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Authors: Liu, Dong, and Zhang, Zhi-Qiang

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

DONG LIU<sup>1</sup> & ZHI-QIANG ZHANG<sup>2, 3\*</sup>

<sup>1</sup> Key Laboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun 130102, P. R. China. E-mail: liudong@iga.ac.cn

<sup>2</sup> Landcare Research, 231 Morrin Road, Auckland, New Zealand.

<sup>3</sup> Centre for Biodiversity & Biosecurity, School of Biological Sciences, University of Auckland, Auckland, New Zealand

\* Corresponding author. E-mail: zhangz@landcareresearch.co.nz

### Abstract

Three New Zealand species of *Notophthiracarus* (Oribatida: Phthiracaridae) are described as new to science: *Notophthiracarus motumuka* **sp. nov.** from the Lady Alice Island, Hen & Chickens Islands, *Notophthiracarus tamaki* **sp. nov.** from the Tamaki Estuary Tohuna Torea, Auckland, and *Notophthiracarus rimi* **sp. nov.** from the Red Island, Mercury Islands. All holotype specimens are deposited at New Zealand Arthropod Collection, Landcare Research and some paratypes are also deposited in Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences.

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

### Introduction

The genus *Notophthiracarus* Ramsay, 1966 is one of the largest genera within the family Phthiracaridae and is widespread in the regions of the world except Nearctic Region (Subías 2014, Niedbała 2002). It is mainly distinguished from others by genital setae arranged in a single row (distance between  $g_6$  and  $g_5$  longer than that between  $g_5$  and  $g_4$  or  $g_3$  and  $g_4$ ), two setae ( $an_1$  and  $an_2$ ) near the paraxial margin of ano-adanal plate, and seta  $d$  on tibiae IV short and coupled with solenidions (Niedbała 1994). According to Niedbała (2012) and data summarized by various authors, 43% known phthiracarid mites (83 species) belong to the genus *Notophthiracarus* in Australian Region. *Notophthiracarus* is also the most diverse group of phthiracarid species in New Zealand, representing 24 species (Liu & Zhang, 2013). In this paper we report three additional new species of *Notophthiracarus* from New Zealand.

### 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 ( $\mu\text{m}$ ).

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

## Descriptions of new species

### *Notophthiracarus motumuka* sp. nov.

(Figs. 1–8)

**Material examined:** Holotype: adult (NZAC, in alcohol, 82/7), New Zealand: ND, Hen & Chickens Is. Lady Alice Island, Main Ridge above Grave Bay, from litter, 1 Jan. 1982, leg. R. Hay. Paratype: one adult (NIGA, in alcohol, 82/7), same data as holotype.

**Etymology.** Named after the type locality—the Lady Alice Island. Motu Muka is the Māori name for the Lady Alice Island, which is a large one (also known as the Big Chicken) among the Hen & Chicken Islands. It is here used as a noun in apposition.

**Description.** *Measurements.* Holotype: Prodorsum: length 240, width 155, height 95, setae: *ss* 38, *ro* 33, *in* 85; notogaster: length 428, width 270, height 287; setae: *c*<sub>1</sub> 78, *d*<sub>1</sub> 70, *e*<sub>1</sub> 75, *h*<sub>1</sub> 70, *ps*<sub>1</sub> 63; ventral region: *ad*<sub>1</sub> 90, *ad*<sub>2</sub> 98, *ad*<sub>3</sub> 19, *an*<sub>1</sub> 45, *an*<sub>2</sub> 48; genito-aggenital plate 100×102, ano-adanal plate 80×175. Paratype: Prodorsum: length 250, width 160, height 97; notogaster: length 435, width 275, height 290.

*Integument.* Colour yellowish. Surface of body covered with small and rounded foveoles with some distances between them.

