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THE ORIBATID MITE GENUS *HAMMERELLA*, WITH DESCRIPTION OF A NEW SUBGENUS AND SPECIES FROM VIETNAM (ACARI: ORIBATIDA: GRANULOPPIIDAE)

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ABSTRACT: The oribatid mite genus *Hammerella* Balogh, 1983 (Granuloppiidae) is discussed and a new generic diagnosis is presented. *Hammerella* (*Parawoasella*) *bayartogtokhi*, a new subgenus and species, is proposed, based on specimens from dark loamy soil and litter (under *Dipterocarpus alatus*) in Vietnam. *Parawoasella* subgen. n. is distinguishable from other subgenera of *Hammerella* by the presence of dorsocentral setae in the adult, resulting in 13 pairs of notogastral setae (versus 10 pairs). An identification key to subgenera and species of *Hammerella* is given.

KEY WORDS: oribatid mites, Granuloppiidae, *Hammerella*, revision, new subgenus and species, taxonomic status, new combination, key, Vietnam

INTRODUCTION

Hammerella is a genus of the oribatid mite family Granuloppiidae (Acari: Oribatida: Oppioidea) that was proposed by Balogh (1983), with *Brachioppiella gracilis* Hammer, 1977 as type species. Currently, it comprises nine[1] named species, which are collectively distributed in tropical and subtropical regions (Subías 2004, online version 2012): *H. fournieri* (Balogh, 1994) from Costa Rica, *H. gracilis* (Hammer, 1977) from Pakistan, *H. kerangas* (Mahunka, 2001) from Borneo, *H. mirabilis* (Mahunka, 1987) from the Oriental region, *H. pectinata* (Aoki, 1983) from the Palearctic and Oriental regions, *H. ramirezi* (Balogh, 1994) from Costa Rica, *H. rostroreticulata* (Ohkubo, Aoki and Hu, 1993) from China, *H. salasi* (Balogh, 1994) from Costa Rica, and *H. sufflata* (Franklin and Woas, 1992) from Brazil.

Our main purpose is to propose our vision of subgenera and species in *Hammerella*, a subject on which past authors have had different opinions (for example, Balogh 1983, 1994; Mahunka 1987; Balogh J., Balogh P. 1992, 2002; Ohkubo, Aoki, Hu 1993; Subías 2004, online version 2006, 2008). As part of this, the taxonomic status of *Bornemiszaella* (see Balogh 1994) and *Woasella* (see Balogh J., Balogh P. 2002) are discussed. Our second goal is to describe a new subgenus and species, *Hammerella* (*Parawoasella*) *bayartogtokhi* subgen. n., sp. n., based on specimens from Vietnam.

MATERIALS AND METHODS

The locality and habitat data for the new species are given below (see *Material examined* section). Specimens were mounted in lactic acid on temporary cavity slides for measurement and drawings. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distension. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. Formulae for leg setation are given in parentheses according to the sequence trochanter–femur–genu–tibia–tarsus (famulus included). Formulae for leg solenidia are given in square brackets according to the sequence genu–tibia–tarsus. General terminology used in this paper mostly follows that of Grandjean (summarized by Norton and Behan-Pelletier 2009).

[1] *Hammerella pinnatifilis* was very poorly described (and figures absent) by Canestrini (1898) as *Belba pinnatifilis* from New Guinea. Subías (2004) provisionally include this species in the genus *Hammerella*, because some characters (for example, morphology of sensilli, structure of costulae) of *Belba pinnatifilis* are similar to characters of *Hammerella* representatives. However, only studying of the type material (it was inaccessible to us) can give the exact answer about generic position of *Belba pinnatifilis*.

RESULTS

New generic diagnosis of *Hammerella* Balogh, 1983

Granuloppiidae (see Balogh 1983; Norton and Behan-Pelletier 2009) with the following combination of characters: sensilli long, ciliate, setiform or with developed head; lamellar setae inserted nearer to interlamellar setae than to rostral; costulae short; notogaster surface smooth; 10 to 13 pairs of notogastral setae (sometimes setae *c* represented by alveoli); one pair of notogastral humeral tubercles present or absent; dorsosejugal border straight; epimeral border IV distinct or indistinct; six pairs of genital setae; adanal setae ad_1 and lyrifissures *iad* in paraanal position.

