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The next new species of *Notophthiracarus* Ramsay, 1966 (Acari, Oribatida, Phthiracaroida) from Madagascar

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ABSTRACT

Five new species of the genus *Notophthiracarus* are described, identified and figured from sifted soil and leaf litter samples from different parts of Madagascar: *N. liratus* sp. n., *N. lineatus* sp. n., *N. micidus* sp. n., *N. obliquus* sp. n., and *N. quasisimilis* sp. n. Comparisons with the most closely related species of the genus are also presented.

KEY WORDS: Madagascar, oribatid mites, Phthiracaridae, taxonomy, new species.

INTRODUCTION

Madagascar hosts one of the world's most unusual, endemic, diverse and threatened concentrations of fauna and flora. This fourth largest island in the world is characterized by the international scientific and conservation community as one of the richest countries in terms of biodiversity, endemism and range of habitats. A very important explanation for Madagascar's high concentration of unique species is its isolation from other landmasses for millions of years. Madagascar was separated from the African continent 165 million years ago and from the Indian subcontinent 80–100 million years ago (Griveaud & Albignac 1972; Paulian 1972; Goodman & Patterson 1997). However, over 80 % of the island has now been stripped of its native vegetation cover. The majority of its area is now species-poor secondary grassland that is burnt annually and is subject to intense erosion. This unique biodiversity, combined with threats to the remaining native vegetation, puts Madagascar amongst the highest priority conservation areas in the world.

Between 2010 and 2013, Czech soil entomologists Dr Baňář (Brno, Czech Republic) and Dr M. Trýzna (Děčín, Czech Republic) organized collections of sifted soil samples from many parts of Madagascar. These samples were used in a study of soil mites, in which oribatid mites from the superfamily Phthiracaroida were abundant. Many new and interesting species of the genus *Notophthiracarus* Ramsay, 1966 were found in this material, which will be described in a future series of taxonomical papers. This work is the second in recent times (after Niedbala & Starý 2014) to describe new species of *Notophthiracarus*.

MATERIAL AND METHODS

Observations and drawings were made and measurements taken using a standard light microscope equipped with a drawing attachment. All the measurements are given in micrometres. The soil and leaf litter samples were collected using a sifting method and were partly extracted by using a Winkler apparatus. All mite specimens were preserved in

85 % ethanol, cleared in 80 % lactic acid and mounted on temporary slides with glycerol. The determined material was preserved in vials with 80 % ethanol. Type materials were deposited at the Department of Animal Taxonomy and Ecology, Poznań, Poland (DATE), the Institute of Soil Biology BC ASCR České Budějovice, Czech Republic (ISB) and the Natural History Museum in Geneva, Switzerland (NHMG). The terminology used is based on that of Niedbala (1992).

TAXONOMY

Superfamily Phthiracaroidae
Family Phthiracaridae Perty, 1841
***Notophthiracarus lineatus* sp. n.**

Fig. 1

Etymology: From the Latin *lineatus* (streaked, marked with lines) and alludes to the foveoles on the notogastral surface joined with lines.

Description:

Measurements (holotype). Prodorsum: length 228, width 159, height 94; setae: sensillus (*ss*) 71, interlamellar (*in*) 76, lamellar (*le*) 7, rostral (*ro*) 38; notogaster: length 404, width 283, height 268, length of notogastral setae: c_1 , h_1 and ps_1 76, $c_1/c_1-d_1=0.8$, genitoaggenital plate 114×71, anoadanal plate 114×66.

Integument. Colour light brown. Integument very finely foveolate, foveolae on notogaster joined with weak lines.

Prodorsum (Fig. 1A, B). Lateral carinae weak. Sigillar fields distinct, median slightly dilated in distal part, considerably longer than lateral fields. Sensilli long, with thin stalk and dilated head with tips covered with small spines. Interlamellar setae long, thick, erect covered with small spines in distal part, similar in shape to notogastral setae. Lamellar and exobothridial setae minute. Rostral setae spiniform and rough.

Notogaster (Fig. 1C, D). Notogastral setae of medium length ($c_1 < c_1-d_1$), thick, covered with small spines in distal part. Setae c_1 and c_3 slightly remote from anterior margin of notogaster, setae c_2 far from notogastral margin. Vestigial setae not discernible. Two pairs of lyrifissures *ia* and *im* present.

Ventral region (Fig. 1E–G). Formula of genital setae: 6:3. Anoadanal plates each with five setae; adanal setae ad_2 longest and thickest, obtuse distally; adanal setae ad_1 longer and thicker than anal setae, all these setae rough; adanal setae ad_3 minute, smooth.

Legs (Fig. 1H). Chaetome of legs of complete type. Setae *d* on femora I slightly remote from distal end of article.

