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## Three new species of the genus *Austrophthiracarus* from New Zealand (Acari: Oribatida: Phthiracaridae)

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### Abstract

Three new species of *Austrophthiracarus* (Oribatida: Phthiracaridae) from New Zealand are described: *Austrophthiracarus matuku* **sp. nov.** from the Bethells Matuku Reserve, Auckland, *Austrophthiracarus notoporosus* **sp. nov.** from the Tutoke Bench, Fiordland and *Austrophthiracarus karioi* **sp. nov.** from the Mt. Karioi, Waikato. Holotype specimens are deposited in the New Zealand Arthropod Collection, Landcare Research and paratypes are deposited in the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences.

**Key words:** Soil mites, Oribatida, Phthiracaridae, *Austrophthiracarus*, new species, New Zealand

### Introduction

The family Phthiracaridae (Oribatida) consists of nearly 800 described species in 10 genera and is the largest family of ptyctimous mites (Niedbala 1994, Subias 2013). This paper is one of a series of recent efforts to increase our understanding of the phthiracarid fauna in New Zealand. Liu & Zhang (2013a) added a new species of *Atropacarus* (*Atropacarus*), Liu & Zhang (2013b) added two new species of *Notophthiracarus*, Liu & Zhang (2013c & d) added three new species of *Austrophthiracarus*, and Liu & Zhang (2013e) added two new species of *Phrathicarus*. This paper describes three more new species of *Austrophthiracarus* from New Zealand.

Balogh and Mahunka (1978) proposed *Austrophthiracarus* with *A. radiatus* as type species. The members of this genus are mainly distinguished by median and lateral fields of prodorsum not fused; rostral setae inserted at distance from the end of rostrum; notogaster with 15 pairs of setae but often neotrichous; genital setae arranged in two rows, setae  $g_6$  close to or even above  $g_4$ , at least setae  $g_6$  and  $g_7$  far away from paraxial region; adanal setae far away from paraxial margin, two setae ( $an_1$  and  $an_2$ ) near the paraxial margin of ano-adanal plate; setae  $d$  on tibiae IV short, coupled with solenidions (Niedbala 1994). Prior to this study, 42 species of *Austrophthiracarus* were known in the Australian Region, of which only seven species have been found in New Zealand (Niedbala 2012, Liu & Zhang 2013c, d). The purpose of this paper is to provide detailed descriptions and illustrations of three new species of this genus from New Zealand. This brings the total number of New Zealand species of the genus *Austrophthiracarus* to 10.

### Material and methods

Measurements and descriptions are based on specimens mounted in temporary cavity slides that were studied using a light microscope equipped with a drawing attachment.

Terminology generally follows Niedbała (1992, 2000). The unit of measurement is micrometre ( $\mu\text{m}$ ).

Holotype specimens are deposited in the New Zealand Arthropod Collection, Landcare Research, Auckland (NZAC). Paratype specimens are deposited in the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun (NIGA).

## Descriptions of new species

### *Austrophthiracarus matuku* sp. nov.

(Figs. 1–9)

**Material examined:** Holotype: adult (NZAC, in alcohol, 87/8), New Zealand: AK, Bethells, Matuku Reserve, from litter, 23 Jun. 1987, leg. R. C. Craw. Paratypes: two adults (NIGA, in alcohol, 87/8), same data as holotype.

**Etymology.** Named after Matuku Reserve, the type locality; used here as a noun in apposition.

**Description.** *Measurements.* Holotype: Prodorsum: length 320, width 245, height 115, setae: *ss* 45, *ro* 35, *le* 40, *in* 56, *ex* 10; mutual distance: *in-in* 107, *ro-ro* 50; notogaster: length 650, width 430, height 400; setae: *c*<sub>1</sub> 124, *d*<sub>1</sub> 85, *e*<sub>1</sub> 80, *h*<sub>1</sub> 85, *ps*<sub>1</sub> 96; ventral region: *ad*<sub>1</sub> 100, *ad*<sub>2</sub> 100, *ad*<sub>3</sub>' 50, *ad*<sub>3</sub> 45, *an*<sub>1</sub> 80, *an*<sub>2</sub> 85; genito-aggenital plate 190×125, ano-adanal plate 300×145. Paratypes: Prodorsum: length 310–330, width 245–248, height 115–120; notogaster: length 635–645, width 420–425, height 390–392.

*Integument.* Colour yellowish. Surface of body strongly foveolate.

*Prodorsum* (Figs. 1–3). Median crista and posterior furrows absent; lateral carinae very short, ending far from sinus; sigillar fields not visible; sensilli (*ss*) short, smooth and fusiform, rounded apically; exobothridial (*ex*) setae short and fine; other prodorsal setae (*in*, *le*, *ro*) short, rough and spiniform; lamellar setae slightly thicker than rostral and interlamellar setae; rostral setae far away from each other; comparative length: *in*>*ss*>*le*>*ro*>*ex*; *in/le*=1.4; mutual distance of setae: *in-in/ro-ro*=2.14.

