Two new species of phthiracarid mites (Acari, Oribatida, Phthiracaridae) from Queensland, Australia

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Introduction

The family Phthiracaridae (Oribatida) – with nearly 800 described species in 10 genera – is the largest group of ptyctimous mites (Niedba 1994; Subías 2013). Phthiracarid mites have globose notogasters and U-shaped ano-genital regions, and are usually considered as important decomposers in the soil (Norton and Behan-Pelletier 2009). The Phthiracaridae is represented in Australia by 122 species in eight genera (Niedba 2012; Liu and Zhang 2013). While sorting and identifying the specimens of ptyctimous mites preserved in Landcare Research in Auckland, New Zealand, we identified two new species of phthiracarid mites from Australia, one belonging to the genus Hoplophthiracarus Jacot, 1933 and the other to the subgenus Steganacarus (Rhacaplacarus) Niedba, 1986.

According to our tally, the genus Hoplophthiracarus currently has about 40 described species in the world. In the Australian Region, it is represented by eight species (Niedba 2012). Hoplophthiracarus species are characterized by the following features: body integumental surface usually covered with concavities; prodorsum with dorsal sigillar field not fused with lateral fields; furrows usually present on back of the prodorsum; interlamellar setae more or less erect; lamellar setae usually very short; notogaster with 15 pairs of setae, setae c1 shorter than distance between setae c1 and d1; two pairs of lyrifissures ia and im; ventral region always with nine pairs of genital setae, setae g6,9 or g7,9 located almost in one row with setae g1, 7; adanal setae remote from paraxial margin of ano-adanal plate, setae ad longer than anal setae, all setae on ano-adanal plate well developed, neotrichy of adanal setae present; setae d on femora I usually at the distal end of segment; and setae d of tibiae IV long and independent of solenidia.

The subgenus Steganacarus (Rhacaplacarus) currently consists of about 29 described species. In the Australian Region, only four species of this subgenus have been recorded (Niedba 2012). Steganacarus (Rhacaplacarus) are characterized by the following set of characteristics: body integumental surface usually covered with concavities; lateral carinae of prodorsum not extended beyond sinus; lamellar and exobothridial setae short (ex, exceptionally vestigial); length ratio of lamellar seta/prodorsum <0.2, length ratio of exobothridial seta/prodorsum <0.7; notogaster without median ridge; 15 pairs of notogastral setae present, but neotrichy may exist; nine pairs of genital setae, genital setae g7,9 located in paraxial margin of plates and nearly in one row with setae g1,5, setae g6 remote from paraxial margin; three pairs of setae along paraxial margin of ano-adanal plates; setae v’ on femora I and setae l’ on genua IV present, length ratio v’/v’ < 2.2; setae d on femora I usually located at the end of segment; setae d of tibiae IV long and independent of solenidia.

The aim of this paper is to give detailed descriptions of the two new species. Keys to species of Hoplophthiracarus and Steganacarus (Rhacaplacarus) of the Australian Region are also proposed to facilitate identification, as we expect more new species of both genera to be discovered from this region.

Methods

Specimens were mounted in temporary cavity slides and were studied using a light microscope equipped with a drawing attachment. Terminology generally follows Niedba (2000). The unit of measurement is micrometre (μm).

Abbreviations for institutions: NZAC, New Zealand Arthropod Collection, Landcare Research, Auckland, New Zealand; NIGA, Northeast Institute of Geography.
and Agroecology, Chinese Academy of Sciences, Changchun, China.

Descriptions of new species

Hoplophthiracarus lamington sp. nov.
(Figures 1–9)

Diagnosis
Surface of body covered with small concavities; median crista and posterior furrows absent; lateral carinae not reaching sinus; sensilli setiform, short, thick and smooth; other prodorsal setae long, robust and covered with dense spines in distal half, except exobothridial setae short and fine; rostral setae curved inward; 15 pairs of notogastral setae present, all covered with dense spines in distal half; vestigial setae \( f_1 \) positioned posterior to setae \( h_1 \); two pairs of lyrifissures \( ia \) and \( im \) present; setae \( h \) of subcapitulum longer than distance between them; formula of genital setae: \((4 + 1): 4, \) setae \( g_s \) situated posteriolateral to \( g_d \); anal setae densely barbed in distal half, anal setae smooth; chaetotaxy of legs complete; setae \( d \) on femora I forked distally, inserted at distal ends of articles.