Holotype: MADAGASCAR: Ranomafana National Park, Vatoharanana, 4.x.2012, evergreen rain forest, 21°17'33.6"S 47°25'57.6"E, 1163 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-209 (DATE).

Paratypes: 3 specimens: MADAGASCAR: Ranomafana National Park, Vatoharanana, 3.x.2012, evergreen rain forest, 21°16'42.2"S 47°26'18.2"E, 1000 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-208 (DATE); 2 specimens from the same locality, MAG-208 (ISB).

Remarks: The new species is readily distinguishable by the foveolated surface of the body joined by weak lines, the dilated median sigillar field of the prodorsum and the shape of the sensilli with heads ciliated at the end. *N. lineatus* is slightly similar to *N. similis* Niedbala, 2001 but the interlamellar and notogastral setae of *N. lineatus* are not dilated at the distal half, sensilli do not have a club-like head, the formula of genital

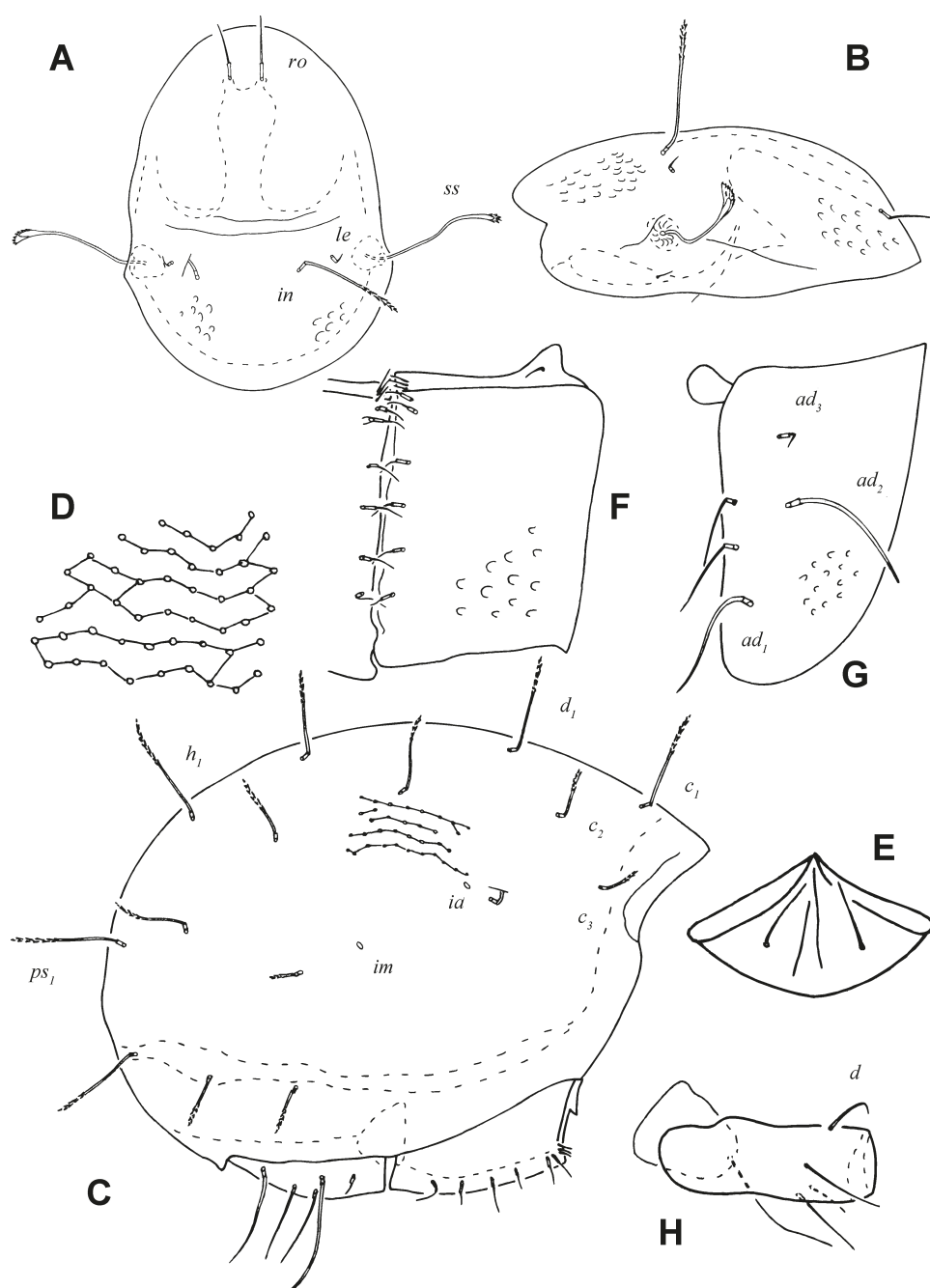


Fig. 1. *Notophtthiracarus lineatus* sp. n. (holotype): (A) prodorsum, dorsal view; (B) prodorsum, lateral view; (C) opisthosoma, lateral view; (D) fragment of surface of notogaster; (E) mentum of infracapitulum; (F) genitoaggenital plate; (G) anoadanal plate; (H) trochanter and femur of leg I.

setae is 6:3 (versus 5:4 in *N. similis*) and ad_2 setae are attenuated (versus ad_2 of equal width in *N. similis*) (Niedbala 2001).

