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New *Perscheloribates* species (Acari, Oribatida, Scheloribatidae) phoretic on beetles (Insecta, Coleoptera)

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Original research

ABSTRACT

Two new species of oribatid mites of the genus *Perscheloribates* (Oribatida, Scheloribatidae), phoretic on passalid and zopherid beetles (Coleoptera), are described from the Philippines and U.S.A., based on adults. *Perscheloribates paracuriosus* n. sp. differs from *Perscheloribates curiosus* Ermilov, 2016 by the length and morphology of notogastral and adanal setae, the presence of lateral keel-shaped ridge, and the absence of custodium. *Perscheloribates parakontumensis* n. sp. differs from *Perscheloribates kontumensis* Ermilov and Frolov, 2019 by the morphology of notogastral setae and the absence of body sculpturing and setae *it* on leg tarsi I–III.

Keywords scheloribatid mites; phoresy; systematics; morphology; Philippines; U.S.A.

Zoobank <http://zoobank.org/4071E221-5201-4E6D-9459-EEE5430D2046>

Introduction

The phoretic association of oribatid mites (Acari, Oribatida) with beetles (Coleoptera) is poorly known. Mainly, the available data refer to the phoresy on beetles of the family Passalidae, e.g.: unidentified *Mesoplophora* (later, it was identified by Niedbala (1985, 2000) as *M. (M.) permodica* Niedbala, 1985, *Mesoplophora (Parplophora) flavida* Niedbala, 1985; *M. (P.) polita* Niedbala, 1985, and *M. (P.) subtilis* Niedbala, 1981), *Malaconothrus*, *Oppia*, *Protoribates*, *Scheloribates*, and *Metaleius* spp. from the different regions of the world (Norton 1980); *Neoamerioppia phoretica* (Franklin & Woas, 1992) from Brazil (Franklin & Woas 1992); *M. (P.) flavida*, *M. (P.) polita*, *Graptoppia (Stenoppia) luisi* Ermilov & Frolov, 2009, *Ramusella (Sabahoppia) blattarum* (Oudemans, 1911), and *Perscheloribates kontumensis* Ermilov & Frolov, 2009) from Vietnam (Ermilov & Frolov 2019a); *Graptoppia (Stenoppia) royi* Ermilov, 2019 from Indonesia (Ermilov 2019). In addition, there are also some data on phoresy of oribatid mites on the beetles of the other families, e.g.: *Euscheloribates samsinaki* Kunst, 1958 and *Mesoplophora* sp. on Scarabaeidae from Slovakia and U.S.A. (Kunst 1958; Norton 1973); *Eremella reticulatus* (Woolley, 1969) on Elateridae from U.S.A. (Woolley 1969); *Scheloribates* sp. on Cerambycidae from Mexico (Norton 1980); *Ramusella (Ramusella) clavipectinata* (Michael, 1885) on Curculionidae from Russia (Ermilov *et al.* 2008); *Dometorina* sp., *Metaleius* sp., *Siculobata (Paraleius) leontonycha* (Berlese, 1910), *S. (P.) leahae* (Knee, 2017), and *Tectocephus velatus sarekensis* Trägårdh, 1910 on Curculionidae from different countries (Norton 1980; Knee *et al.* 2013; Ahadiyat & Akrami 2015; Knee 2017); *Ramusella (Dosangoppia) bochkovi* Ermilov & Frolov, 2019 on Geotrupidae from Russia (Ermilov & Frolov 2019b).

During taxonomic identification of mites phoretic on passalid and zopherid (Zopheridae) beetles from the Philippines and the U.S.A., we found two new species of *Perscheloribates*

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(s.s.). The goal of this paper is to describe and illustrate these new species under the names *Perscheloribates paracuriosus* n. sp. and *P. parakontumensis* n. sp.

Perscheloribates comprises four subgenera and more than 50 species (Ermilov & Starý 2018), which are distributed in tropical and subtropical regions. The nominotypical subgenus comprises about 50 species, which have the same geographical distribution as the genus. The main generic characters of *Perscheloribates* (*Perscheloribates*) were summarized by Hammer (1973), Corpuz-Raros (1980), and Balogh & Balogh (1992). Identification keys for many species from different regions have been presented earlier by Balogh & Balogh (1990, 2002), Ermilov *et al.* (2011), and Ermilov & Martens (2014).