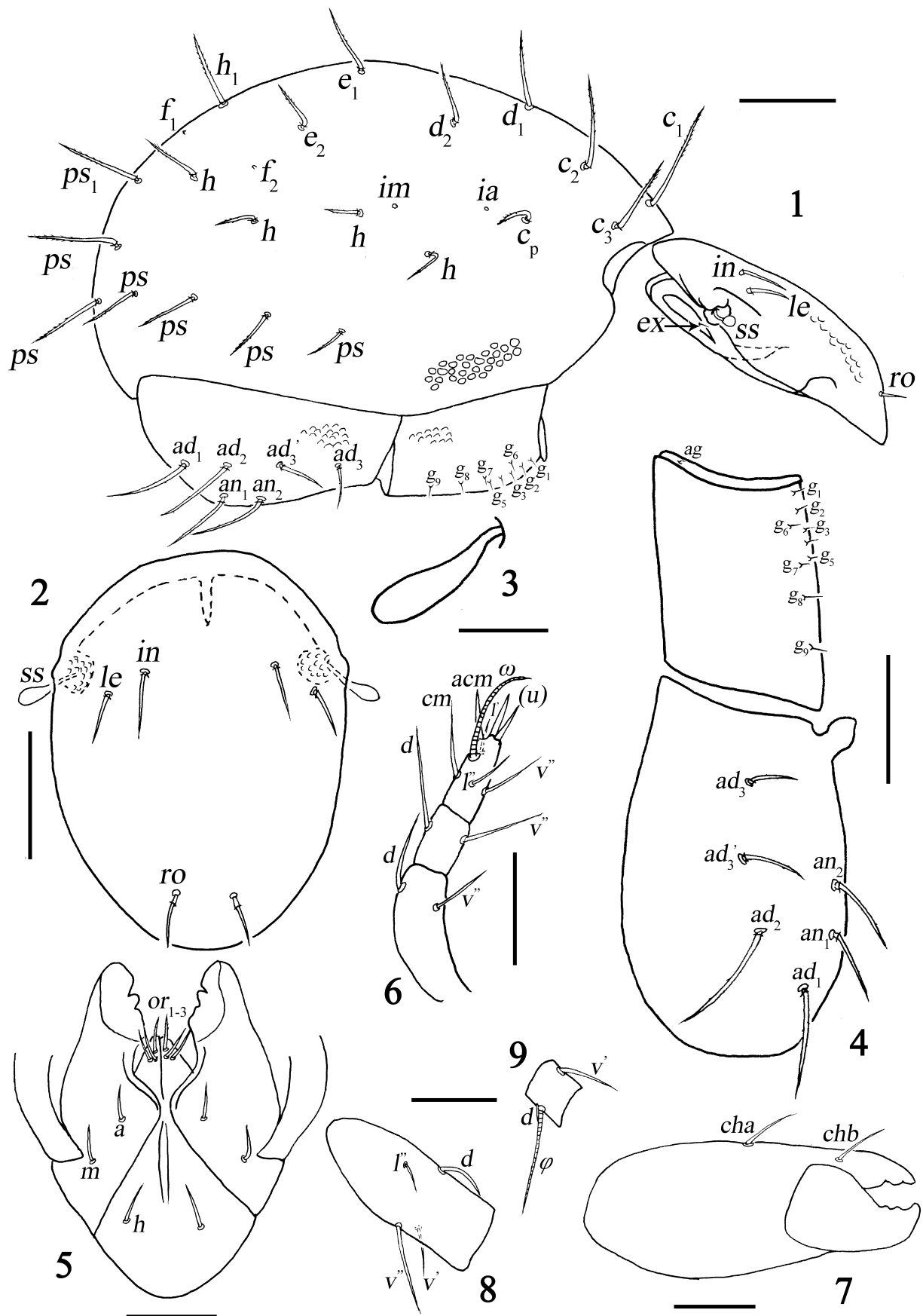
*Notogaster* (Fig. 1). 20 pairs of setae present, fairly short (*c*<sub>1</sub>/*c*<sub>1</sub>-*d*<sub>1</sub>=0.71), robust, densely barbed in distal half; setae *c*<sub>2</sub> further from anterior border than setae *c*<sub>1</sub> and *c*<sub>3</sub>; additional setae present in *h* and *ps* series; vestigial setae *f*<sub>1</sub> positioned posterior to setae *h*<sub>1</sub>; two pairs of lyrifissures *ia* and *im* present.