*Prodorsum* (Figs. 1–2). Median crista and posterior furrows absent; lateral carinae reaching sinus; sigillar fields distinct, dorsal field narrow, longer than lateral fields; sensilli (*ss*) with narrow stalk, and fusiform head, covered with small spines; interlamellar setae (*in*) long, erect and stout, densely covered with small spines in distal half; rostral setae (*ro*) rough and semi-erect, much thinner than interlamellar setae; lamellar (*le*) and exobothridial (*ex*) setae vestigial; comparative length: *in*>*ss*>*ro*; mutual distance of setae: *in*–*in*/*ro*–*ro*=4.

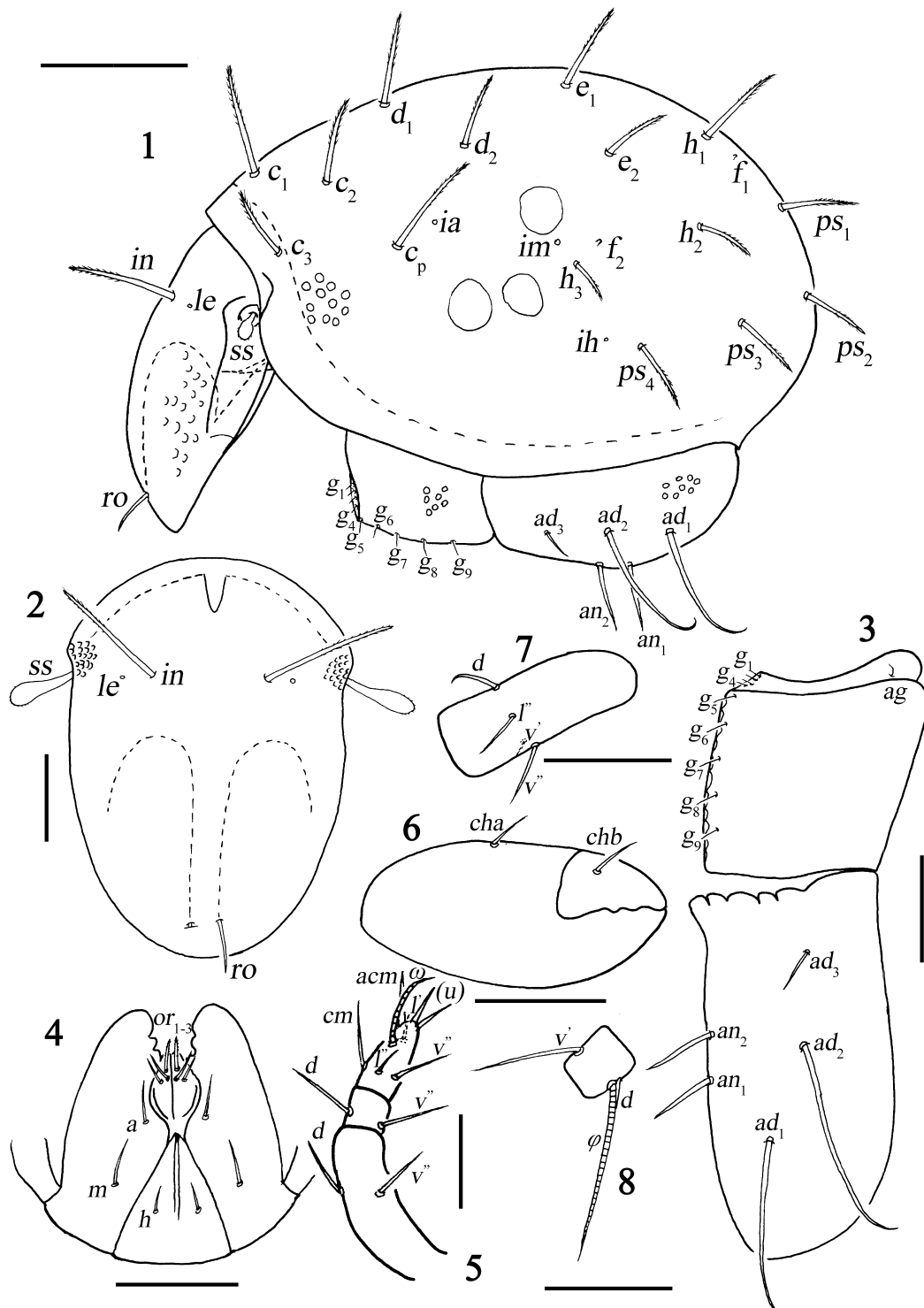
*Notogaster* (Fig. 1). 15 pairs of setae (*c*<sub>1</sub>/*c*<sub>1</sub>–*d*<sub>1</sub>=0.78) present, similar in shape with interlamellar setae; setae *h*<sub>3</sub> shortest and thinnest; setae *c*<sub>1</sub> and *c*<sub>3</sub> near anterior border, setae *c*<sub>2</sub> much further; vestigial setae *f*<sub>1</sub> positioned posterior to setae *h*<sub>1</sub>; three pairs of lyrifissures *ia*, *im* and *ih* present.