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 ventral plate in ventral view. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers. Some paratypes were dissected and mounted in lactic acid on temporary flat slides. 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 & Vachon (1975) for references, Norton (1977) for leg setal nomenclature, and Norton & Behan-Pelletier (2009) for overview.

The following abbreviations are used (including text, figures and table): *lam* = lamella; *plam* = prolamella; *slam* = sublamella; *Al* = sublamellar porose area; *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*, *dp*, *lp*, *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; *v*, *l*, *d*, *cm*, *acm*, *ul*, *sul*, *vt*, *lt* = palp setae; 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; *v*, *ev*, *bv*, *l*, *d*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl* = leg setae.

Systematics

Family Scheloribatidae

Genus *Perscheloribates* Hammer, 1973

Subgenus *Perscheloribates* (*Perscheloribates*) Hammer, 1973

Type species *Perscheloribates clavatus* Hammer, 1973

Perscheloribates (*Perscheloribates*) *paracuriosus* n. sp.

Zoobank: 4637B85A-2B7A-46E5-BCEB-1BD63BD07E7D

(Figures 1–3)

Figure 1 *Perscheloribates paracuriosus* n. sp., adult: a – dorsal view; b – ventral view (gnathosoma and legs omitted). Scale bar 100 μ m.

Diagnosis — Body size: 348–381 $\times$ 166–199. Rostrum pointed. Prolamella and translamella absent. Rostral, lamellar and interlamellar setae long, setiform, barbed; *ro* shortest, *in* longest. Bothridial seta long, lanceolate, barbed. Lateral keel-shaped ridge present. Notogastral seta short, setiform, roughened, *c*, *la*, *lm* short, simple, others longer, flexible. Epimeral and genital setae setiform, roughened. Anal and adanal setae flexible, roughened. Leg seta *it* absent on all tarsi.

Description — Measurements – a relatively small species. Body length: 365 (holotype, male), 348, 381 (two paratypes, two females); notogaster width: 182 (holotype), 166, 199 (two paratypes).

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

Figure 2 *Perscheloribates paracuriosus* n. sp., adult: a – anterior part of body, lateral view (gnathosoma and legs omitted); b – posterior part of body, lateral view; c – posterior view; d – subcapitulum, ventral view (lips and adoral setae omitted); e – left lip with adoral setae; f – palp, left, paraxial view; g – chelicera, left, paraxial view. Scale bar 100 µm (a, b, c), scale bar 20 µm (d, g), scale bar 10 µm (f), scale bar 5 µm (e).

Prodorsum (Figs 1a, 2a) – Rostrum pointed. Lamella located dorsolaterally, about half of prodorsum (measured in lateral view). Sublamella thin, slightly shorter than lamella. Sublamellar porose area (4) rounded. Prolamella and translamella absent. Rostral (53–57), lamellar (65–73) and interlamellar (102–110) setae setiform, barbed. Bothridial seta (82–86) lanceolate, barbed, with long stalk and shorter pointed apically head. Exobothridial seta (12–16) setiform, roughened. Alveolar vestige of second exobothridial seta and lateral keel-shaped ridge present. Sejugal porose area not observed. Dorsophragma slightly elongated.

Notogaster (Figs 1a, 2a-c) – Anterior notogastral margin convex medially. Pteromorph triangular, broadly rounded distally. Ten pairs of notogastral setae setiform, roughened, with different length and morphology; c, la, lm shorter (12–16), simple, others distinctly longer (lp, 24–36; others 32–41), with flexible tip. Four pairs of sacculi with small opening and drop-like

chamber. Distance $S1-S1$ equal $S2-S2$. Opisthonotal gland opening and all lyrifissures distinct. Circumgastric scissure not observed. Circumgastric sigillar band visible.

Gnathosoma (Figs 2d-g) – Subcapitulum longer than wide ($82-86 \times 65-73$). Three pairs of subcapitular setae setiform, barbed; h ($28-32$) longer than a ($20-24$) and m ($20-24$). Two pairs of adoral setae ($10-12$) setiform, barbed. Palp ($49-53$) with setation 0-2-1-3-9(+ ω). Postpalpal seta (4) spiniform. Chelicera ($90-94$) with two setiform, barbed setae, cha ($41-32$) longer than chb ($16-20$). Trägårdh's organ narrowly triangular.