*Gnathosoma* (Figs. 5–7). Subcapitulum normal (Fig. 5); setae *h*, *m* and *a* simple and smooth; setae *h* shorter than distance between them; adoral seta *or*<sub>1</sub> apparently flat with barbs; *or*<sub>2-3</sub> simple and smooth; palp (Fig. 6) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Fig. 7) typical of family.

*Ano-genital region* (Figs. 1, 4). Nine pairs of genital setae (*g*) arranged in two rows with formula: (4+5): 0; ano-adanal plates each with six setae (*ad*, *an*), all thick, straight and slightly barbed; comparative length: *ad*<sub>1</sub>=*ad*<sub>2</sub>>*an*<sub>2</sub>>*an*<sub>1</sub>>*ad*<sub>3</sub>'>*ad*<sub>3</sub>.

*Legs* (Figs. 8–9). Chaetotaxy of legs complete; setal counts for leg segments: I: 1-4-2(2)-5(1)-17(3); II: 1-3-2(1)-3(1)-12(2), III: 2-2-1(1)-2(1)-10, IV: 2-1-1-2(1)-10; setae *d* on femora I long, inserted at level of setae *v*", more anterior to the level of *l*" and far from distal end of segment; setae *a*" on tarsi I and setae *ft*" on tarsi II curved distally; setae *a*" on tarsi II curved distally; setae *s* and *pv*' on tarsi IV present; setae *s* on tarsi I and II present.

**Remark.** This new species is similar to *Austrophthiracarus paralargus* Niedbała & Penttinen, 2007 from Australia in the following features: surface of body strongly foveolate, sigillar fields not visible, similar shape of sensilli and other prodorsal setae, similar length of notogastral setae, vestigial setae *f*<sub>1</sub> positioned posterior to setae *h*<sub>1</sub>, two pairs of lyrifissures *ia* and *im* present, genital setae with formula: (4+5): 0, chaetotaxy of legs complete, and setae *d* on femora I long and far from distal end of segment. These two species can be easily distinguished from each other by the following ten characters (a versus b): in *A. matuku* sp. nov., (1a) rostral setae far from each other (*in-in/ro-ro*=2.14); (2a) lateral carinae short; (3a) *in*>*ss*>*le*>*ro*; (4a) 20 pairs of notogastral setae present, setae not obtuse apically; (5a) ano-adanal plates with six pairs of setae, all adanal setae far from paraxial margin; in *A. paralargus*, (1b) rostral setae close to each other (*in-in/ro-ro*≈4.62); (2b) lateral carinae absent; (3b) *in*>*ro*>*le*=*ss*; (4b) 22 pairs of notogastral setae present, setae obtuse apically; (5b) ano-adanal plates with seven pairs of setae, one pair of adanal setae shifted towards the paraxial margin.



**FIGURES 1–9.** *Austrophthiracarus matuku* sp. nov.: 1, lateral view of body (legs removed); 2, prodorsum, dorsal view; 3, sensillus, dorsal view; 4, right side of ventral plate; 5, subcapitulum, palpi removed; 6, palp, antiaxial view; 7, chelicera, antiaxial view; 8, femur I; 9, tibia IV. Scale bars: 1, 2, 4=100  $\mu$ m; 5–9=50  $\mu$ m; 3=25  $\mu$ m.

It also similar to *Austrophthiracarus largus* Niedbala, 2000 from New Caledonia, but differs by following features (a versus b): in *A. matuku* **sp. nov.**, (1a) surface of body strongly foveolate; (2a) sigillar fields not visible; (3a) lateral carinae short; (4a) region under lateral carinae without striations; (5a) sensilli smooth and rounded apically; (6a)  $in > ss > le > ro > ex$ ; (7a)  $in-in/ro-ro=2.14$ ; (8a) five setae situated in line in setae *ps* series; (9a) setae *v'* on femora I present; (10a) setae *l''* on femora I located proximal to setae *d*; in *A. largus*, (1b) surface of body densely porose; (2b) sigillar fields visible; (3b) lateral carinae absent; (4b) region under lateral carinae striated; (5b) sensilli spinose and pointed apically; (6b)  $in > ss = ro > le > ex$ ; (7b)  $in-in/ro-ro \approx 1.45$ ; (8a) only three setae situated in line in setae *ps* series; (9b) setae *v'* on femora I absent; (10b) setae *l''* on femora I located distal to setae *d*.

Compared with *Austrophthiracarus espeletius* (Balogh, 1984) from the Neotropical Region, this new species can be distinguished by following features: in *A. Matuku* **sp. nov.**, (1a) surface of body strongly foveolate; (2a) sigillar fields not visible; (3a) lateral carinae short; (4a) sensilli smooth, with rounded end; (5a) rostral setae situated near anterior margin of prodorsum; (6a)  $in-in/ro-ro=2.14$ ; (7a) two pairs of *ps* setae situated under  $ps_1$ ; (8a)  $h < h-h$ ; (9a) setae *g*, close to anterior margin of genito-aggenital plates; in *A. espeletius*, (1b) surface of body punctate; (2b) sigillar fields visible; (3b) lateral carinae absent; (4b) sensilli barbed, with sharp distal point; (5b) rostral setae situated far from anterior margin of prodorsum; (6b)  $in-in/ro-ro \approx 2.83$ ; (7b) only one pair of *ps* setae situated under  $ps_1$ ; (8b)  $h = h-h$ ; (9b) setae  $g_1$  far from anterior margin of genito-aggenital plates.

