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Contribution to the knowledge of the genus *Plenotocepheus* (Acari, Oribatida, Otocepheidae)

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ABSTRACT — The oribatid mite genus *Plenotocepheus* (Oribatida, Otocepheidae) is recorded for the first time in the Antilles; one new species is described from the mould in the chimney of a deep cave of the Gaspar Grande Island, Trinidad. *Plenotocepheus* (*Plenotocepheus*) *trinidadensis* n. sp. differs from its most similar congener *P. (Plenotocepheus) neotropicus* Ermilov, Sandmann, Marian and Maraun, 2013 by the length of some notogastral setae and number of notogastral condyles. Generic and subgeneric diagnoses and an identification key to the known subgenera and species of *Plenotocepheus* are presented.

KEYWORDS — oribatid mites; morphology; systematics; generic diagnosis; new species; key; fauna; cave; Antilles

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INTRODUCTION

Plenotocepheus (Oribatida, Otocepheidae – see Schatz *et al.* 2011) is a genus of oribatid mites that was proposed by Hammer (1966) with *Plenotocepheus mollicoma* Hammer, 1966 as type species. It comprises 2 subgenera and 12 (see "Remarks on the genus *Afrotocepheus* Mahunka, 1985" section) species, which are distributed in the Neotropical, Ethiopian, Oriental and Australian regions (Subías 2004, updated 2016).

Among the oribatid mite material collected from cave of the Gaspar Grande Island, Trinidad, I found a new species of *Plenotocepheus*. This genus is recorded for the first time in the Antilles. The main goal of the paper is to describe and illustrate this species, update generic and subgeneric diagnoses

and give an identification key to known taxa of *Plenotocepheus*.

MATERIALS AND METHODS

Material — Holotype (male) and two paratypes (both males): Trinidad, 10°39'51.10"N, 61°39'53.79"W, Gaspar Grande Island, limestone, chimney of 20 m deep cave with a few shrubs and trees around (shade), decay of *Clusia* on clayish soil, mould, 11.I.1955. Material was collected by Dr. P.W. Hummelinck (1907–2003) during his voyages in the Antilles, and sorted by Dr. M. Sellnick (1884–1971).

Methods — Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. The body length was measured in lateral view, from the tip of the rostrum

to the posterior edge of the ventral plate. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers. Formulas for leg setation are given in parentheses according to the sequence: trochanter-femur-genu-tibia-tarsus (femulus included). Formulas for leg solenidia are given in square brackets according to the sequence: genu-tibia-tarsus. Morphological terminology used in this paper follows that of F. Grandjean: see Travé & Vachon (1975) for general references, Norton (1977) for leg setal nomenclature, and Norton & Behan-Pelletier (2009) for overview. Drawings were made with a camera lucida using a Carl Zeiss transmission light microscope "Axioskop-2 Plus".

SYSTEMATICS

Genus *Plenotocepheus* Hammer, 1966

Type species: *Plenotocepheus mollicoma* Hammer, 1966, p. 66

Generic diagnosis

Adult — Otocephidae (e.g. Aoki 1961 – as for Tetracondylidae, Aoki 1965; key to families in Norton & Behan-Pelletier 2009). Body elongate oval. Pedotecta I and II represented by small laminae. Prodorsal and notogastral condyles normally developed or selectively absent. Medial prodorsal and medial notogastral condyles never fused in one medial unpaired condyle. Costulae long, parallel, reaching or not the insertions of lamellar setae. Prodorsal setae setiform (exception: interlamellar setae in *P. ensifer*). Bothridial setae clavate, fusiform or lanceolate. Notogaster with 12 or 14 pairs of setae setiform or flagellate, rarely ensiform, usually long (sometimes longer than notogaster). Epimeral setal formula 3-1-3-3. Three pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae. Aggenital condyles absent. Adanal lyrifissures distanced from anal plates, located in inverse apoanal or direct apoanal positions or transversely oriented. Adanal setae ad_3 inserted laterally or anteriorly to iad . Leg setae u on tarsi simple. *Juvenile instars*. Not known.