***Notophthiracarus liratus* sp. n.**

Fig. 2

Etymology: From the Latin *liratus* (bearing ridges) and alludes to the ornamentation of the notogastral surface, which resembles a fingerprint.

Description:

Measurements (holotype). Prodorsum: length 313, width and height 222; setae: ss 134, in 51, le 61, ro 35; notogaster: length 525, width 439, height 404; genitoaggenital plate 162×114 , anoadanal plate 121×83 .

Integument. Colour light brown. Surface of notogaster ornamented with longitudinal parallel ribs, resembling a finger dermatoglyph.

Prodorsum (Fig. 2A, B). Prominent median crista present. Posterior part covered with dense foveolae, anterior part with some triangular tubercles. Only some traces of lateral carinae visible. Median sigillar fields long and narrow, longer than lateral ones. Sensilli long, bulbous in proximal part and very thin and tapering in distal part. Prodorsal setae (except vestigial exobothridial setae) needle-like, smooth.

Notogaster (Fig. 2C, D). All notogastral setae vestigial. Setae c_1 and c_2 remote from anterior margin of notogaster, setae c_3 situated near notogastral margin. Of the lyrifissures only im visible. Vestigial setae f_1 anterior of setae h_1 .

Ventral region (Fig. 2E–G). Seta h of mentum very long, considerably longer than distance between them. Arrangement of genital setae: 5:4. Anoadanal plates each with five similar in length, rather short setae.

Legs (Fig. 2H). Chaetome of legs incomplete. Setae v'' of femora I absent. Setae d of femora I needle-like, situated at distal end of article.

Holotype: MADAGASCAR: Ranomafana National Park, Vatoharanana, 5.x.2012, evergreen rain forest, $21^{\circ}16'59.7''S$ $47^{\circ}25'30.3''E$, 1126 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-210 (DATE).

Paratypes: 4 specimens, same data as holotype, MAG-210 (DATE); 1 specimen: MADAGASCAR: Ranomafana National Park, Vatoharanana, 4.x.2012, evergreen rain forest, $21^{\circ}17'33.6''S$ $47^{\circ}25'57.6''E$, 1163 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-209 (ISB).

Remarks: The new species is easy distinguishable from congeners by the unusual presence of triangular tubercles on the anterior part of the prodorsum and dense foveoles at the posterior part of the prodorsum, prominent median crista of the prodorsum, long sensilli (bulbous proximally and tapering distally), dermatoglyphical ornamentation of the notogastral surface and all notogastral setae vestigial. The new species resembles *N. dactyloscopicus* (Mahunka, 1978) from Mauritius, characterized by dermatoglyphical ornamentation of the notogaster, while all other characters are different. Proximal part of sensilli are similar to *N. armatus* (Mahunka, 1986) described from the West Usambara Mountains, Tanzania, but other characters are different (Mahunka 1978, 1986).

***Notophthiracarus micidus* sp. n.**

Fig. 3

Etymology: From the Latin *micidus* (thin, poor) and alludes to the shape of the majority of notogastral setae.