### ***Austrophthiracarus notoporosus* sp. nov.**

(Figs. 10–18)

**Material examined:** Holotype: adult (NZAC, in alcohol, 77/12), New Zealand: FD, Tutoko Bench, 1219 m, from shaded litter, moss and liverworts, 13 Jan. 1977, leg. J.S. Dugdale. Paratypes: two adults (NIGA, in alcohol, 77/12), same data as holotype.

**Etymology.** Named after “porose area-like” structures on the surface of notogaster, which usually occur in higher oribatids; used here as a noun in apposition.

**Description.** *Measurements.* Holotype: Prodorsum: length 215, width 160, height 75, setae: *ss* 25, *ro* 35, *in* 76, *le* 53; notogaster: length 433, width 295, height 265; setae:  $c_1$  70,  $d_1$  50,  $e_1$  50,  $h_1$  55,  $ps_1$  60; ventral region:  $ad_1$  58,  $ad_2$  60,  $ad_3$  42,  $ad_3'$  40,  $an_1$  50,  $an_2$  50; genito-aggenital plate 80×120, ano-adanal plate 80×202. Paratypes: Prodorsum: length 212–220, width 160–165, height 75–85; notogaster: length 395–420, width 232–278, height 235–250.

*Integument.* Colour yellowish. Surface of body finely punctate; notogaster with 8–10 pairs of rounded and densely “porose area-like” structures.

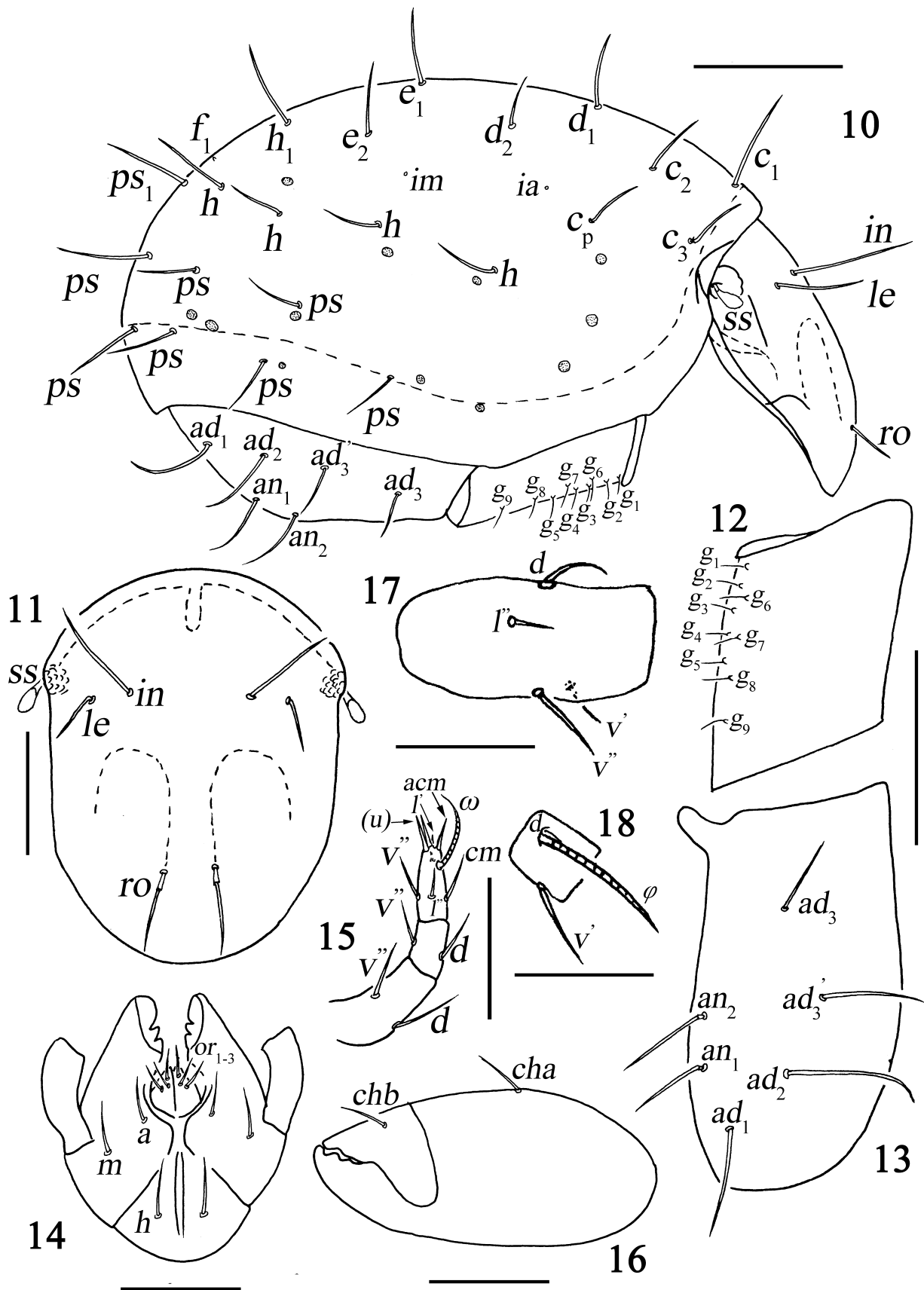
*Prodorsum* (Figs. 10–11). Median crista and posterior furrows absent; lateral carinae short, ending far from sinus; sigillar fields distinct, dorsal field longer than lateral fields; sensilli (*ss*) short with narrow stalk, and head rounded and slightly barbed; interlamellar and lamellar setae (*in*, *le*) long, erect, stout and rough; rostral setae (*ro*) rough, semi-erect; exobothridial setae (*ex*) vestigial; comparative lengths:  $in > le > ro > ss$ ;  $in/le \approx 1.4$ ; mutual distance of setae:  $in-in/ro-ro \approx 2.3$ .