Description
Measurements. Holotype: Prodorsum: length 465, width 340, height 170, setae: \( ss \) 65, \( ro \) 105, \( le \) 145, in 210, \( ex \) 7, mutual distance \( in-in \) 70, \( ro-ro \) 62; notogaster: length 890, width 690, height 590; setae: \( c_1 \) 150, \( d_1 \) 75, \( e_1 \) 80, \( h_1 \) 80, \( ps_1 \) 72; ventral region: \( ad_1 \) 108, \( ad_2 \) 150, \( ad_3 \) 70, \( an_1 \) 105, \( an_2 \) 95; genito-agenital plate 210 × 265, ano-adanal plate 215 × 335. Paratypes: Prodorsum: length 440–460, width 330–355, height 160–165; notogaster: length 865–880, width 675–690, height 580–585.

Integument. Colour yellowish. Surface of body covered with small concavities.

Prodorsum (Figures 1 and 2). Median crista and posterior furrows absent; lateral carinae not reaching sinus; sigillar fields distinct, dorsal field widened towards rostral setae, longer than lateral fields; sensilli \( (ss) \) setiform, short, thick and smooth; other prodorsal setae \( (in, le, ro) \) long, robust and covered with dense spines in distal half, except exobothridial setae \( (ex) \) short and fine; rostral setae \( (ro) \) curved inward; comparative length: \( in > le > ro > ss > ex, in/le \approx 1.45; \) mutual distance of setae: \( in-in/ro-ro \approx 1.13. \)

Notogaster (Figure 1). 15 pairs of setae \( (c_1/c_1-d_1 = 0.64) \) present, robust and covered with dense spines in distal half; dorsal setae longer than lateral, setae \( c_1 \) longest, setae \( c_p \) and \( ps_x \) much shorter and thinner than others; setae \( c_{1-2} \) far away from anterior border, setae \( c_2 \) more so than \( c_1 \) and \( c_3 \); vestigial setae \( f_1 \) positioned posterior to setae \( h_1 \); two pairs of lyrifissures \( ia \) and \( im \) present.

Gnathosoma (Figures 5–7). Subcapitulum normal (Figure 5); 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; palpal (Figure 6) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Figure 7) typical of family.

Ano-genital region (Figures 1, 3–4). Formula of genital setae: \((4 + 1): 4, \) setae \( g_s \) situated posteriolateral to \( g_d \); anal setae \( (ad) \) similar in shape with notogastral setae, densely barbed in distal half; anal setae \( (an) \) smooth; comparative length: \( ad_2 > ad_1 > an_1 > an_2 > ad_3. \)

Legs (Figures 8 and 9). Setal counts for leg segments (without tarsi): I: 1-4-2(2)-5(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 forked distally, inserted at distal ends of articles; setae \( a'' \) on tarsi I and setae \( f'' \) 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.

Material examined

Type deposition
Holotype specimen is deposited in NZAC. Paratypes are deposited in NIGA.

Etymology
This new species is named after its type locality; used here as a noun in apposition.

Remarks
This new species is similar to Hoplophthiracrus hulli Niedbala, 1987 in sharing the following features: similar shape of prodorsal \( (in, le, ro, ex) \), notogastral and adanal setae; similar shape of sigillar fields; vestigial setae \( f_1 \) positioned posterior to setae \( h_1 \); \( h > h-h; ad_2 > ad_1 > an > ad_3; \) chaetotaxy of legs complete; setae \( d \) on femora I forked distally, inserted at distal ends of articles. However, the new species can be easily distinguished from the latter species by the following seven characters (a versus b) in \( H. \) lamington sp. nov., (1a) median crista of prodorsum absent; (2a) posterior furrows of prodorsum absent; (3a) sensilli thick, setiform and much shorter \( (ss 65); (4a) in > le > ro > ss > ex, \) lamellar setae longer \( (in/le \approx 1.45); \) interlamellar setae not reaching the insertions of rostral setae; (5a) two pairs of lyrifissures \( ia \) and \( im \) present; (6a) notogastral setae shorter, setae \( c_2 \) more remote from anterior margin; (7a) formula of genital setae: \((4 + 1): 4, \) setae \( g_s \) situated posteriolateral to \( g_d \); in \( H. \) hulli, (1b) median...
crista present; (2b) posterior furrows present; (3b) sensilli thin, sickle-shaped and much longer (ss139); (4b) in > ro > ss > le > ex, lamellar setae shorter (in/le = 3), interlamellar setae reaching beyond the insertions of rostral setae; (5b) four pairs of lyrifissures ia, im, ip and ips present; (6b) notogastral setae longer, setae c2 more close to anterior margion; (7b) formula of genital setae: (4 + 2): 3, setae g6 situated at level between g4 and g5.