Type species. *Brachioppiella gracilis* Hammer, 1977

Subgenera of *Hammerella* and their species

1) *Hammerella* (*Hammerella*) Balogh, 1983

Diagnosis. Rostrum without incisions; sensilli with developed head, ciliate; 10 pairs of notogastral setae present (setae *c* represented by alveoli); dorsal setae of notogaster inserted in two parallel rows; one pair of notogastral humeral tubercles present; epimeral border IV distinctly developed.

Type species. *Brachioppiella gracilis* Hammer, 1977

Known species:

— *H.* (*H.*) *gracilis* (Hammer, 1977) (*Brachioppiella*)

— *H.* (*H.*) *pectinata* (Aoki, 1983) (*Senectoppia*)

2) *Hammerella* (*Interoppia*) Mahunka, 1987

Diagnosis. Rostrum without incisions; sensilli with developed ciliate head; 10 pairs of notogastral setae present (setae *c* developed); dorsal setae of notogaster inserted in two parallel rows; one pair of notogastral humeral tubercles present; epimeral border IV indistinct.

Type species. *Interoppia mirabilis* Mahunka, 1987

Known species:

— *H.* (*I.*) *kerangas* (Mahunka, 2001) (*Senectoppia*)

— *H.* (*I.*) *mirabilis* (Mahunka, 1987) (*Interoppia*)

— *H.* (*I.*) *rostroreticulata* (Ohkubo, Aoki and Hu, 1993) (*Interoppia*)

Remarks. *Interoppia* was proposed by Mahunka (1987) as a genus of Oppiidae. Balogh and Balogh (2002) included the type species of *Interoppia* (*I. mirabilis*) in the genus *Hammerella* (*Granuloppia* group). These genera were differentiated mainly by the "presence" or "absence" of epimeral border IV. If epimeral border IV is "present or absent", this probably says more about the depth of the muscle sigillae than about the border itself. As this seems to be potentially a continuously variable trait, this character (presence or absence of epimeral border IV) has limited value and in our opinion can be used only for independent subgenera (not genera).

3) *Hammerella* (*Bornemiszaella*) P. Balogh, 1994 **stat. n.**

Diagnosis. Rostrum with incisions; sensilli setiform, with long and usually bifurcate cilia; 10 pairs of notogastral setae present (setae *c* represented by alveoli); dorsal setae of notogaster inserted in four paralel rows; notogastral humeral tubercles absent; epimeral border IV indistinct.

Type species. *Bornemiszaella fournieri* P. Balogh, 1994

Known species:

— *H.* (*B.*) *fournieri* (P. Balogh, 1994) **comb. n.** (*Bornemiszaella*)

— *H.* (*B.*) *ramirezi* (P. Balogh, 1994) **comb. n.** (*Bornemiszaella*)

— *H.* (*B.*) *salasi* (P. Balogh, 1994) **comb. n.** (*Bornemiszaella*)

Remarks. *Bornemiszaella* was proposed by P. Balogh (1994) as a genus of Granuloppiidae, differentiated from other genera by characters of pedotecta I, the rostrum, sensilli and humeral region. These characters (including also the position of dorsal notogastral setae) are not apomorphic in Granuloppiidae and in our opinion can be used as diagnostic traits to justify subgenera, but not genera.

4) *Hammerella* (*Woasella*) Balogh and Balogh, 2002 **stat. n.**

Diagnosis. Rostrum without incisions; sensilli with developed ciliate head; 10 pairs of notogastral setae present (setae *c* developed); dorsal setae of notogaster inserted in four paralel rows; one pair of notogastral humeral tubercles present; epimeral border IV indistinct.

Type species. *Pulchroppia sufflata* Franklin and Woas, 1992

Known species:

— *H.* (*W.*) *sufflata* (Franklin and Woas, 1992) **comb. n.** (*Pulchroppia*)

Remarks. Franklin and Woas (1992) described *Pulchroppia sufflata* as a representative of *Pulchroppia* Hammer, 1979 (Oppiidae). However,

Fig. 1–2. *Hammerella* (*Parawoasella*) *bayartogtokhi* sp. n., adult: 1 — dorsal view, only basal part of legs shown; 2 — ventral view, legs not shown. Scale bar 100 μm.

it is similar morphologically to members of Granuloppiidae, and we agree with J. Balogh and P. Balogh (2002), who included it instead in the *Granuloppia* group and proposed the generic name *Woasella* for this species. They did not give a generic diagnosis, but some morphological characters that allow its differentiation (Article 13.1 of Rules of Zoological Nomenclature) were presented in a key. While *Pulchroppia sufflata* was not specifically listed as type species, it can be considered fixed by monotypy (Article 68.3 of Rules of Zoological Nomenclature).