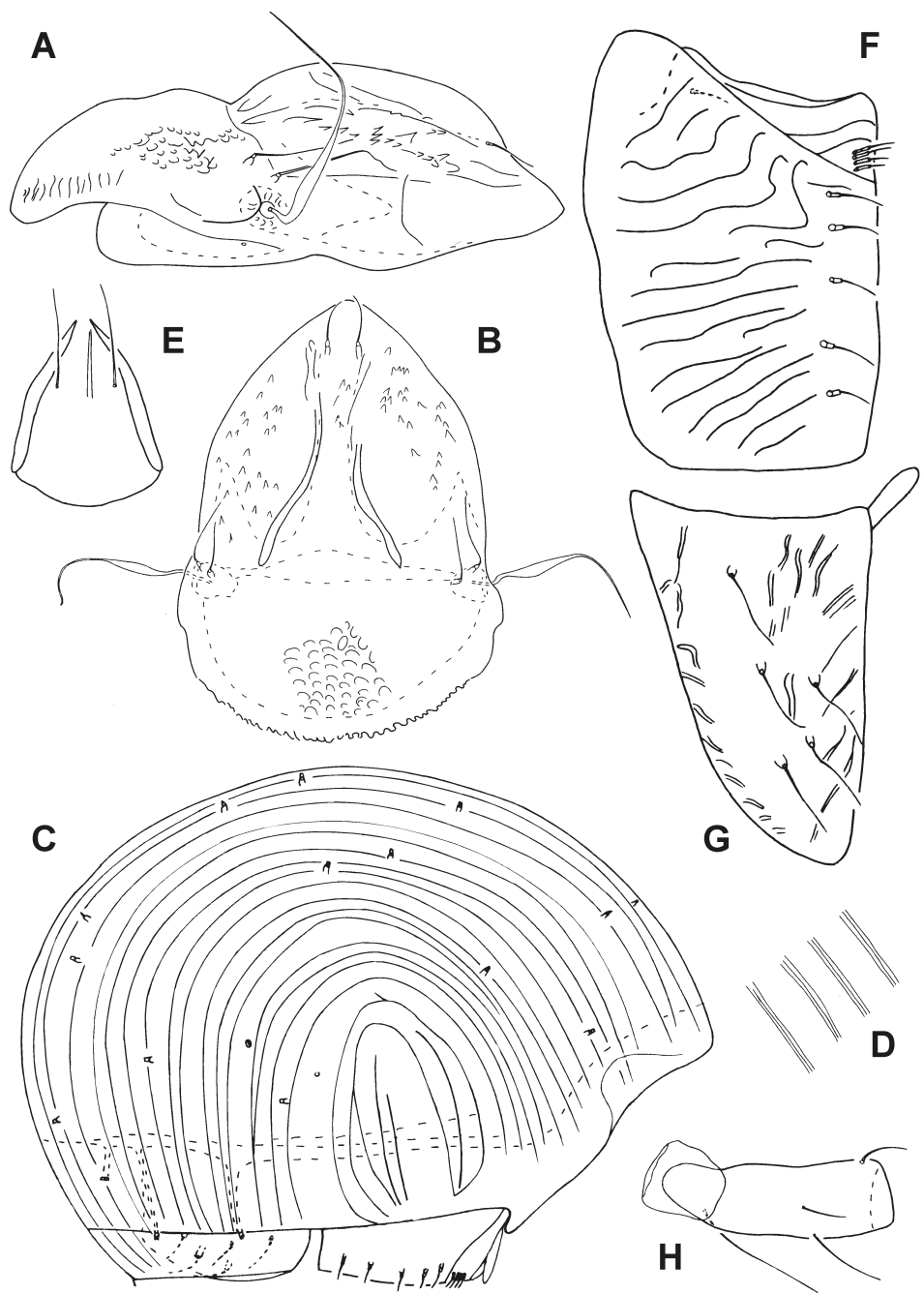


Fig. 2. *Notophtthiracarus liratus* sp. n. (holotype): (A) prodorsum, lateral view; (B) prodorsum, dorsal view; (C) opisthosoma, lateral view; (D) fragment of surface of notogaster; (E) mentum of infracapitulum; (F) genitoaggenital plate; (G) anoadanal plate; (H) trochanter and femur of leg I.

Description:

Measurements (holotype). Prodorsum: length 429, width 298, height 177; setae: *ss* 88, *in* 164, *le* 76, *ro* 83, *ex* 45; notogaster: length 768, width 283, height 303; length of notogastral setae: c_1 and d_1 139, $c_1/c_1-d_1=0.66$, c_3 76, h_1 10 and ps_1 30; genitoaggenital plate 212×116 ; anoadanal plate 237×101 .

Integument. Colour light brown. Surface of body punctated. Relatively large species.

Prodorsum (Fig. 3A, B). Distinct lateral carinae present. Sigillar fields long and very narrow. Sensilli short, crescent-like, rough. Prodorsal setae long, fine attenuate. Interlamellar, lamellar and rostral setae procumbent; rostral setae located near each other.

Notogaster (Fig. 3C). Notogastral setae c_1 , d_1 and c_3 relatively long ($c_1 < c_1-d_1$), fine and attenuate, other notogastral setae minute. Setae c_1 and c_2 remote from anterior margin of notogaster, setae c_3 located near the notogastral margin. Setae f_1 vestigial, situated slightly posterior of setae h_1 . All lyrifissures *ia*, *im*, *ip*, *ips* present.

Ventral region (Fig. 3D, E). Setae *h* of mentum longer than distance between them. Genitoaggenital plates with formula of genital setae: 4:5; genital setae g_{6-8} remote from paraxial border of plate. Left genitoaggenital plate with two aggenital setae (one more seta is probably the abnormal case). Anoadanal plates with long and attenuate adanal setae ad_1 , adanal setae ad_3 shorter, but anal setae and adanal setae ad_2 minute.