Compared to Hoplophthiracarus penicillatus Niedba, 2004, these two species are very close in having similar shape of sigillar fields; similar shape of
notogastral, anal, adanal and some prodorsal setae (in, le, ro); chaetotaxy of legs complete, and setae d on femora I forked distally, inserted at distal ends of articles. However, the new species can be easily distinguished from the latter species by the following features: lateral carinae not reaching sinus (versus reaching beyond sinus in H. penicillatus); sensilli thicker and shorter (versus thinner and longer in H. penicillatus); exobothridial setae present (versus vestigial in H. penicillatus); in–in > ro–ro (versus in–in < ro–ro in H. penicillatus); two pairs of lyrifissures ia and im present (versus four pairs in H. penicillatus); h > h–h (versus h < h–h in H. penicillatus); formula of genital setae: (4 + 1): 4 (versus (4 + 2): 3 in H. penicillatus).

Key to species of Hoplophthiracarus reported from Australian Region

1. Notogastral setae hooked distally; exobothridial setae vestigial ................. H. hamatus (Hammer 1973)
   – Notogastral setae not hooked distally; exobothridial setae present .................. 2

2. Interlamellar setae very short, shorter than exobothridial setae .................... H. lividus Niedbała, 2000
   – Interlamellar setae long, much longer than exobothridial setae ........................ 3

   – Notogastral setae spinose ............................................. 4

4. Lateral carinae of prodorsum absent ........................... 5
   – Lateral carinae of prodorsum present ................................ 6

5. Sensilli short with rounded head; setae d on femora I not forked distally... H. montigenus Niedbała, 1981
   – Sensilli long and setiform; setae d on femora I forked distally ............ H. mallacoolaensis Niedbała, 2006

6. Sensilli with head; setae d on femora I not forked distally ................ 7
   – Sensilli without head; setae d on femora I forked distally .................. 8

7. Vestigial setae f₁ positioned posterior to setae h₁; posterior furrows of prodorsum absent ........................................ H. raflaski Niedbała, 1997
   – Vestigial setae f₁ positioned anterior to setae h₁; posterior furrows of prodorsum present ........................................ H. proximus Niedbała, 1984

8. Four pairs of lyrifissures present; posterior furrows of prodorsum present ....... H. hulli Niedbała, 1987
   – Two pairs of lyrifissures present; posterior furrows of prodorsum absent ........... H. lamington sp. nov.

Steganacarus (Rhacaplacarus) walteri sp. nov.  
(Figures 10–18)

Diagnosis
Surface of body covered with small concavities; median crista and posterior furrows absent; lateral carinae short; sigillar fields distinct, dorsal field narrow, longer than laterals; sensilli setiform and smooth; interlamellar setae long and flagelliform; sparsely barbed in distal half; lamellar and rostral setae short, semi-erect and barbed; exobothridial setae short and fine; notogastral setae in different length and shape, setae c₁,₂ and ps₁,₃ long, similar in shape with interlamellar setae; setae c₁ and h₁,₂ medium long; other setae short and spiniform; two pairs of lyrifissures ia and im present; setae h of subcapitulum longer than distance between them; formula of genital setae: (4 + 5): 0; adanal and anal setae similar in shape with interlamellar setae, except setae ad₃ short, barbed and spiniform; chaetotaxy of legs complete; setae d on femora I inserted at distal ends of articles.

Description
Measurements. Holotype: Prodorsum: length 518, width 380, height 188, setae: ss 150, ro 90, le 70, in 445, ex 45, mutual distance in–in 92, ro–ro 40; notogaster: length 1025, width 820, height 760; setae: c₁ 460, c₉ 100, d₁ 100, e₁ 100, h₁ 275, h₃ 100, ps₁ 510, ps₉ 92; ventral region: ad₁ 220, ad₂ 240, ad₃ 33, an₁ 210, an₂ 220; genito-agenital plate 260 × 312, ano-adanal plate 195 × 460. Paratype: Prodorsum: length 515, width 377, height 185; notogaster: length 1020, width 820, height 755.

Integument. Colour yellowish. Surface of body covered with small concavities.

Prodorsum (Figures 10 and 11). Median crista and posterior furrows absent; lateral carinae short, not reaching sinus; sigillar fields distinct, dorsal field narrow, longer than lateral fields; sensilli (ss) setiform and smooth; interlamellar setae (in) long, erect, covered with sparse spines in distal half and flagellate distally; lamellar and rostral setae (le, ro) short, semi-erect and barbed; lamellar setae spiniform and thinner, exobothridial setae (ex) short and fine; comparative length: in > ss > ro > le > ex, in/le = 6.36; mutual distance of setae: in–in/ro–ro = 2.3.

Notogaster (Figure 10). 15 pairs of setae in different length (c₁/c₁–d₁ = 1.53) and shape, sparsely barbed in distal half; setae c₁,₂ and ps₁,₃ long, similar in shape with interlamellar setae; setae c₁ and h₁,₂ medium long; other setae short and spiniform; setae c₁,₃ far away from anterior border, setae c₂ more so than c₁ and c₃; vestigial setae f₁ invisible; two pairs of lyrifissures ia and im present.

