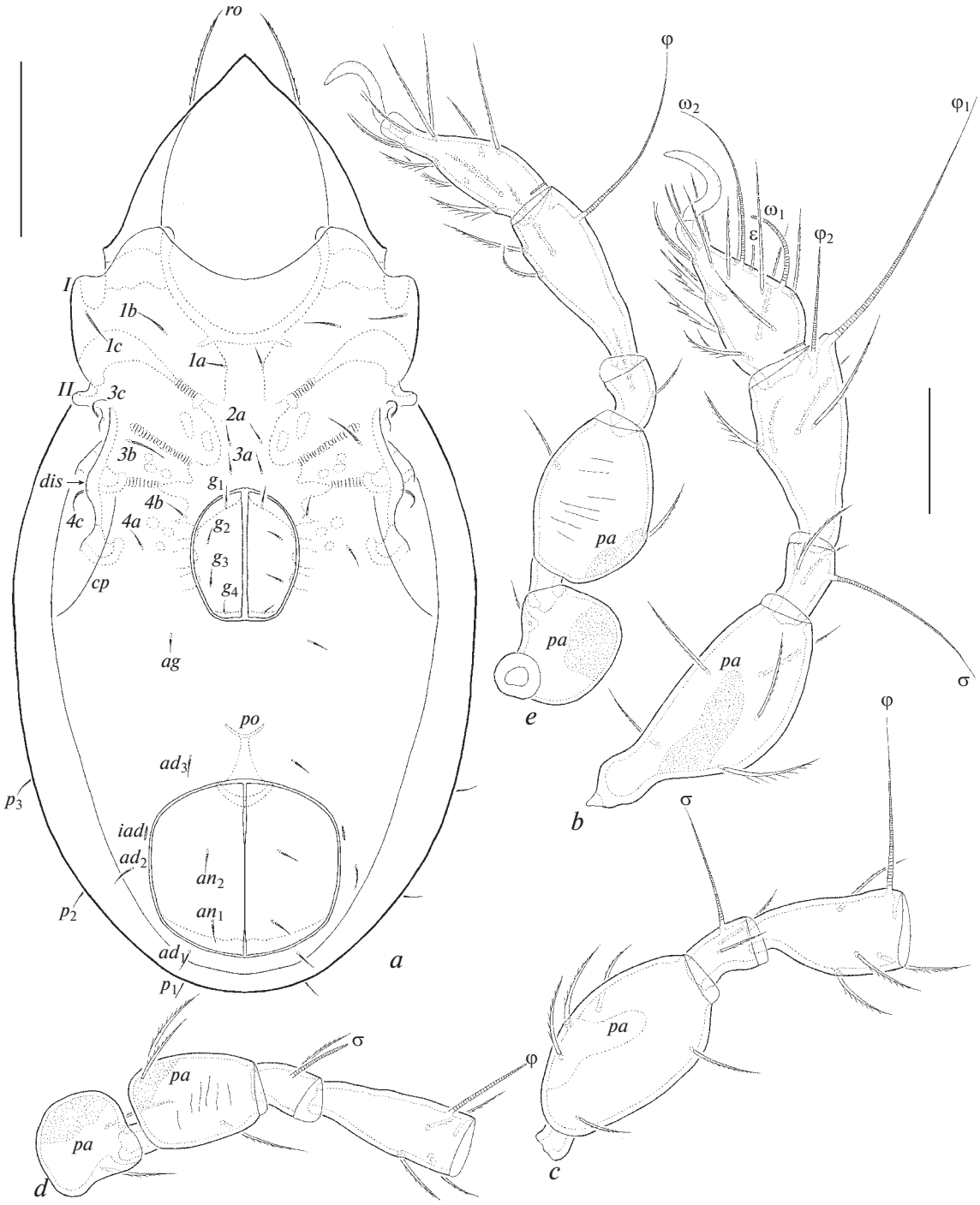

Fig. 4. *Multoribates mexicanus* sp. n., adult: *a* – ventral view (gnathosoma and legs not illustrated); *b* – leg I, without trochanter, right, paraxial view; *c* – leg II, without trochanter and tarsus, right, antiaxial view; *d* – leg III, without tarsus, right, paraxial view; *e* – leg IV, left, paraxial view. Scale bar (μm): *a* – 50; *b*–*e* – 20.

cumpedal carina of medium size, reaching of level of the discidium.