Legs (Fig. 3F). Chaetome of legs complete. Setae *d* of femora I located at distal end of article.

Holotype: MADAGASCAR: Ranomafana National Park, 1.x.2012, evergreen rain forest, $21^{\circ}15'10.3''S$ $47^{\circ}25'01.2''E$, 1077 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-207 (DATE).

Paratypes: 2 specimens: MADAGASCAR: Zombitse National Park, Miliokakely, 28.i.2013, dry seasonal deciduous forest, $22^{\circ}52'38.1''S$ $44^{\circ}42'48.6''E$, 823 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina and E.M. Rabotoson, MAG-247 (1 DATE & 1 ISB).

Remarks: The new species is unique among congeners for the shape of notogastral and anoadanal setae, by very narrow sigillar fields of the prodorsum and crescent-shaped sensilli.

Notophthiracarus obliquus sp. n.

Fig. 4

Etymology: The specific name of the new species is Latin *obliquus* (slanting or sideways) and alludes to the oblique location of genital setae g_{6-9} .

Description:

Measurements (holotype). Prodorsum: length 333, width 212, height 126; setae: *ss* 61, *in* 123, *le* 18, *ro* 45, *ex* 20; notogaster: length 555, width 404, height 399; length of notogastral setae: setae c_1 124, $c_1/c_1-d_1=1.0$, genitoaggenital region 139×96 , anoadanal region 134×76 .

Integument. Colour yellow, surface of body punctated.

Prodorsum (Fig. 4A, B). Lateral carinae short. Sigillar fields well developed, median slightly longer than lateral ones. Sensilli short, club-like, smooth. Prodorsal setae filiform, attenuate, procumbent, *in* > *le* > *ro* > *ex*.

Notogaster (Fig. 4C). Fifteen pairs of filiform, attenuate notogastral setae, majority of them long ($c_1 > c_1-d_1$), with exception minute setae c_3 , cp , ps_4 . Setae c_1 and c_2 remote