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

*Ano-genital region* (Figs. 1, 3). Genital setae (*g*) with formula: 5: 4; ano-adanal plates each with five pairs of rough setae (*an* and *ad*), setae *ad*<sub>1</sub> and *ad*<sub>2</sub> long, thick and hooked distally, setae *an*<sub>1</sub> and *an*<sub>2</sub> thinner but straight, setae *ad*<sub>3</sub> shortest and thinnest, but distinctly longer and thicker than genital setae; comparative length: *ad*<sub>2</sub>>*ad*<sub>1</sub>>*an*<sub>2</sub>>*an*<sub>1</sub>>*ad*<sub>3</sub>.

*Legs* (Figs. 7–8). Setal counts for leg segments (without tarsi): I: 1-4-2(2)-4(1); II: 1-3-2(1)-3(1), III: 2-2-1(1)-2(1), IV: 2-1-1-2(1); chaetotaxy of legs complete; setae *d* on femora I inserted at level of 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 more close to *Notophthiracarus repostus* Niedbala, 1989 in sharing the following features: posterior furrows of prodorsum absent, similar shape of sensilli, interlamellar and notogastral setae, lamellar and exobothridial setae vestigial, vestigial setae *f*<sub>1</sub> positioned posterior to setae *h*<sub>1</sub>, formula of genital setae: 5: 4, similar shape of setae *ad*<sub>2</sub> and *ad*<sub>3</sub>, and chaetotaxy of legs complete. However, the new species can be easily distinguished from the latter species by the following eight characters (a versus b): in *N. motumuka* sp. nov., (1a) lateral carinae of prodorsum present; (2a) dorsal field of prodorsum not bifurcate at distal end, lateral fields longer; (3a) rostral setae relatively short (*ro* 33), *in*–*in*/*ro*–*ro*=4; (4a) three pairs of lyrifissures *ia*, *im* and *ips* present; (5a) *h*<*h*–*h*; (6a) setae *ps*<sub>4</sub> situated at the level between setae *ad*<sub>1</sub> and *ad*<sub>2</sub>; (7a) setae *ad*<sub>1</sub>



**FIGURES 1–8.** *Notophtiracarus motumuka* sp. nov.: 1, lateral view of body (legs removed); 2, prodorsum, dorsal view; 3, left side of ventral plate; 4, subcapitulum, palpi removed; 5, palp, antiaxial view; 6, chelicera, antiaxial view; 7, femur I; 8, tibia IV. Scale bars: 1=100µm; 2–4, 6–8=50µm; 5=25µm.

similar as  $ad_2$ , long, thick and hooked distally; (8a) setae  $d$  of femora I not bifurcate distally; in *N. repostus*, (1b) lateral carinae of prodorsum absent; (2b) dorsal field of prodorsum bifurcate at distal end, lateral fields shorter; (3b) rostral setae fairly long ( $ro$  66),  $in-in/ro-ro \approx 1.39$ ; (4b) two pairs of lyrifissures  $ia$  and  $im$  present; (5b)  $h > h-h$ ; (6b) setae  $ps_4$  situated at the level between setae  $ad_2$  and  $ad_3$ ; (7b) setae  $ad_1$  thinner and much shorter than  $ad_2$ , slightly hooked distally; (8b) setae  $d$  of femora I bifurcate distally.