Plenotocepheus (Plenotocepheus) Hammer, 1966

Subgeneric diagnosis

Costulae reaching the insertions of lamellar setae. Notogaster with 14 pairs of setae.

Plenotocepheus (Neotocepheus) Hammer, 1966

Type species: *Neotocepheus colliger* Hammer, 1966, p. 68

Subgeneric diagnosis

Costulae not reaching the insertions of lamellar setae. Notogaster with 12 pairs of setae.

Plenotocepheus (Plenotocepheus) trinidadensis

n. sp.

(Figures 1-3)

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Diagnosis — Body size: 597 – 630 × 315 – 332. Body surface macrofoveolate. Interlamellar setae longer than lamellar and rostral setae, all setiform, barbed. Bothridial setae clavate, smooth. Prodorsal medial condyles triangular, lateral condyles truncate. Medial and lateral notogastral condyles absent. Notogastral setae setiform, with flagellate tips, barbed, differing in length, h_3 shortest, p_1 and p_3 shorter than c_1 and da , other setae longer. Subcapitular setae a narrowly phylliform. Epimeral setae thin, barbed, $1b$, $3b$ and $4a$ longest, $4b$ slightly shorter, other setae shorter. Genital and aggenital setae setiform, thin, slightly barbed, adanal and anal setae thicker, setiform, barbed. Leg claws slightly serrate on dorsal side. Leg setae pv'' on tarsi IV and v'' on tibiae III and IV broadly phylliform, l' on trochanters III long, thickened, heavily barbed.

Measurements — Body length: 630 (holotype, male), 597, 614 (two paratypes, both males); notogaster width: 332 (holotype, male), 315, 332 (two paratypes).

Integument (Figs 1A-B, 2) — Body color light brown. Body surface porose and densely foveolate (diameter foveoles up to 10). Lateral body sides (between lateral condyles and acetabula II) tuberculate (diameter of tubercles up to 4). Lateral parts of genital plates with one slightly developed longitudinal strium.

FIGURE 1: *Plenotocepheus trinidadensis* n. sp.: A – dorsal view (legs not illustrated); B – ventral view (legs except trochanters IV not illustrated). Scale bar 100 μm.

FIGURE 2: *Plenotocepheus trinidadensis* n. sp.: lateral view, right side (legs except trochanters III and IV not illustrated). Scale bar 100 μ m.

Prodorsum (Figs 1A, 2) — Rostrum broadly rounded. Costulae (*cos*) longer than half of prodorsum, thin, located dorsally. Rostral (*ro*, 77 – 82) and lamellar (*le*, 90 – 94) setae setiform, barbed, curving antero-medially. Interlamellar setae (*in*, 118 – 123) slightly thicker, barbed, directed upwards. Bothridial setae (*bs*, their length out of bothridia 90 – 98) clavate, smooth, with longer stalk and shorter head narrowly rounded distally. Exobothridial setae (*ex*, 20 – 24) thin, indistinctly barbed. Lateral carinae not developed. Prodorsal condyles poorly visible, medial condyles (*co.pm*) triangular, located separately, lateral condyles (*co.pl*) truncate distally.

Notogaster (Figs 1A, 2) — Medial and lateral notogastral condyles absent. Notogaster with 14 pairs setae setiform, with flagellate tips, barbed, *h*₃ shortest (61 – 73), *p*₁ and *p*₃ (90 – 94) shorter than *c*₁ and *da* (114 – 118), other setae longer (131 – 147). Lyrifissures (*ia*, *im*, *ip*, *ih*, *ips*) and opisthonotal gland openings (*gla*) distinct.

Gnathosoma (Figs 1B, 2) — Generally, morphology is typical for *Plenotocepheus* (Grobler 1995a; Ermilov *et al.* 2013). Subcapitulum longer than wide

(135 – 143 $\times$ 82 – 90). Subcapitular setae *a* (20 – 24) narrowly phylliform, indistinctly barbed, *m* and *h* similar in length (49 – 53), setiform, barbed. Adoral setae and their alveoli absent. Palps (69) with setation 0-2-1-3-8(+ ω). Chelicerae (143 – 147) with two setiform, barbed setae, *cha* (45) longer than *chb* (28). Trägårdh's organ narrowly triangular.