*Notogaster* (Fig. 10). 21 pairs of setae present, medium long ( $c_1/c_1-d_1 \approx 0.65$ ), robust and rough; setae  $c_2$  further from anterior border than setae  $c_1$  and  $c_3$ ; additional setae present in *h* and *ps* series; vestigial setae  $f_1$  positioned posterior to setae  $h_1$ ; two pairs of lyrifissures *ia* and *im* present.

*Gnathosoma* (Figs. 14–16). Subcapitulum normal (Fig. 14); setae *h*, *m* and *a* simple and smooth; setae *h* longer than distance between them; adoral seta  $or_1$  apparently flat with barbs;  $or_{2-3}$  simple and smooth; palp (Fig. 15) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Fig. 16) typical of family.

*Ano-genital region* (Figs. 10, 12–13). Nine pairs of genital setae (*g*) arranged in two rows with formula (4+5): 0; ano-adanal plates each with six setae (*ad*, *an*), all thick and rough; comparative lengths:  $ad_2 > ad_1 > an_1 = an_2 > ad_3 > ad_3'$ .

*Legs* (Figs. 17–18). Setal counts for leg segments: I: 1-4-2(2)-4(1)-17(3); II: 1-3-2(1)-3(1)-12(2), III: 2-2-1(1)-2(1)-10, IV: 2-1-1-2(1)-10; chaetotaxy of legs complete; setae *d* on femora I inserted at level anterior to setae *l''*; setae *a''* on tarsi I and setae *ft''* on tarsi II curved distally; setae *a''* on tarsi II curved distally; setae *s* and *pv'* on tarsi IV present; setae *s* on tarsi I and II present.



**FIGURES 10–18.** *Austrophthiracarus notoporosus* sp. nov.: 10, lateral view of body (legs removed); 11, prodorsum, dorsal view; 12, left side of genito-aggenital plate; 13, left side of ano-adanal plate; 14, subcapitulum, palpi removed; 15, palp, antiaxial view; 16, chelicera, antiaxial view; 17, femur I; 18, tibia IV. Scale bars: 10, 12–13=100  $\mu$ m; 11, 14–16=50  $\mu$ m; 17–18=25  $\mu$ m.

**Remark.** This new species is special in having “porose area-like” structures on the surface of notogaster, which usually occur in higher oribatids. However, we can not confirm what these really are now, and it will need further research in the future.

The new species is distinguishable from congeners by the following combination of characters: 21 pairs of rough notogastral setae present; surface of notogaster punctate, with 8–10 pairs of rounded and densely porose area-like structures; lateral carinae of prodorsum short; sensilli short with rounded head; interlamellar and lamellar setae long,  $in > le$ ; exobothridial setae vestigial; two pairs of lyrifissures  $ia$  and  $im$  present; formula of genital setae (4+5): 0; ano-adanal plates each with six setae; chaetotaxy of legs complete, setae  $d$  on femora I not forked, inserted at level distal to setae  $l''$ .

***Austrophthiracarus karioi* sp. nov.**

(Figs. 19–28)

**Material examined:** Holotype: adult (NZAC, in alcohol, 81/96), New Zealand: WO, Mt. Karioi near base, from litter, 11 Oct. 1981, leg. C. F. Butcher. Paratype: one adult (NIGA, in alcohol, 81/96), same data as holotype.