Epimeral and lateral podosomal regions (Figs 1b, 2a) – Epimeral setal formula 3-1-3-3. Setae setiform, roughened; $1b$ and $3b$ ($24-28$) longer than $1c$, $3c$, $4a$, $4b$, $4c$ ($16-20$) and $1a$, $2a$, $3a$ ($10-12$). Setae $1c$ inserted laterally on pedotectum I. Pedotectum II quadrangular in ventral view, with one protruding tip. Discidium rounded distally. Circumpedal carina long, reaching pedotectum II.

Anogenital region (Figs 1b, 2a-c) – Four pairs of genital ($10-12$) and one pair of aggenital ($12-14$) setae setiform, roughened. Two pairs of anal ($32-41$) and three pairs of adanal ($32-41$) setae flexible, roughened. Adanal lyrifissure located close and parallel to anal plates. Marginal porose area not observed. Preanal organ of typical, goblet-like form. Ovipositor elongated (138×20), blade (65) shorter than length of distal section (beyond middle fold; 73). Each of the three blades with four smooth setae, $\psi_1 \approx \tau_1$ (24) setiform, $\psi_2 \approx \tau_a \approx \tau_b \approx \tau_c$ (12) thorn-like. Six coronal setae (2) spiniform.

Legs (Figs 3a-d) – 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 (1-5-2-4-17) [1-2-2], II (1-5-2-4-13) [1-1-2], III (2-3-1-3-13) [1-1-0], IV (1-2-2-3-11) [0-1-0]; homology of setae and solenidia indicated in Table 1. Seta it absent on all tarsi, seta a' absent on tarsus IV. 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, other solenidia setiform.

Material examined — Holotype (male) and two paratypes (two females): Philippines, Negros Oriental, Sibulan Municipality, Lake Balinsasayao, $09^{\circ}21'N$, $123^{\circ}10'E$, 835 m a.s.l., phoretic on a specimen of *Aceraius lamellatus* Gravley, 1918 (Coleoptera, Passalidae), 9 August 1982 (P.D. Heideman). Data on localization of mites on *A. lamellatus* was not reported. Host specimen in the University of Michigan Museum of Zoology (UMMZ) bearing the voucher label, “Mites removed, B.M. OConnor #83-1800-024.” The host specimen was collected in a decaying log in primary dipterocarp forest.

Type deposition — The holotype and one paratype are deposited in the collection of the University of Michigan Museum of Zoology, Ann Arbor, MI, USA; one paratype is 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.

Table 1 Leg setation and solenidia of adult *Perscheloribates paracuriosus* n. sp..

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	$d, (l), bv'', v''$	$(l), \sigma$	$(l), (v), \phi_1, \phi_2$	$(ft), (tc), (p), (u), (a), s, (pv), v', (pl), \varepsilon, \omega_1, \omega_2$
II	v'	$d, (l), bv'', v''$	$(l), \sigma$	$(l), (v), \phi$	$(ft), (tc), (p), (u), (a), s, (pv), \omega_1, \omega_2$
III	l', v'	d, l', ev'	l', σ	$l', (v), \phi$	$(ft), (tc), (p), (u), (a), s, (pv)$
IV	v'	d, ev'	d, l'	$l', (v), \phi$	$ft'', (tc), (p), (u), a'', s, (pv)$

Note: Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus). Single prime (') indicates setae on anterior and double prime (') setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

Figure 3 *Perscheloribates paracuriosus* n. sp., adult: a – leg I, left, paraxial view; b – leg II, without tarsus, left, paraxial view; c – leg III, without tarsus, left, antiaxial view; d – leg IV, left, antiaxial view. Scale bar 50 μ m.

Etymology — The species name *paracuriosus* refers to the similarity between the new species and *Perscheloribates curiosus* Ermilov, 2016.