***Notophthiracarus tamaki* sp. nov.**

(Figs. 9–19)

**Material examined:** Holotype: adult (NZAC, in alcohol, 83/166), New Zealand: AK, Tamaki Estuary Tohuna Torea, from litter, 13 Oct. 1983, leg. D. Russell. Paratypes: two adults (NZAC, in alcohol, 83/166), same data as holotype; two adults (NIGA, in alcohol, 83/166), same data as holotype.

**Etymology.** Named after type locality. It is here used as a noun in apposition.

**Description. Measurements.** Holotype: Prodorsum: length 330, width 210, height 124, setae:  $ss$  50,  $ro$  13,  $in$  20,  $le$  13,  $ex$  23; notogaster: length 750, width 375, height 435; setae:  $c_1$  13,  $d_1$  15,  $e_1$  23,  $h_1$  18,  $ps_1$  15; ventral region:  $ad_1$  12,  $an_1$  11,  $g_1$  10; genito-aggenital plate  $150 \times 195$ , ano-adanal plate  $105 \times 200$ . Paratypes: Prodorsum: length 232–380, width 178–230, height 104–170; notogaster: length 510–858, width 305–440, height 370–550.

**Integument.** Colour brown. Surface of notogaster with distinct polygonal sculpture, other regions covered with very small and rounded foveoles with some distances between them.

**Prodorsum** (Figs. 9, 11–12). Median crista developed; posterior furrows present; lateral carinae absent; sigillar fields distinct, dorsal field narrow and bifurcate anteriorly, longer than lateral fields; sensilli ( $ss$ ) short and fusiform, covered with small spines; other prodorsal setae ( $in$ ,  $le$ ,  $ro$ ,  $ex$ ) minute and smooth; comparative length:  $ss > ex > in > le = ro$ ; mutual distance of setae:  $in-in/ro-ro \approx 2.4$ .