**Etymology.** Named after type locality Mt. Karioi—an extinct volcano in the Waikato region of New Zealand's North Island; used here as a noun in apposition.

**Description.** *Measurements.* Holotype: Prodorsum: length 285, width 212, height 75, setae:  $ss$  25,  $ro$  10,  $in$  13,  $le$  12,  $ex$  7.5; notogaster: length 516, width 280, height 352; setae:  $c_1$  10,  $d_1$  10,  $e_1$  12.5,  $h_1$  9.5,  $ps_1$  10; ventral region:  $ad_1$  10,  $ad_2$  10,  $an_1$  10,  $an_2$  10; genito-aggenital plate 245×145, ano-adanal plate 245×225. Paratype: Prodorsum: length 330, width 250, height 110; notogaster: length 670, width 410, height 450.

*Integument.* Colour yellowish. Surface of body punctate.

*Prodorsum* (Figs. 19, 21). Weak median crista and posterior furrows present; lateral carinae absent; sigillar fields weak, dorsal field narrow, longer than lateral fields; sensilli ( $ss$ ) with short, narrow stalk and rounded head; other prodorsal setae ( $in$ ,  $le$ ,  $ro$  and  $ex$ ) short and fine; comparative length:  $ss > in > le > ro > ex$ ; mutual distance of setae:  $in-in/ro-ro=4.75$ .

*Notogaster* (Fig. 19–20). 16 (holotype) or 18 (paratype) pairs of setae present, similar in shape with interlamellar setae; setae  $c_2$  further from anterior border than setae  $c_1$  and  $c_3$ ; additional setae present in  $ps$  series (holotype) or in  $h$  and  $ps$  series (paratype); vestigial setae  $f_1$  positioned posterior to setae  $h_1$  in holotype and ventral to setae  $h_1$  in paratype; three pairs of lyrifissures  $ia$ ,  $im$  and  $ip$  present.

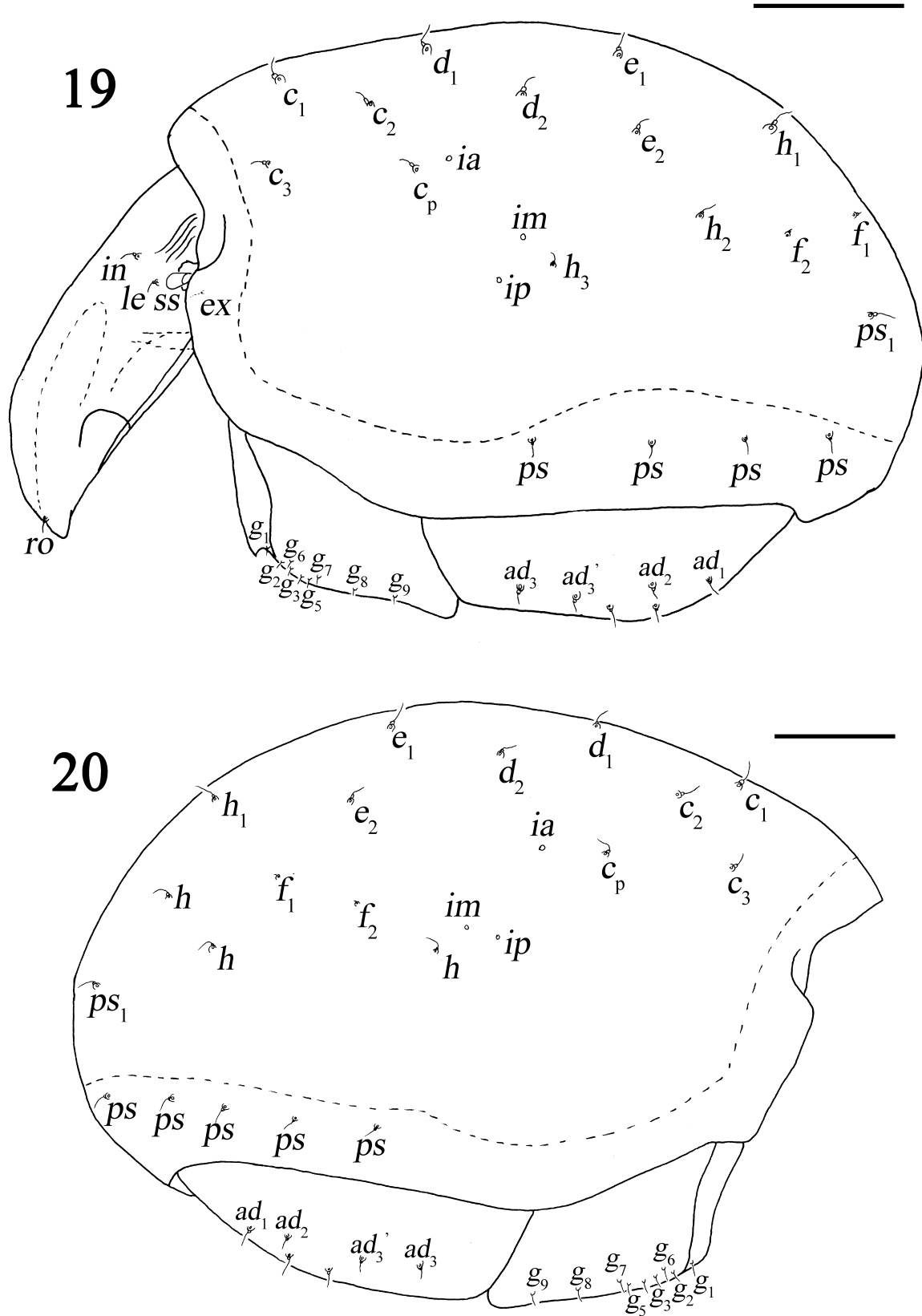
*Gnathosoma* (Figs. 24–26). Subcapitulum normal (Fig. 24); setae  $h$ ,  $m$  and  $a$  simple and smooth; setae  $h$  nearly equal with distance between them; adoral seta  $or_1$  apparently flat with barbs;  $or_{2-3}$  simple and smooth; palp (Fig. 25) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Fig. 26) typical of family.