Woasella is morphologically similar to *Hammerella* (*Bornemiszaella*), but can be differentiated by the rostrum, sensilli and humeral region, as indicated in the diagnoses. These characters are not apomorphic in Granuloppiidae and in our opinion can be used as diagnostic traits to justify subgenera, but not genera.

Hammerella (Parawoasella) subgen. n.

Diagnosis. Rostrum rounded; sensilli with developed ciliate head; 13 pairs of notogastral setae (setae *c* developed; *da*, *dm*, *dp* present); dorsal setae of notogaster inserted in four parallel rows; one pair of notogastral humeral tubercles present; epimeral border IV indistinct.

Type species. *Hammerella bayartogtokhi* sp. n.

Known species:

— *H.* (*P.*) *bayartogtokhi* **sp. n**.

Etymology. The prefix *para* is Latin meaning "near" and refers to the similarity between the new subgenus and the subgenus *Hammerella* (*Woasella*).

Remarks. *Hammerella* (*Parawoasella*) **subgen. n.** is distinguishable from other subgenera of *Hammerella* by the presence 13 pairs of notogastral setae (versus 10 pairs). Number of notogastral setae is not an apomorphic character therefore we used it as diagnostic trait to justify subgenus, but not genus.

Hammerella (*Parawoasella*) *bayartogtokhi* sp. n.

Figs 1–20

Diagnosis. With characters of *Hammerella* (*Parawoasella*) given above. Body length 431–481 × 249–282; surface smooth, except lateral parts of prodorsum microgranulate. Costulae and

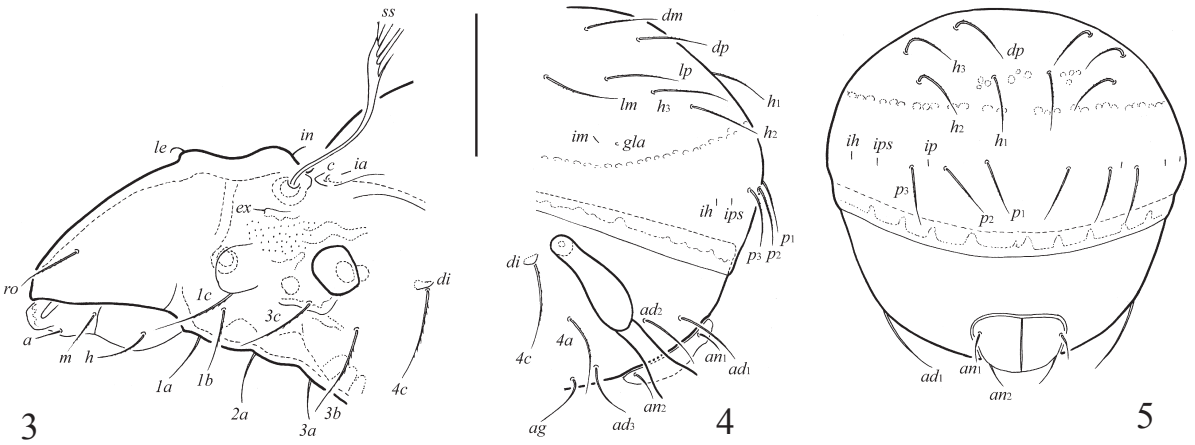

Fig. 3–5. *Hammerella* (*Parawoasella*) *bayartogtokhi* sp. n., adult: 1 — lateral view of proterosoma, legs (except trochanter III) not shown; 2 — lateral view of posterior part of mite, only basal part of leg IV shown; 3 — posterior view, legs not shown. Scale bar 100 μm.

translamella well developed. Rostral setae setiform and barbed. Lamellar, interlamellar and exobothridial setae thin and smooth. Sensilli with dilated head, having long and short cilia unilaterally. Notogastral setae *c* present, short, thin; other 12 pairs setiform, barbed, of medium size. Palptarsus solenidion dilated distally. Epimeral border II with two short, pigmented, ridge-like structures; sejugal border with two pairs of tubercles.