Remarks — In the presence of a pointed rostrum, lanceolate bothridial head and developed notogastral setae, and in the absence of prolamella, the new species is similar to *Perscheloribates curiosus* Ermilov, 2016 from Cuba (see Ermilov & Tolstikov 2016), but differs from the latter by the morphological differentiation of the notogastral setae (*c*, *la*, *lm* short, simple; others distinctly longer, flexible) (versus all setae short, similar in length, simple in *P. curiosus*), the presence of flexible anal and adanal setae (versus simple in *P. curiosus*) and a keel-shaped ridge on the lateral side of the prodorsum (versus absent in *P. curiosus*), and the absence of custodium (versus present in *P. curiosus*).

***Perscheloribates (Perscheloribates) parakontumensis* n. sp.**

Zoobank: [OE24D8AB-6CBD-4AF0-BFDD-0A7CE11E7EE3](https://doi.org/10.24435/202004368)

(Figures 4–6)

Diagnosis — Body size: 348–365 × 182–199. Rostrum pointed. Prolamella and translamella absent. Rostral, lamellar and interlamellar setae long, setiform, barbed; *ro* shortest, *in* longest. Bothridial seta long, lanceolate, with long, setiform apex, barbed. Lateral keel-shaped ridge present. Notogastral setae short, setiform, roughened. Epimeral and anogenital setae setiform, roughened.

Description — Measurements – Small species. Body length: 348 (holotype, female), 348–365 (three paratypes, one male and two females); notogaster width: 182 (holotype), 182–199 (three paratypes).

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

Prodorsum (Figs 4a, 5a) – Rostrum pointed. Lamella located dorsolaterally, about half of prodorsum (measured in lateral view). Sublamella thin, similar to lamella in length. Sublamellar porose area (4) rounded. Prolamella absent, but its basal part sometimes developed. Translamella absent. Rostral (53–61), lamellar (69–73) and interlamellar (77–82) setae setiform, barbed. Bothridial seta (65–73) lanceolate, barbed, with long stalk and shorter head having long setiform apex. Exobothridial seta (20–24) setiform, slightly barbed. Alveolar vestige of second exobothridial seta and lateral keel-shaped ridge present. Sejugal porose area not observed. Dorsophragma slightly elongated.

Notogaster (Figs 4a, 5a-c) – Anterior notogastral margin convex medially. Pteromorph triangular, broadly rounded distally. Ten pairs of notogastral setae (10–12) setiform, roughened. Four pairs of sacculi with small opening and drop-like chamber. Distance *S1*–*S1* shorter than *S2*–*S2*. Opisthonotal gland opening and all lyrifissures distinct. Circumgastric scissure often not observed. Circumgastric sigillar band visible.

Gnathosoma (Fig. 4b) – Similar to *Perscheloribates paracuriosus* n. sp. Subcapitulum longer than wide (82–90 × 65–73). Three pairs of subcapitular setae setiform, barbed; *h* (24–28) longer than *a* (18–20) and *m* (10–12), *m* thinnest. Two pairs of adoral setae (10) setiform, barbed. Palp (49–53) with setation 0-2-1-3-9(+ω). Postpalpal seta (4) spiniform. Chelicera (90–94) with two setiform, barbed setae, *cha* (32–36) longer than *chb* (16–20). Trägårdh's organ narrowly triangular.

Epimeral and lateral podosomal regions (Figs 4b, 5a) – Epimeral setal formula 3-1-3-3. Setae setiform, roughened; *1b*, *1c*, *3b*, *3c*, *4c* (16–24) longer than *1a*, *2a*, *3a*, *4a*, *4b* (10–12). Setae *1c* inserted laterally on pedotectum I. Pedotectum II quadrangular in ventral view, with one protruding tip. Discidium rounded distally. Circumpedial carina long, reaching pedotectum II.

Anogenital region (Figs 4b, 5a-c) – Four pairs of genital (8–10), one pair of aggenital (10–12), two pairs of anal (10–41) and three pairs of adanal (10–12) setae setiform, roughened. Adanal lyrifissure located close and parallel to anal plates. Marginal porose area complete, band-like. Preanal organ of typical, goblet-like form. Ovipositor elongated (134 × 28), blade

Figure 4 *Perscheloribates parakontumensis* n. sp., adult: a – dorsal view; b – ventral view (legs omitted). Scale bar 100 μ m.

(61) shorter than length of distal section (beyond middle fold; 73). Each of the three blades with four smooth setae, $\psi_1 \approx \tau_1$ (24) setiform, $\psi_2 \approx \tau_a \approx \tau_b \approx \tau_c$ (12) thorn-like. Six coronal setae (2) spiniform.