*Ano-genital region* (Figs. 19–20, 22–23). Nine pairs of genital setae ( $g$ ) present with formula (4+4): 1; ano-adanal plates each with six pairs of short and fine setae ( $an$  and  $ad$ ), except left ano-adanal plate of paratype with seven setae.

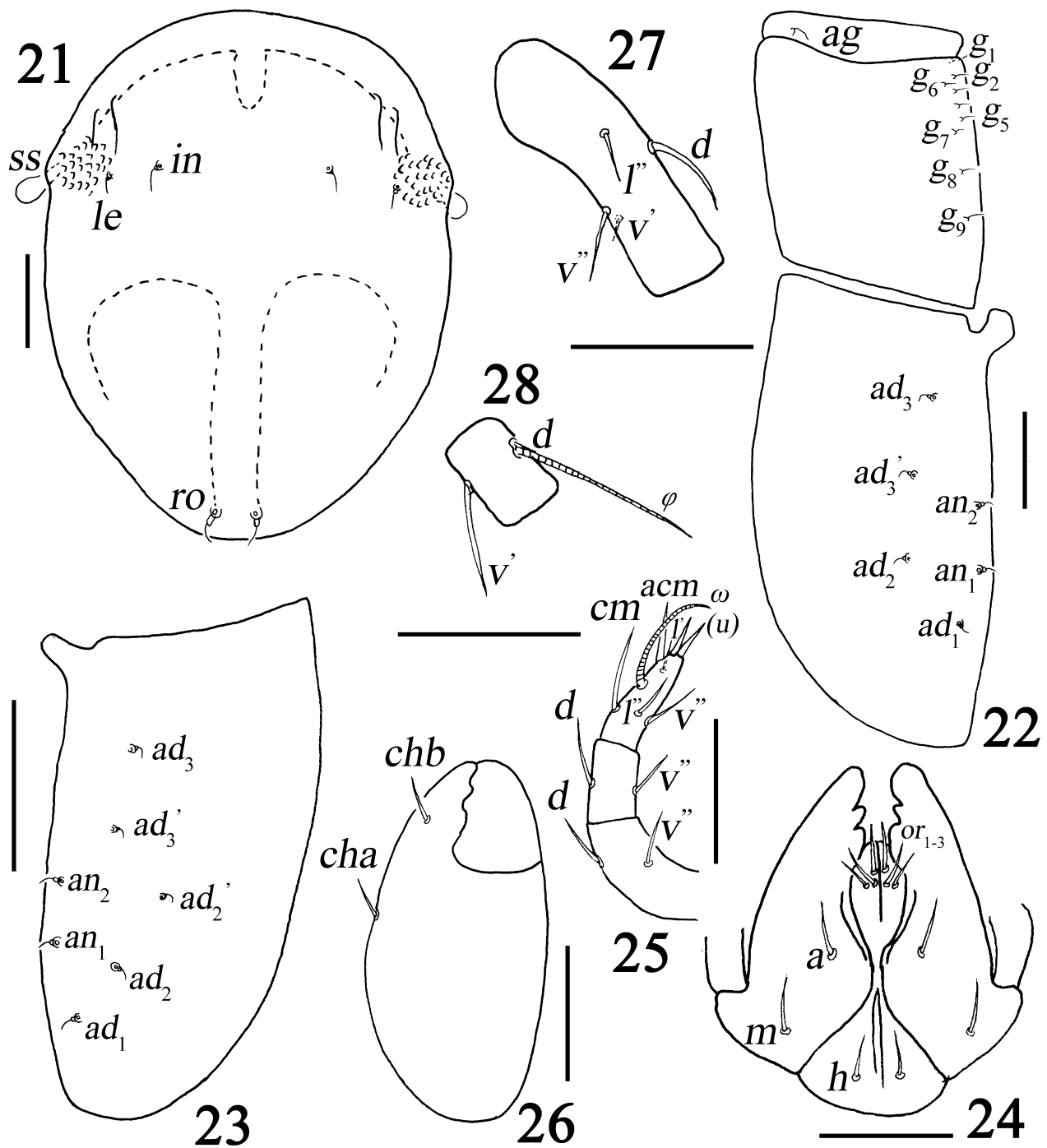
*Legs* (Figs. 27–28). Setal counts for leg segments: I: 1-4-2(2)-4(1)-17(3); II: 1-3-2(1)-3(1)-12(2), III: 2-2-1(1)-2(1)-10, IV: 2-1-1-2(1)-10; chaetotaxy of legs complete; setae  $d$  on femora I long, inserted at level anterior to setae  $l''$ ; setae  $a''$  on tarsi I and setae  $ft''$  on tarsi II curved distally; setae  $a''$  on tarsi II curved distally; setae  $s$  and  $pv'$  on tarsi IV present; setae  $s$  on tarsi I and II present.