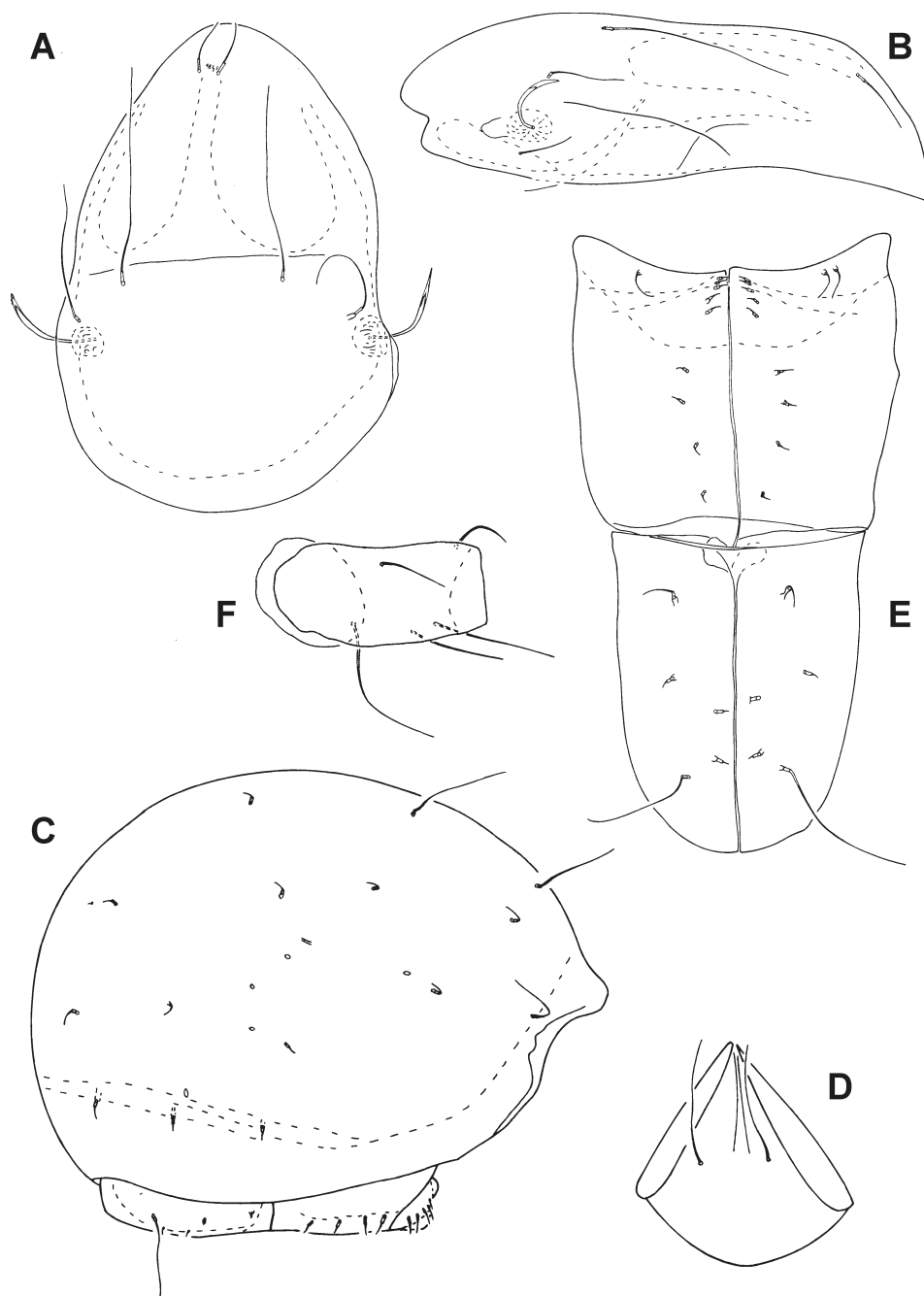


Fig. 3. *Notophtiracarus micidus* sp. n. (holotype): (A) prodorsum, dorsal view; (B) prodorsum, lateral view; (C) opisthosoma, lateral view; (D) mentum of infracapitulum; (E) genitoaggenital and anoanal plates; (F) trochanter and femur of leg I.

from anterior margin of notogaster, setae c_3 near notogastral margin. Vestigial setae f_1 situated posterior of setae h_1 . All lyrifissures ia , im , ip and ips present.

Ventral region (Fig. 4D, E). Setae h of mentum shorter than distance between them. Formula of genital setae: 5:4, five pairs of setae in longitudinal row in progenital position, genital setae g_{6-9} located slightly obliquely. Anoadanal plates each with five setae, anal setae distanced from each other, adanal setae ad_1 situated antero-laterally to anal setae an_1 , adanal setae ad_2 antero-laterally to anal setae an_2 ; only adanal setae ad_1 long, filiform and attenuate, other setae minute.

Legs (Fig. 4F, G). Leg formulae of setae and solenidia of “complete type”. Setae d on femora I long, ciliate and situated at distal end of article.

Holotype: MADAGASCAR: Ranomafana National Park, Vatoharanana, 4.x.2012, evergreen rain forest, 21°17'33.6"S 47°25'57.6"E, 1163 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-209 (DATE).

Remarks: The new species is extraordinary among congeners by the presence of an unusual arrangement of genital setae in two rows (one row oblique), heterotrichy of notogastral setae, setae c_3 , cp , and p_4 minute, other setae long, filiform and attenuate, and ciliate setae d of femora of legs I.

Notophthiracarus quasisimilis sp. n.

Fig. 5

Etymology. The prefix *quasi* (near) is Latin and refers to the similarity of the new species to *Notophthiracarus similis* Niedbala, 2001.

Description:

Measurements (holotype). Prodorsum: length 333, width 212, height 126, setae: ss 61, in 123, le 18, ro 45, ex 20; notogaster: length 555, width 404, height 399; length of notogastral setae: c_1 124, $c_1/c_1-d_1=1.0$, genitoaggenital region 139×96, anoadanal region 134×76.

Integument. Colour yellow. Surface of body covered with strong sculpture of irregular, deep foveoles.

Prodorsum (Fig. 5A, B). Prominent median crista present. Lateral carinae and posterior furrows absent. Median sigillar field broad anteriorly and longer than lateral fields. Sensilli long with thin pedicel and club-like head covered with small spines. Interlamellar setae long, robust, covered with dense spines in distal half. Lamellar and exobothridial setae minute. Rostral setae spiniform, rough, directed inward.

Notogaster (Fig. 5C). Median, well-framed flat field present, 15 pairs of medium-size notogastral setae robust, similar to interlamellar setae, covered with spines in distal half, all dorsal setae situated below median flat field. Setae c_1 slightly remote from anterior margin of notogaster, setae c_3 situated almost at notogastral border, setae c_2 far from notogastral border. Two pairs of lyrifissures ia and im present. Vestigial setae not visible because of strong sculpture.

Ventral region (Fig. 5D–G). Formula of minute, genital setae: 5:4. Anoadanal plates with five pairs of rough setae, adanal setae ad_2 longest and thickest, obtuse and bent distally, adanal setae ad_1 longer than anal setae, adanal setae ad_3 minute.

Legs (Fig. 5H). Chaetome of complete type; setae d on femora I slightly remote from distal end of article.