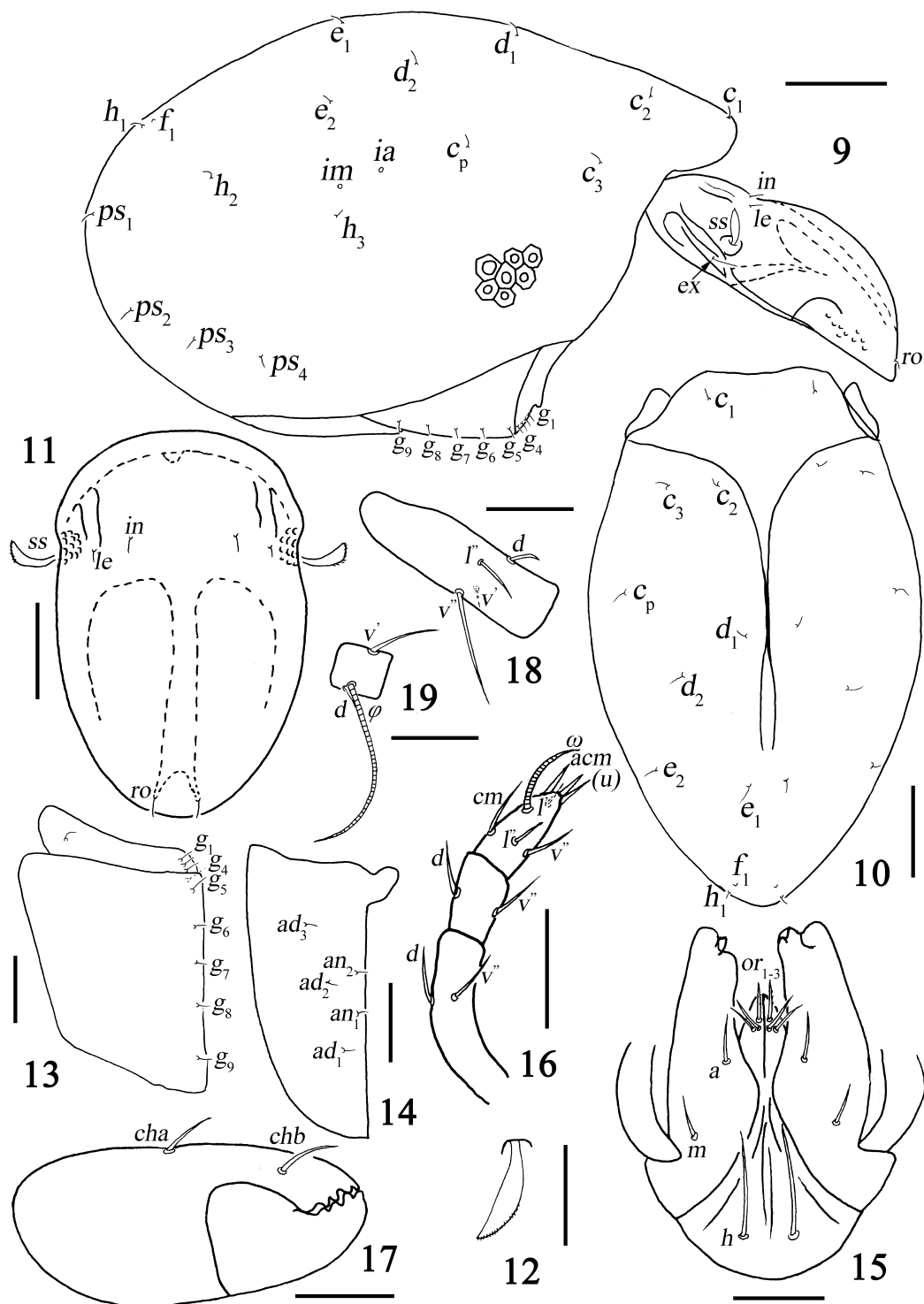
**Notogaster** (Fig. 9–10). Anterior cowl distinct, covered posterior part of prodorsum, not reaching interlamellar setae; one dorsal, longitudinal carinae present, starting from anterior margin and ending at the insertion levels between setae  $d_1$  and  $e_1$ ; it widens anteriorly and gradually narrows to an thick line at insertion level of setae  $d_1$ , then slightly broad posteriorly; 15 pairs of minute setae ( $c_1 < 1/10 c_1 - d_1$ ) present, similar in shape with prodorsal setae; setae  $c_1$  close to anterior border, setae  $c_{2-3}$  much more remote than  $c_1$ ; vestigial setae  $f_1$  positioned anterior to setae  $h_1$ ; two pairs of lyrifissures  $ia$  and  $im$  present.

**Gnathosoma** (Figs. 15–17). Subcapitulum normal (Fig. 15); setae  $h$ ,  $m$ , and  $a$  simple and smooth; setae  $h$  more than two times longer than distance between them; adoral setae typical of family; palp (Fig. 16) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Fig. 17) typical of family.

**Ano-genital region** (Figs. 9, 13–14). Genital setae ( $g$ ) with formula: 5: 4; ano-adanal plates each with five pairs of minute and fine setae ( $an$  and  $ad$ ).

**Legs** (Figs. 18–19). Setal counts for leg segments (without tarsi): I: 1-4-2(2)-4(1); II: 1-3-2(1)-3(1), III: 2-2-1(1)-2(1), IV: 2-1-1-2(1); 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.