Description. *Measurements*. Body length 431 (holotype, male), 431–481 (mean 456; six paratypes: five males and one female); body width 249 (holotype), 249–282 (mean 260; six paratypes).

Integument. Body color light brown; surface smooth, except lateral parts of prodorsum microgranulate.

Prodorsum (Figs. 1, 3, 6, 7). Rostrum rounded. Costulae length less than half that of prodorsum, pair slightly converging. Translamella present, but pigmented less than costula. With darkened line running from medial part of costulae, directed anterolaterally to acetabula I. Interbothridial region with two transverse thin lines and several pairs of small, poorly visible muscle sigillae anterior to them. Postbothridial region with one pair of small tubercles. Rostral setae (*ro*) 36–41, setiform, barbed, set on small tubercles. Lamellar (*le*) and interlamellar (*in*) setae 12–16, setiform, thin, smooth, slightly curved. Exobothridial setae (*ex*) 12–16, setiform, thin, straight, smooth. Sensilli (*ss*) with long stalk and oblong, dilated lanceolate head, having 4–6 long and 3–4 short cilia unilaterally; opposite side of heads smooth or with one short cilium.

Notogaster (Figs. 1, 3–5). Anterior margin straight, with one pair of distinct humeral tubercles opposing postbothridial tubercles. Setae *c* present, short (8), smooth, inserted at base of respective humeral tubercle. The other twelve pairs of notogastral setae of medium size (*da*, *la*, *dm*, *lm*, *dp*, *lp*, h_3 53–61, h_1, h_2 41–49, p_1–p_3 36–41) setiform, barbed. Setae p_1–p_3 inserted laterally on posterior part, others inserted dorsally in two parallel rows. Lyrifissures (*ia*, *im*, *ip, ih, ips*) short, distinct. Opisthonotal gland openings poorly visible, located posteriorly to *im*.

Gnathosoma (Figs. 2, 3, 16–18). Subcapitulum longer than wide (90–98 × 61–69). Hypostomal setae setiform, barbed; *h* (36–45) longer than *m* (28–32) and *a* (16–20). Adoral setae absent. Palps 61–65, with setation 0–2–1–3–8(+1ω). Solenidion dilated distally, inserted on anterior part of palptarsus and connected with *acm*. Chelicerae 90–94. Cheliceral setae long, setiform, barbed; *cha* (28) longer, than *chb* (16). Trägårdh's organ distinct.

Epimeral and lateral podosomal regions (Figs. 2, 3, 8, 9). Epimeral border IV indistinct, represented by poorly pigmented line and also muscle sigillar bands. Epimeral border II with two short, pigmented, ridge-like structures. Sejugal border with two pairs of tubercles (anterior tubercles large, posterior tubercles small) directed toward each other. Medial epimeral setae (*1a*, *2a*, *3a*) shorter (32–36) setiform, slightly barbed. The other epimeral setae longer (61–69) setiform, barbed or with short cilia. Discidia (*di*) elongate, blunt-ended.

Anogenital region (Figs. 2, 4, 5, 10, 11, 12). Six pairs of genital (g_1–g_6, 12–16) and two pairs of anal (an_1, an_2, 24–28) setae setiform, smooth. One pair of aggenital (*ag*) and three pairs of adanal