Legs (Figs 6a-d) – 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 (1-5-3-4-19) [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 2. Seta *it* present on all tarsi. 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, other solenidia setiform.

Material examined — Holotype (female) and three paratypes (one male and two females):

Figure 5 *Perscheloribates parakontumensis* n. sp., adult: a – anterior part of body, lateral view (gnathosoma and legs omitted); b – posterior part of body, lateral view; c – posterior view. Scale bar 100 μ m.

U.S.A., Michigan, Emmet Co., Wilderness State Park, 45°44'N, 84°55'W, phoretic on specimens of *Phellopsis obcordata* (Kirby, 1873) (Coleoptera, Zopheridae), May 1981 (J. Kukor). Host specimen in UMMZ bearing the voucher label, "Mites removed, B.M. OConnor #81-0604-001." Mites were found on 3 specimens of *P. obcordata* collected from a fruiting body of the polypore fungus, *Porodaedalea pini* (Brot.) Murrill, 1905 (= *Fomes pini*, = *Phellinus pini*), growing on red pine, *Pinus resinosa* Alton, 1789. Mites were found in pits on the dorsal surface of the elytra. The habitat consists of around 4050 hectares of dense coniferous and mixed hardwood forest on the northeast shore of Lake Michigan. The host beetle is associated with several species of polypore fungi in dense boreal forests in Eastern North America (Evans 2014), suggesting that the normal habitat of this mite species is either on or in the fungal fruiting bodies or in the mycelium growing within the wood of the host tree.

Type deposition — The holotype and two paratypes are deposited in the collection of the University of Michigan Museum of Zoology, Ann Arbor, MI, USA; one paratype is deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All

Figure 6 *Perscheloribates parakontumensis* n. sp., adult: a – leg I, right, antiaxial view; b – leg II, without tarsus, right, antiaxial view; c – leg III, without tarsus, right, antiaxial view; d – leg IV, left, antiaxial view. Scale bar 50 μ m.

Table 2 Leg setation and solenidia of adult *Perscheloribates parakontumensis* n. sp..

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	d, (l), bv'', v''	(l), v', σ	(l), (v), φ ₁ , φ ₂	(ft), (tc), (it), (p), (u), (a), s, (pv), v', (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)

Note: See Table 1 for explanation.

specimens are stored in ethanol with a drop of glycerol.

Etymology — The species name *parakontumensis* refers to the similarity between the new species and *Perscheloribates kontumensis* Ermilov & Frolov, 2019.

Remarks — In the presence of pointed rostrum, lanceolate bothridial head with long setiform apex and developed notogastral setae, and in the absence of prolamella, the new species is similar to *Perscheloribates kontumensis* Ermilov & Frolov, 2019 from Vietnam (see Ermilov & Frolov 2019a), but differs from the latter by the presence of simple notogastral setae (versus with flexible tip in *P. kontumensis*) and the absence of body sculpturing (versus simple in *P. kontumensis*) and setae *it* on leg tarsi I–III (versus absent in *P. kontumensis*).

General remarks

As previously noted (Norton 1980; Ermilov 2019; Ermilov & Frolov 2019a, b), some oribatid mites are actively phoretic on insects, having morphological adaptations for attachment to the host (for example, gripping setae of beetles between the rostrum of the aspis and the anterior portion of the genital plates in ptyctimous mites, or specifically curved leg claws for holding onto setae of the host as in *Siculobata* (*Paraleius*)) (Norton 1980).

However, other oribatid species (including *P. paracuriosus* n. sp. and *P. parakontumensis* n. sp.) have no visible adaptations, so mostly hold the host's surface by hiding in various depressions and grooves of the host body and using the force of the pretarsal claws for attaching to the surface.

Beetles of the family Passalidae are one of the more common insect hosts actively used by oribatid mites for phoresy (Ermilov 2019), however, phoretic oribatid mites had not been previously reported from *A. lamellatus*, nor from any beetles of the family Zopheridae. Hence, our findings (*P. paracuriosus* n. sp. on *A. lamellatus* and *P. parakontumensis* n. sp. on *P. obcordata*) are the first records of the use of *A. lamellatus* and zopherid beetles by oribatid mites for phoresy.

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