Gnathosoma (Figures 14–16). Subcapitulum normal (Figure 14); setae h, m and a simple and smooth; setae h longer than distance between them; adoral seta or₁ apparently flat with barbs; or₂,₁ simple and smooth; palp
(Figure 15) 4-segmented, with femur and genu fused; palpal setation: 0-2-2-7(1); supracoxal seta simple and smooth; chelicera (Figure 16) typical of family.

Ano-genital region (Figures 10, 12 and 13). Formula of genital setae: (4 + 5): 0, setae g₆ situated between level of g₄ and g₅; adanal and anal setae (ad and an) similar in
shape with interlamellar setae, except setae \( ad_3 \) short, barbed and spiniforous; comparative length: \( ad_2 > ad_1 = an_2 > an_1 > ad_3 \).

**Legs** (Figures 17 and 18). Setal counts for leg segments (without tarsi): I: 1-4-2(2)-5(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 distal ends of articles; setae \( a^t \) on tarsi I and setae \( f^u \) on tarsi II curved distally; setae \( a^t \) on tarsi II curved distally; setae \( s \) and \( p^v \) on tarsi IV present; setae \( s \) on tarsi I and II present.

**Material examined**


**Type deposition**

Holotype specimen is deposited in NZAC. Paratype is deposited in NIGA.

**Etymology**

This new species is named after Dr David E. Walter, who spent a significant portion of his career in Queensland, Australia, and has made outstanding contributions to acarology in the world.

**Remarks**

This new species is similar to *Steganacarus (Rhacaplacarus) diaphoros* Niedbala, 2000 in sharing the following features: similar shape of prodorsal, anal and adanal setae, notogastral setae in different length and shape, \( h > h-b \) and chaetotaxy of legs complete, but the new species can be easily distinguished from the latter species by the following characters (a versus b): in *S. (R.) walteri* sp. nov., (1a) dorsal field of prodorsum long; (2a) lateral carinae short, not reaching sinus; (3a) posterior furrows of prodorsum absent; (4a) setae \( d_1 \) and \( e_1 \) short and spiniforous; (5a) two pairs of lyrifissures \( ia \) and \( im \) present; (6a) formula of genital setae: \( 4 + 5 \) \( > > \); (7a) setae \( d \) on femora I not forked distally; in *S. (R.) diaphoros*, (1b) dorsal field of prodorsum short; (2b) lateral carinae long, reaching beyond sinus; (3b) posterior furrows present; (4b) setae \( d_1 \) and \( e_1 \) long and flagellate distally; \( (5b) \) four pairs of lyrifissures \( ia, im, ip \) and \( ips \) present; (6b) formula of genital setae: \( 4 + 2 \) \( \approx \); (7b) setae \( d \) on femora I forked distally. In addition, this new species have larger body size (length of notogaster >1000 versus <750 in *S. (R.) diaphoros*).

It is also similar to *Steganacarus (Rhacaplacarus) szeptycki* Niedbala, 2009, but can be differed by the following features: lateral carinae short, not reaching sinus (versus long, reaching beyond sinus in *S. (R.) szeptycki*); sigillar fields distinct, dorsal field, longer than laterals (versus sigillar fields weak, dorsal field shorter than laterals); sensilli smooth (versus barbed); lamellar short much shorter (\( in/le \) = 6.36 versus \( in/le \approx 2.71 \)); \( in > ss > ro > le \) (versus \( in > le > ss > ro \)); only setae \( c_{1-2} \) and \( ps_{1-3} \) long and flagellate distally (versus all notogastral long and flagellate distally); two pairs of lyrifissures \( ia \) and \( im \) present (versus three pairs); formula of genital setae: \( 4 + 5 \) \( > \); (7b) setae \( d_3 \) short and spiniforous (versus long and flagellate distally); setae \( d \) on femora I not forked distally (versus forked); body large, length of notogaster >1000 (versus <700).

**Key to species of Steganacarus (Rhacaplacarus) reported from Australian Region**

1. Notogaster with cowl-like structure in anterior part
   
   1.1 Notogaster without cowl-like structure in anterior part

2. All notogastral setae short, swollen in aspergillum-shape
   
   2.1 Notogastral setae long and flagelliform, or some notogastral setae long and flagelliform and some short and spiniforous

3. All notogastral setae long and flagelliform
   
   3.1 All notogastral setae long and flagelliform

4. Formula of genital setae: \( 4 + 2 \) \( \approx \); setae \( d \) on femora I forked distally
   
   4.1 Formula of genital setae: \( 4 + 5 \) \( \approx \); setae \( d \) on femora I not forked distally

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