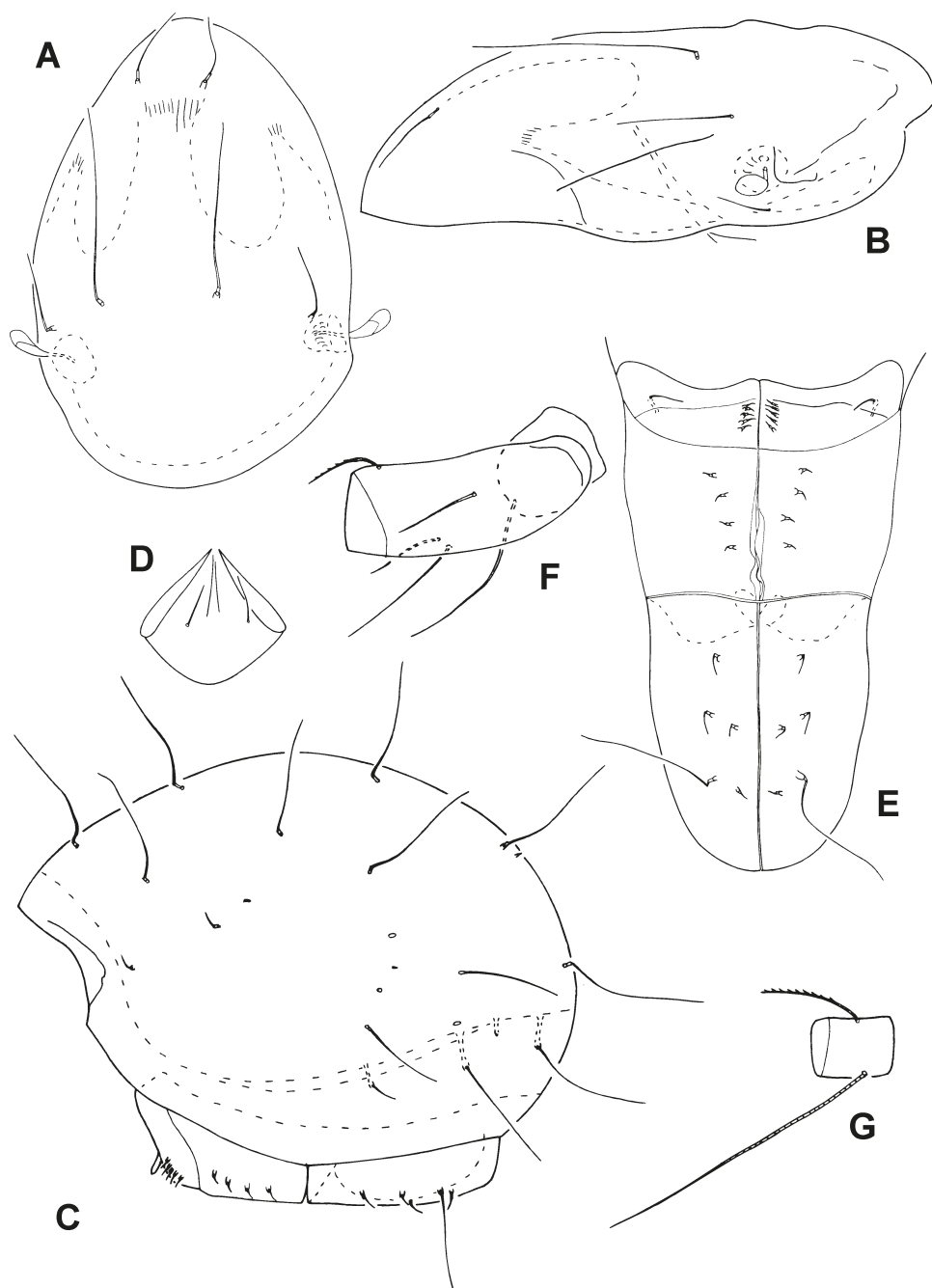


Fig. 4. *Notophthiracarus obliquus* sp. n. (holotype): (A) prodorsum, dorsal view; (B) prodorsum, lateral view; (C) opisthosoma, lateral view; (D) mentum of infracapitulum; (E) genitoaggenital and anoanal plates; (F) trochanter and femur of leg I; (G) tibia of leg IV.