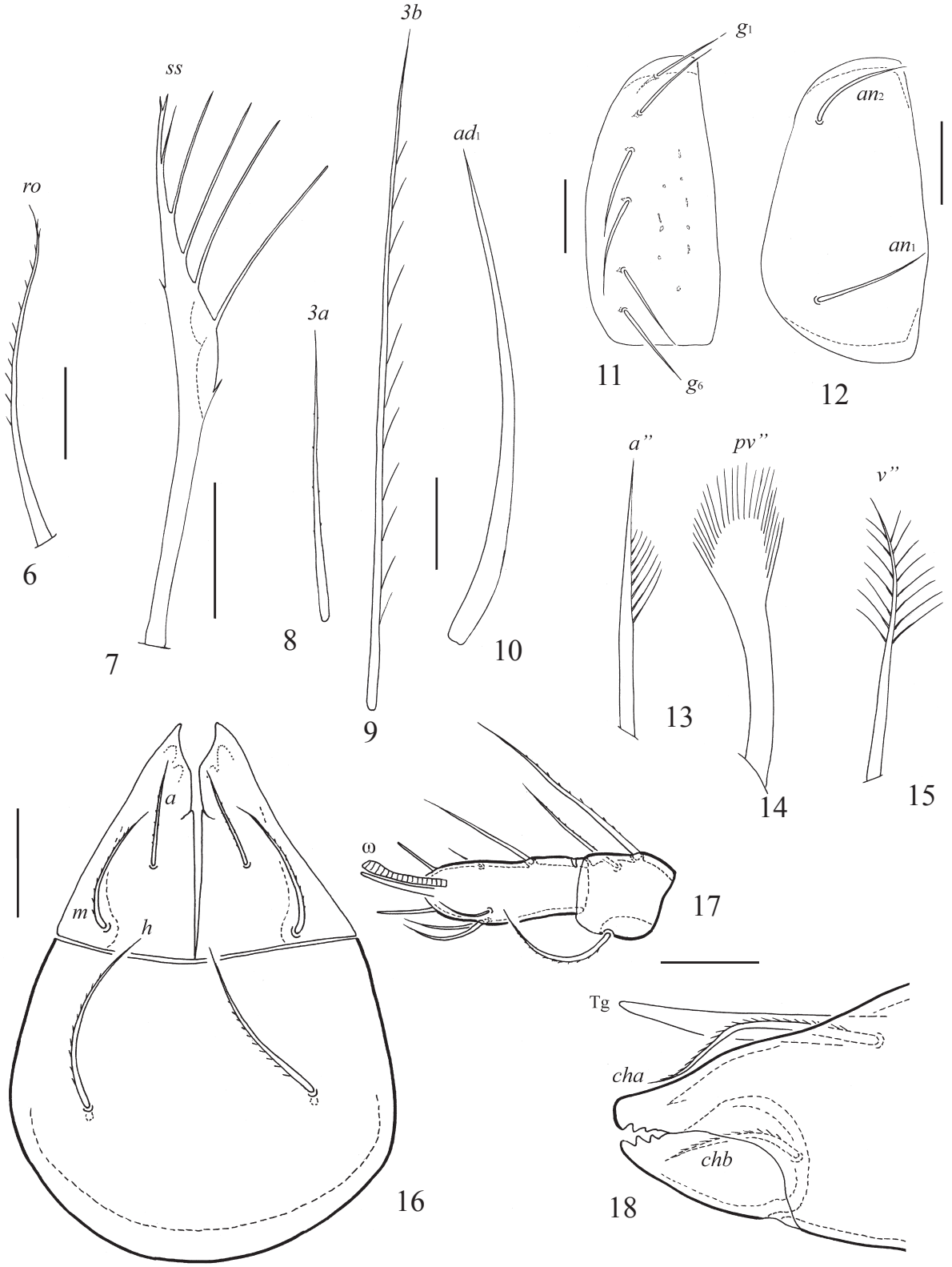

Fig. 6–18. *Hammerella* (*Parawoasella*) *bayartogtokhi* sp. n., adult: 6 — rostral seta; 7 — distal part of sensillus; 8 — epimeral seta *3a*; 9 — epimeral seta *3b*; 10 — adanal seta ad_1; 11 — genital plate, right; 12 — anal plate, right; 13 — seta *a″* on leg tarsus IV; 14 — seta *pv″* on leg tarsus IV; 15 — seta *v″* on leg tibia IV; 16 — subcapitulum; 17 — tarsus and tibia of palp; 18 — anterior part of chelicera. Scale bar 10 μm (6, 8–11, 13–15, 17, 18); 20 μm (7, 12, 16).

(ad_1–ad_3) setae (53–61) directed medially, setiform, smooth or with indistinct barbs.