Epimeral and lateral podosomal regions (Figs 1B, 2) — Apodemes 1, 2, 3 and sejugal apodemes distinct. Short sternal apodeme present on epimere I. Epimeral setal formula: 3-1-3-3; setae setiform, barbed, *1b*, *3b* and *4a* longest (57 – 65), *4b* slightly shorter (45 – 53), other setae shorter (32 – 36). Pedotecta I (Pd I) and II (Pd II) represented by small laminae. Discidia (*dis*) elongate triangular, rounded distally.

Anogenital region (Figs 1B, 2) — Three pairs of genital setae (*g*₁-*g*₃, 32 – 36), one pair of aggenital (*ag*, 36 – 45) setae setiform, thin, slightly barbed. Three pairs of adanal (*ad*₁-*ad*₃, 61 – 69), two pairs of anal (*an*₁, *an*₂, 49) setae thicker, setiform, barbed. Adanal setae *ad*₃ located in adanal position, intersetal distance *ad*₃-*ad*₃ larger than *ad*₂-*ad*₂ and *ad*₁-*ad*₁.

FIGURE 3: *Plenotocepheus trinidadensis* n. sp.: A – leg I, right, antiaxial view; B – tibia and tarsus of leg II, right, antiaxial view; C – genu and tibia of leg tarsus III, left, antiaxial view; D – leg IV, left, antiaxial view (setae p not labeled). Scale bar 50 μ m.

TABLE 1: Leg setation and solenidia of adult *Plenotocepheus trinidadensis* n. sp.

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	$d, (l), bv''$	$(l), v', \sigma$	$(l), (v), \varphi_1, \varphi_2$	$(ft), (tc), (it), (p), (u), (a), s, (pv), \varepsilon, \omega_1, \omega_2$
II	v'	$d, (l), bv''$	$(l), v', \sigma$	$l', (v), \varphi$	$(ft), (tc), (it), (p), (u), (a), s, (pv), \omega_1, \omega_2$
III	l', v'	d, ev'	l, σ	$(v), \varphi$	$(ft)^*, (tc), (it), (p), (u), (a), s, (pv)$
IV	v'	d, ev'	d	$(v), \varphi$	$ft'', (tc), (p), (u), (a), s, (pv)$

Note: Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus). Single prime (') marks setae on the anterior and double prime (") setae on the posterior side of a given leg segment. Parentheses refer to a pair of setae. Tr – trochanter, Fe – femur, Ge – genu, Ti – Tibia, Ta – tarsus.

* – ft' present or absent

Adanal lyrifissures (*iad*) inverse apoanal.

Legs (Figs 3A-D) — Morphology generally typical for *Plenotocepheus* (Grobler 1995a, b; Ermilov et al. 2013). Claw of each leg strong, slightly serrate on dorsal side. Tarsi without teeth. Formulas of leg setation and solenidia: I (1-4-3-4-16) [1-2-2], II (1-4-3-3-15) [1-1-2], III (2-2-1-2-15(14)) [1-1-0], IV (1-2-2-12) [0-1-0]; homology of setae and solenidia indicated in Table 1. Famulus short, indistinctly dilated distally. Leg setae setiform (except broadly phylliform pv'' on tarsi IV and v'' on tibiae III and IV), barbed (except smooth p on tarsi I and s on tarsi I, II), l' on trochanters III long, thickened, heavily barbed, u setiform on all tarsi. Solenidia ω_1 on tarsi I and ω_1 and ω_2 on tarsi II of medium size, erect, blunt-ended, other solenidia long, setiform.

Type deposition — The holotype is deposited in the collection of the Netherlands Centre for Biodiversity Naturalis, Leiden, The Netherlands; two paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Etymology — The specific name *trinidadensis* refers to Trinidad, where the new species was collected.