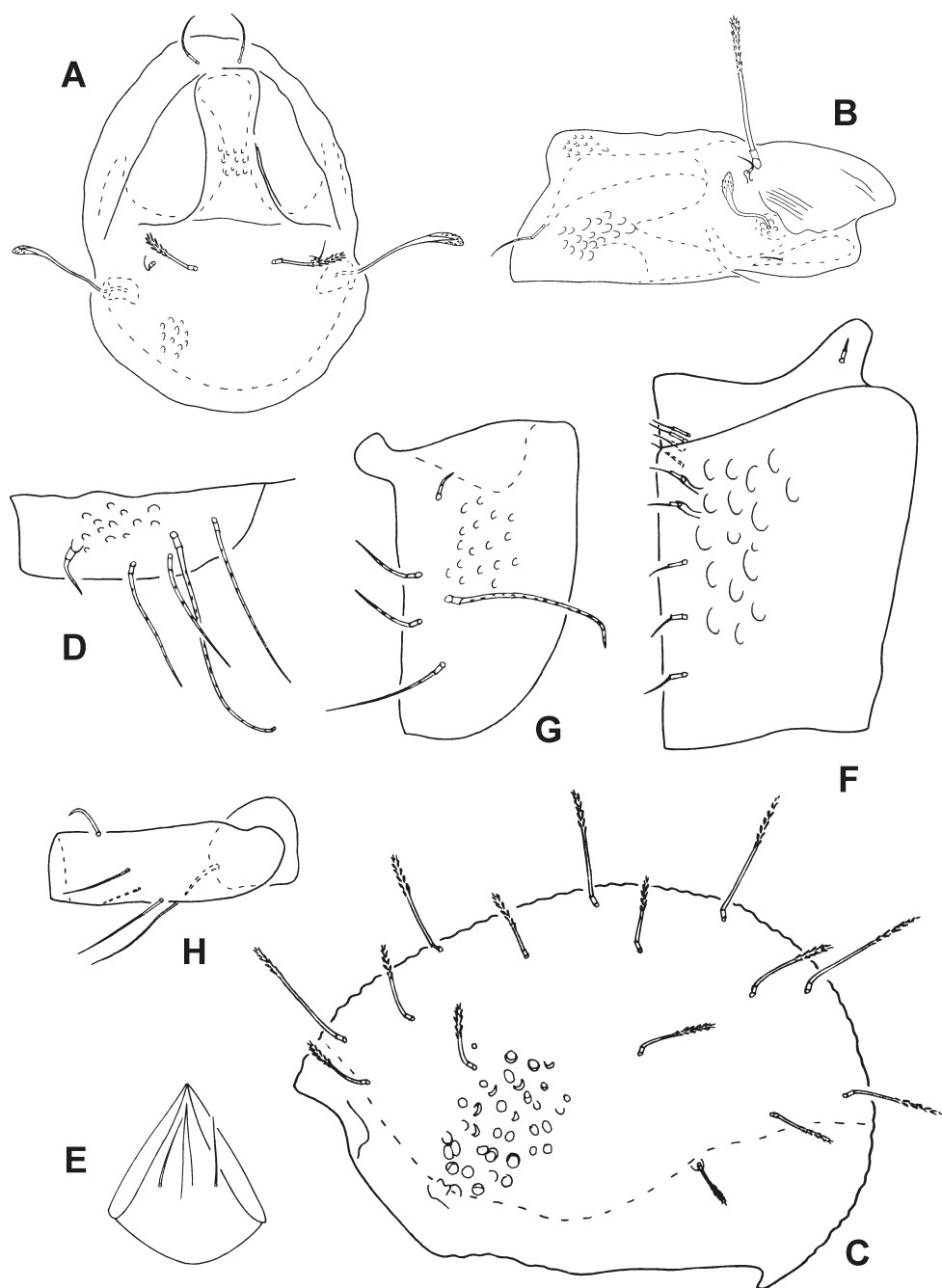


Fig. 5. *Notophthiracarus quasisimilis* sp. n. (holotype): (A) prodorsum, dorsal view; (B) prodorsum, lateral view; (C) notogaster, lateral view; (D) anoadanal plate, lateral view; (E) mentum of infracapitulum; (F) genitoaggenital plate; (G) anoadanal plate; (H) trochanter and femur of leg I.

Holotype: MADAGASCAR: Ranomafana National Park, Vatoharanana, 4.x.2012, evergreen rain forest, 21°17'33.6"S 47°25'57.6"E, 1163 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-209 (DATE).

Paratypes: 19 specimens, same data as holotype, MAG-209 (DATE); 14 specimens: MADAGASCAR: Ranomafana National Park, 1.x.2012, evergreen rain forest, 21°15'10.3"S 47°25'01.2"E, 1077 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-207 (8 ISB & 6 NHMG); 1 specimen: MADAGASCAR: Ranomafana National Park, Vatoharanana, 3.x.2012, evergreen rain forest, 21°16'42.2"S 47°26'18.2"E, 1000 m, sifting of forest leaf litter sample, Winkler apparatus extraction, leg. L.S. Rahanitriniaina, MAG-208 (NHMG).

Remarks: The characters of the new species are the same as those of *Notophthiracarus similis* Niedbała, 2001 described from Madagascar, with the exception of a prominent prodorsal crista, irregular deep foveoles on the body and setae *h* of the mentum longer than the distance between them in *N. quasisimilis* (Niedbała 2001).

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