**Remark.** This new species is most similar to *Notophthiracarus tripartitus* Niedbala, 1989 in sharing the following features: notogaster with anterior cowl and dorsal carinae; median crista of prodorsum present; posterior furrows present; lateral carinae absent; dorsal field of prodorsum bifurcate distally; prodorsal, notogastral, anal and adanal setae short and fine; two pairs of lyrifissures



**FIGURES 9–19.** *Notophthiracarus tamaki* sp. nov.: 9, lateral view of body (legs removed); 10, dorsal view of notogaster; 11, prodorsum, dorsal view; 12, sensillus, dorsal view; 13, right side of genito-aggenital plate; 14, right side of genito-aggenital plate; 15, subcapitulum, palpi removed; 16, palp, antiaxial view; 17, chelicera, antiaxial view; 18, femur I; 19, tibia IV. Scale bars: 9–10=100µm; 11–19=50µm.

present; setae *h* much longer than distance between them; formula of genital setae: 5: 4; chaetotaxy of legs complete. However, the new species can be easily distinguished from the latter species by the following five characters (a versus b): in *N. tamaki* **sp. nov.**, (1a) surface of notogaster with distinct polygonal sculpture; (2a) sensilli short and fusiform; (3a) anterior cowl not concave in dorsal view, and small, not reaching interlamellar setae; (4a) notogaster with one short dorsal carina, not same in width longitudinally; (5a) vestigial setae *f*<sub>1</sub> positioned anterior to setae *h*<sub>1</sub>; in *N. tripartitus*, (1b) surface of notogaster foveolate; (2b) sensilli long and lanceolate; (3b) anterior cowl concave in dorsal view, and large, reaching far beyond interlamellar setae; (4b) notogaster with two long dorsal carinae, nearly same in width longitudinally; (5b) vestigial setae *f*<sub>1</sub> positioned posterior to setae *h*<sub>1</sub>.

***Notophthiracarus rimi* sp. nov.**

(Figs. 20–29)

**Material examined:** Holotype: adult (NZAC, in alcohol, 72/227), New Zealand: Red I. Mercury Is. CL., from litter, 24 Nov. 1972, leg. G. W. Ramsay. Paratypes: four adults (NZAC, in alcohol, 72/227), same data as holotype; three adults (NIGA, in alcohol, 72/227), same data as holotype.

**Etymology.** The specific name (*rimi*) is abbreviation for Red Island, Mercury Islands. It is used here as a noun in apposition.

**Description. Measurements.** Holotype: Prodorsum: length 255, width 175, height 95, setae: *ss* 35, *ro* 48, *in* 75, *le* 10, *ex* 15; notogaster: length 504, width 320, height 310; setae: *c*<sub>1</sub> 80, *d*<sub>1</sub> 70, *e*<sub>1</sub> 75, *h*<sub>1</sub> 72, *ps*<sub>1</sub> 70, *ps*<sub>4</sub> 46; ventral region: *ad*<sub>1</sub> 50, *ad*<sub>2</sub> 70, *ad*<sub>3</sub> 15, *an*<sub>1</sub> 45, *an*<sub>2</sub> 45; genito-aggenital plate 102×150, ano-adanal plate 95×178. Paratypes: Prodorsum: length 205–225, width 150–155, height 75–80; notogaster: length 370–375, width 255–257, height 245–255.

**Integument.** Colour yellowish. Surface of body covered with very small and rounded foveoles, especially dense on notogaster.