Legs (Figs. 13–15, 19, 20). Tarsi each with one smooth claw; that of tarsus IV larger than others. Formulae of leg setation and solenidia: I (1–5–2–4–20) [1–2–2], II (1–5–2–4–13) [1–1–2], III (2–3–1–3–13) [1–1–0], IV (1–2–2–3–10) [0–1–0]; homology of setae and solenidia indicat-

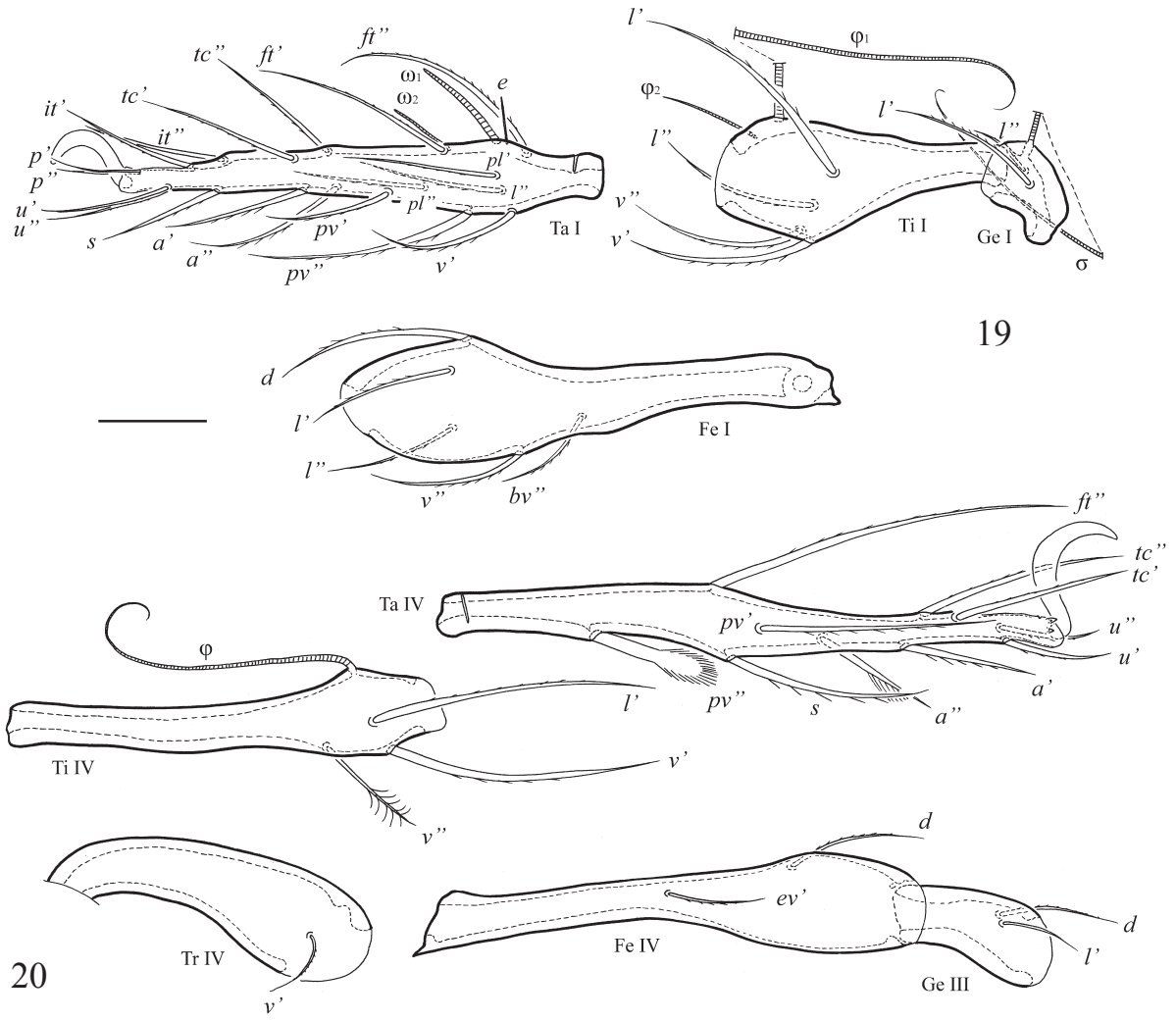

Fig. 19–20. *Hammerella* (*Parawoasella*) *bayartogtokhi* sp. n., adult: 19 — leg I, without trochanter, right, paraxial view; 20 — leg IV, left, antiaxial view. Scale bar 20 μm.

ed in Table 1. Setae setiform and barbed, but some ventral setae with short cilia. Three setae on tarsus IV modified relative to those on other legs: *a"* setiform, with cilia unilaterally only in medial part; *pv"* dilated distally and with radiate cilia; *v"* setiform, with long cilia in medio-distal part. Famulus setiform, straight, blunt-ended, inserted posterior to solenidion ω_1. Solenidia ω_1, ω_2 on tarsi I and II and σ on genua III rod-like, weakly thickened. Other solenidia longer, thinner, setiform.