Anogenital region (Figs 3*b*–3*d*, 4*a*). Four pairs of genital (6–8), one pair of aggenital (8–10), two pairs of anal (8–10) and three pairs of adanal (8–10) setae setiform, roughened. Adanal lyrifissure located close and parallel to anal plate. Marginal porose areanot observed. Preanal organ of typical, goblet-like form. Ovipositor elongated (73 × 20), blade (32) shorter than length of distal section (beyond middle fold; 41).

Each of the three blades with four smooth setae, $\psi_1 \approx \approx \tau_1$ (16) setiform, $\psi_2 \approx \tau_a \approx \tau_b \approx \tau_c$ (8) thorn-like. Coronal seta not observed.

Legs (Figs 4*b*–4*e*). Claw of leg pretarsus sparsely barbed on dorsal side. Porose area on femora I–IV and on trochanters III, IV slightly visible; ventral porose area in basal part of tarsus and distal part of tibia not observed. Formulas of leg setation and solenidia: I (1-5-2-4-18) [1-2-2], II (1-5-2-4-15) [1-1-2], III (2-3-1-3-15) [1-1-0], IV (1-2-2-3-12) [0-1-0]; homology of setae and solenidia indicated in Table 1. Famulus of tarsus I short, erect, slightly swollen distally, inserted between solenidia ω_1 and seta ω_2. Solenidion ω_1 on tarsus I, ω_1 and ω_2 on tarsus II, σ on genu III, and φ on tibia III bacilliform, φ_2 on tibia I slightly thickened, blunt-ended, other solenidia setiform. Solenidion ω_2 and seta *tc*" on tarsus I connected.

Remarks. The new species is morphologically most similar to *Multoribates heterotrichus* (Mahunka 1984) from Tanzania (see Mahunka, 1984) in the presence of clavate bothridial setae and monodactylous legs, however differs from the latter by the presence of cilia in bothridial heads (versus barbed), 13 pairs of short notogastral setae (versus 14 pairs of medium size) and the pointed rostrum (versus rounded).

Etymology. The species name *mexicanus* refers to the country of origin, Mexico.

REMARKS

Oribatid mites of the genera *Monoschelobates* and *Multoribates* phoretic on animals had not been previously known. Hence, our findings (*Mo. paramasani* sp. n. and *Mu. mexicanus* sp. n.) are the first records of the use of Insecta (passalid beetles) by these scheloribatid mites for phoresy. Neither of the new species have clear morphological adaptations for phoresy.

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НОВЫЕ ВИДЫ РОДОВ *MONOSCHELOBATES* BALOGH ET MAHUNKA 1969 И *MULTORIBATES* HAMMER 1961 (ACARI, ORIBATIDA, SCHELORIBATIDAE), ФОРЕЗИРУЮЩИХ НА ЖУКАХ-ПАССАЛИДАХ ИЗ НЕОТРОПИЧЕСКОЙ ОБЛАСТИ

С. Г. Ермилов[1, *], Б. М. ОКоннор[2, **]

[1]*Институт экологической и сельскохозяйственной биологии (X-BIO), Тюменский государственный университет, Тюмень, 625003 Россия*

[2]*Отделение экологии и эволюционной биологии (музей зоологии), Мичиганский университет, Анн Арбор, МИ, 48109 США*

**e-mail: ermilovacari@yandex.ru*

***e-mail: bmoc@umich.edu*

Описаны два новых вида панцирных клещей (Oribatida) родов *Monoschelobates* Balogh et Mahunka 1969 и *Multoribates* Hammer 1961 (семейство Scheloribatidae), форезирующих на жуках-пассалидах (Passalidae) *Verres longicornis* и *Ptichopus angulatus* из Коста-Рики и Мексики. *Monoschelobates paramasani* sp. n. отличается от *Monoschelobates masani* Ermilov 2016 широкотреугольным рострумом, односторонне расширенными ботридиальными щетинками и сравнительно короткими межламеллярными щетинками. *Multoribates mexicanus* sp. n., в отличие от *Multoribates heterotrichus* (Mahunka 1984), имеет реснички на ботридиальных головках, 13 пар коротких нотогастральных щетинок и заостренный рострум.

Ключевые слова: клещи-шелорибатиды, Коста-Рика, Мексика, систематика, морфология, форезия