**Remark.** This new species is close to *Austrophthiracarus aenus* Niedbala, 2000 from New Caledonia in having short prodorsal and notogastral setae, similar shape of sensilli, lateral carinae absent, setae  $h$  of subcapitulum nearly equal with distance between them, formula of genital setae: (4+4): 1. However, the new species can be easily distinguished from the latter species by the following eight characters (a versus b): in *A. karioi* sp. nov., (1a) median crista and posterior furrows of prodorsum present; (2a) sigillar fields weak, dorsal field narrow, not expanded distally at the level of rostral setae; (3a) prodorsal and notogastral setae (except sensilli) fine; (4a) exobothridial setae not vestigial; (5a) 16 or 18 pairs of notogastral setae present; (6a) three pairs of lyrifissures  $ia$ ,  $im$  and  $ip$  present; (7a) setae  $v'$  on femora I and  $a'$  on tarsi I present; (8a) setae  $d$  on femora I positioned in the middle, at level anterior to setae  $l''$ ; in *A. aenus*, (1b) median crista and posterior furrows of prodorsum absent; (2b) sigillar fields distinct, dorsal field expanded distally at the level of rostral setae; (3b) prodorsal and notogastral

setae (except sensilli) thicker and spiniform; (4b) exobothridial setae vestigial; (5b) 19 pairs of notogastral setae present; (6b) two pairs of lyrifissures *ia* and *im* present; (7b) setae *v'* on femora I and *a'* on tarsi I absent; (8b) setae *d* on femora I displaced towards proximal end of article, at level posterior to setae *l''*.



**FIGURES 19–20.** *Austrophthiracarus karioidi* sp. nov.: 19, lateral view of body (legs removed); 20, lateral view of body of paratype (legs and prodorsum removed); Scale bars: 100  $\mu$ m.



**FIGURES 21–28.** *Austrophthiracarus karioi* sp. nov.: 21, prodorsum, dorsal view; 22, right side of ventral plate; 23, left side of ano-adanal plate (paratype); 24, subcapitulum, palpi removed; 25, palp, antiaxial view; 26, chelicera, antiaxial view; 27, femur I; 28, tibia IV. Scale bars: 21–22, 24–28=50  $\mu$ m; 23=100  $\mu$ m.

Compared with *Austrophthiracarus baloghi* Niedbala, 1987 from Australia, this new species can be distinguished by following features: (1a) surface of body punctate; (2a) median crista of prodorsum weak; (3a) prodorsal and notogastral setae (except sensilli) fine; (4a)  $le > ro$ ; (5a) 16 or 18 pairs of notogastral setae present; (6a) three pairs of lyrifissures *ia*, *im* and *ip* present; (7a) setae *h* of subcapitulum nearly equal with distance between them; (8a) nine genital setae present with formula (4+4): 1; (9a) setae *v'* on femora I present; in *A. baloghi*, (1b) surface of body covered with concavities and irregular protuberances; (2b) median crista of prodorsum much stronger; (3b) prodorsal and notogastral setae (except sensilli) much thicker and obtuse; (4b)



*ro>le*; (5b) 17 pairs of notogastral setae present; (6b) two pairs of lyrifissures *ia* and *im* present; (7b) setae *h* of subcapitulum much longer than distance between them; (8b) ten genital setae present with formula (5+5): 0; (9b) setae *v'* on femora I absent.

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