Material examined. Holotype (male) and six paratypes (five males and one female): southern Vietnam, north-eastern Binh Phuoc Province, Phuoc Long district, Bu Gia Map National Park, 12°12′N, 107°12′E, under *Dipterocarpus alatus* in dark loamy soil with litter (leaves and branches), 17–31 May 2011, collected by A.E. Anichkin.

Type deposition. The holotype is deposited in the collection of the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia; three paratypes are deposited in the collection of Siberian Zoological Museum, Novosibirsk, Russia; three paratypes are in the personal collection of the first author.

Etymology. The species is named in honor of the distinguished acarologist Prof. Dr. Badamdorj Bayartogtokh (National University of Mongolia, Ulaanbaatar, Mongolia), for his extensive contributions to our knowledge of the oribatid mites.

Key to subgenera and species of the genus *Hammerella*

1. Dorsal setae of notogaster inserted in two parallel rows 2
— Dorsal setae of notogaster inserted in four subparallel rows 6
2. Epimeral border IV distinctly developed 3
— *Hammerella* (*Hammerella*) Balogh, 1983
— Epimeral border IV indistinct 4
— *Hammerella* (*Interoppia*) Mahunka, 1987

Table 1.
Leg setation and solenidia of adult *Hammerella* (*Parawoasella*) *bayartogtokhi* sp. n.

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

Roman letters refer to normal setae (*e* to famulus), Greek letters to solenidia. 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.

3. Some sensillar cilia longer than length of head; interlamellar setae shorter than lamellar and rostral setae ..... *H.* (*H.*) *gracilis* (Hammer)
— All sensillar cilia shorter than length of head; interlamellar setae longer than lamellar and rostral setae ..... *H.* (*H.*) *pectinata* (Aoki)
4. Rostrum truncate anteriorly; sensillar cilia considerable shorter than length of head; costulae are connected distally by a transverse ridge .... *H.* (*I.*) *rostroreticulata* (Ohkubo, Aoki and Hu)
— Rostrum rounded; many sensillar cilia equal to or longer than length of head; costulae are not connected distally by a transverse ridge 5
5. Smaller species (341–372 × 198–213); rostral setae longer than lamellar setae, interlamellar setae shortest ..... *H.* (*I.*) *kerangas* (Mahunka)
— Larger species (396–441 × 228–257); rostral, lamellar and interlamellar setae differ little in length ..... *H.* (*I.*) *mirabilis* (Mahunka)
6. Sensilli setiform, with long and usually bifurcate cilia ..... 7 — *Hammerella* (*Bornemiszaella*) Balogh, 1994 stat. n.
— Sensilli with developed head, ciliate 9
7. Notogastral setae short, not reaching insertion of next seta in respective longitudinal row; lamellar setae not shorter than sensilli; sensilli with 6–7 cilia ..... *H.* (*B.*) *salasi* (Balogh) comb. n.
— Notogastral setae long, reaching insertion of seta posterior to it in respective row; lamellar setae considerable shorter than sensilli; sensilli with 4–5 cilia 8
8. Larger species (402–443 × 242–250); interlamellar setae considerable shorter than lamellar setae ..... *H.* (*B.*) *fournieri* (Balogh) comb. n.
— Smaller species (299–324 × 168–172); interlamellar setae not shorter than lamellar setae .... *H.* (*B.*) *ramirezi* (Balogh) comb. n.
9. Ten pairs of notogastral setae; interlamellar setae longer than rostral setae ..... *Hammerella* (*Woasella*) Balogh and Balogh, 2002 stat. n., *H.* (*W.*) *sufflata* (Franklin and Woas) comb. n.
— Thirteen pairs of notogastral setae; interlamellar setae shorter than rostral setae ..... *Hammerella* (*Parawoasella*) subgen. n., *H.* (*P.*) *bayartogtokhi* sp. n.

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