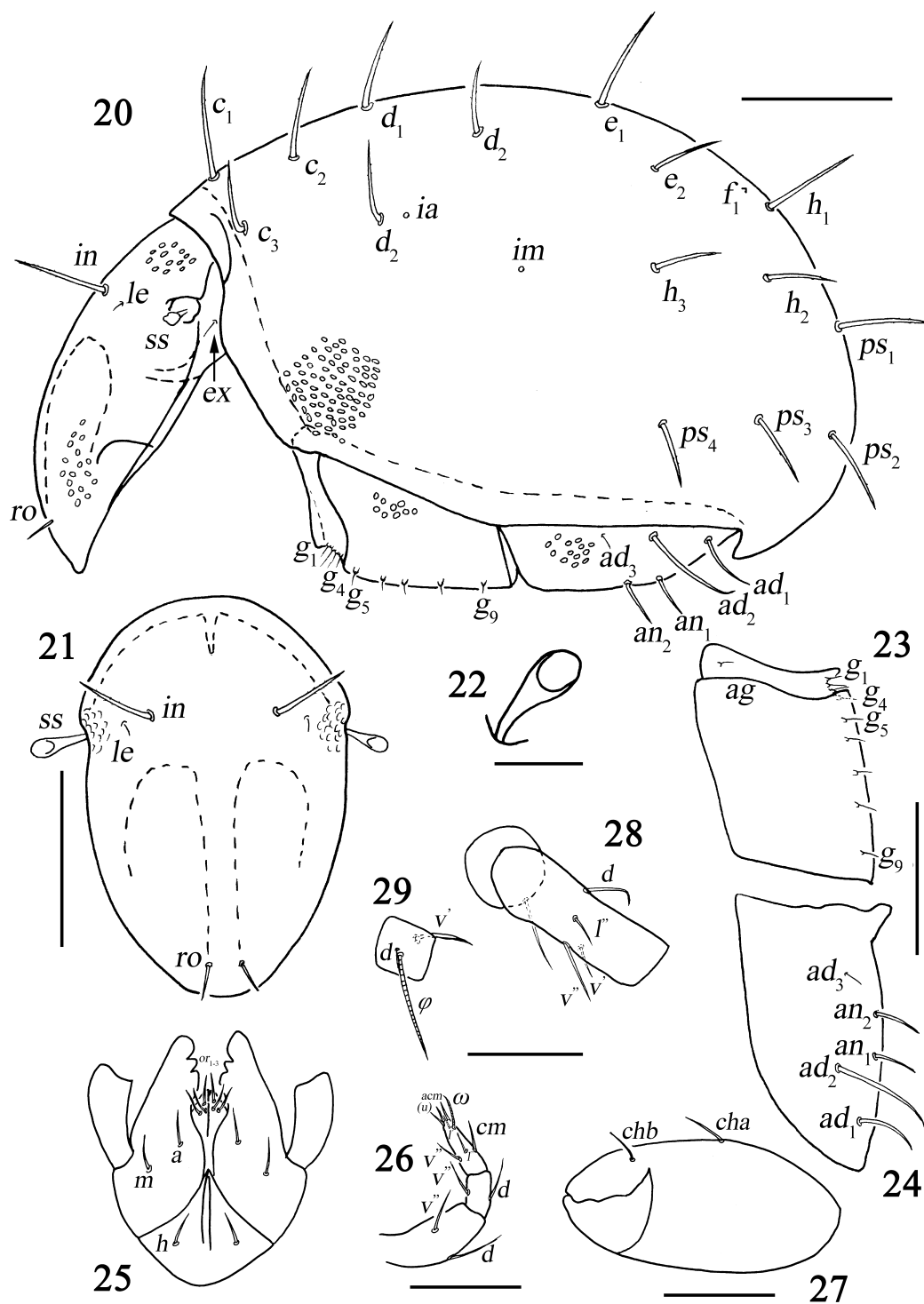
**Prodorsum** (Figs. 20–22). Median crista, lateral carinae and posterior furrows absent; sigillar fields distinct, dorsal field narrow, longer than lateral fields; sensilli (*ss*) with narrow stalk, and rounded and rough head; interlamellar setae (*in*) long, erect and stout, sparsely covered with small spines in distal half; rostral setae (*ro*) rough and semi-erect, much thinner than interlamellar setae; lamellar (*le*) and exobothridial (*ex*) setae short and fine; comparative length: *in*>*ro*>*ss*>*ex*>*le*; *in/le* 7.5; mutual distance of setae: *in*–*in/ro*–*ro*≈3.73.

**Notogaster** (Fig. 20). 15 pairs of setae (*c*<sub>1</sub>/*c*<sub>1</sub>–*d*<sub>1</sub>=0.68) present, similar in shape with interlamellar setae; setae *e*<sub>2</sub>, *h*<sub>2</sub> and *h*<sub>3</sub> shortest; setae *c*<sub>1</sub> and *c*<sub>3</sub> near anterior border, setae *c*<sub>2</sub> much further; vestigial setae *f*<sub>1</sub> positioned anterior to setae *h*<sub>1</sub>; two pairs of lyrifissures *ia* and *im* present.

**Gnathosoma** (Figs. 25–27). Subcapitulum normal (Fig. 25); setae *h*, *m*, and *a* simple and smooth; setae *h* shorter than distance between them; adoral setae typical of family; palp (Fig. 26) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Fig. 27) typical of family.

**Ano-genital region** (Figs. 20, 23–24). Genital setae (*g*) with formula: 5: 4; ano-adanal plates each with five pairs of setae (*an* and *ad*), setae *ad*<sub>1</sub> and *ad*<sub>2</sub> long, thick, rough and slightly hooked, setae *ad*<sub>3</sub> minute and fine, setae *an*<sub>1</sub> and *an*<sub>2</sub> thinner and straight, setae *ad*<sub>3</sub> short and fine, similar in shape as genital setae; comparative length: *ad*<sub>2</sub>>*ad*<sub>1</sub>>*an*<sub>1</sub>=*an*<sub>2</sub>>*ad*<sub>3</sub>.

**Legs** (Figs. 28–29). Setal counts for leg segments (without tarsi): I: 1-4-2(2)-4(1); II: 1-3-2(1)-3(1), III: 2-2-1(1)-2(1), IV: 2-1-1-2(1); chaetotaxy of legs complete; setae *d* on femora I inserted in the middle of article and slightly posterior to the level of 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 20–29.** *Notophtiracarus rimi* sp. nov.: 20, lateral view of body (legs removed); 21, prodorsum, dorsal view; 22, sensillus, dorsal view; 23, right side of genito-aggenital plate; 24, right side of ano-adanal plate; 25, subcapitulum, palpi removed; 26, palp, antiaxial view; 27, chelicera, antiaxial view; 28, trochanter and femur I; 29, tibia IV. Scale bars: 20–21, 23–24=100µm; 25–29=50µm; 22=25µm.



**Remark.** This new species is very close to *Notophthiracarus claviger* Niedbala, 1993 in having the following features: lateral carinae absent, similar shape of prodorsal and notogastral setae,  $h < h-h$ , setae  $ad_3$  short and fine, and chaetotaxy of legs complete. However, the new species can be easily distinguished from the latter species by the following six characters (a versus b): in *N. rimi* **sp. nov.**, (1a) notogaster elongated oval in shape; (2a) sigillar fields distinct, dorsal field narrower; (3a) setae  $h_1$  inserted below level of  $e_2$ , setae  $ps_1$  situated much below level of  $h_2$ , and setae  $ps_2$  situated slightly below level of  $ps_3$ ; (4a) formula of genital setae: 5: 4; (5a) setae  $ad_2$  situated slightly posterior to the insertion level of  $an_1$ ; (6a) setae  $d$  on femora I inserted slightly posterior to the level of setae  $l''$ ; in *N. claviger*, (1b) notogaster rounded in shape; (2b) sigillar fields poorly visible, dorsal field broader; (3b) setae  $h_1$  inserted slightly above level of  $e_2$ , setae  $ps_1$  situated slightly above level of  $h_2$ , and setae  $ps_2$  situated slightly above level of  $ps_3$ ; (4b) formula of genital setae: 6: 3; (5b) setae  $ad_2$  situated slightly posterior to the insertion level of  $an_2$ ; (6b) setae  $d$  on femora I inserted much posterior to the level of setae  $l''$ .

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