Remarks — *Plenotocepheus* (*Plenotocepheus*) *trinidadensis* n. sp. is morphologically most similar to *P. (Plenotocepheus) neotropicus* Ermilov, Sandmann, Marian and Maraun, 2013 from Ecuador in the absence of medial notogastral condyles, presence of long interlamellar and bothridial setae and well-developed notogastral setae, but differs by the

notogastral setae c_1 and da distinctly shorter than c_2 and la (versus similar in length) and the absence of lateral notogastral condyles (versus developed).

REMARKS ON THE GENUS *Afrotocepheus* MAHUNKA, 1985

Mahunka (1985) proposed a new genus, *Afrotocepheus* with *Afrotocepheus sinarmatus* Mahunka, 1985 as type species. Later, Grobler (1995a, p. 15) presented explanations on the impossibility of generic support of for *Afrotocepheus*, proposed its synonymy with *Plenotocepheus* Hammer, 1966 and combined *A. sinarmatus* with *Plenotocepheus*. However, Balogh and Balogh (2002) and Subías (2004, updated 2016) did not accept Grobler's proposal. In my opinion, Grobler's explanations are correct, therefore I agree with her taxonomic changes.

DISTRIBUTION

At present, the known representatives of the genus *Plenotocepheus* are registered in Ecuador (1 species), Republic of Trinidad and Tobago (Trinidad) (1 species), Chile (Juan Fernández Islands) (1 species), Zimbabwe (1 species), South Africa (6 species), India (1 species) and New Zealand (3 species) (Fig. 4). Thus, three species were registered in the Neotropical region, seven species in southern Ethiopian region, one in the Oriental region and one in the Australian region. Each species was recorded in a single country, often only from the type locality, except *Plenotocepheus* (*Plenotocepheus*) *verrucosus* Grob-

FIGURE 4: Map on distribution of *Plenotocepheus* species: 1 – *P. (Plenotocepheus) neotropicus* Ermilov, Sandmann, Marian and Maraun, 2013 (Ecuador); 2 – *P. (Plenotocepheus) trinidadensis* n. sp. (Trinidad); 3 – *P. (Neotocepheus) longipilus* (Trägårdh, 1931) (Juan Fernández); 4 – *P. (Plenotocepheus) undatus* Mahunka, 1973 (Zimbabwe); 5 – *P. (Plenotocepheus) crinitus* Grobler, 1995, *P. (Plenotocepheus) discrepans* Grobler, 1995, *P. (Plenotocepheus) dentatus* Grobler, 1995, *P. (Plenotocepheus) africanus* Mahunka, 1984, *P. (Plenotocepheus) sinarmatus* (Mahunka, 1985) (all South Africa); 6 – *P. (Plenotocepheus) verrucosus* Grobler, 1995 (South Africa and India); 7 – *P. (Neotocepheus) colliger* (Hammer, 1966), *P. (Plenotocepheus) delicatissimus* Hammer, 1966, *P. (Plenotocepheus) mollicoma* Hammer, 1966 (all New Zealand).

ler, 1995(a) which was registered in South Africa and India, in the southern Ethiopian and Oriental regions.

Key to known subgenera and species of *Plenotocepheus*

1. Costulae not reaching insertions of lamellar setae; notogaster with 12 pairs of setae (2)
Subgenus *P. (Neotocepheus)* Hammer, 1966
— Costulae reaching insertions of lamellar setae; notogaster with 14 pairs of setae (3)
Subgenus *P. (Plenotocepheus)* Hammer, 1966
2. Interlamellar setae inserted between bothridia; medial prodorsal condyles separated; medial notogastral condyles present; body length: 1100×580 *P. (Neotocepheus) colliger* (Hammer, 1966).
— Interlamellar setae inserted anteromedial to bothridia; medial prodorsal condyles connected; medial notogastral condyles absent; body length:

1080 *P. (Neotocepheus) longipilus* (Trägårdh, 1931).

3. All or some medioposterior notogastral setae longer than notogaster (4)
— All medioposterior notogastral setae shorter than notogaster (7)
4. All medioposterior notogastral setae longer than notogaster (5)
— Only some medioposterior notogastral setae longer than notogaster (6)
5. Adanal setae longer than notogaster; interlamellar setae longer than prodorsum; bothridial setae with narrowly elongated head; body length: $795 - 811 \times 374 - 421$ *P. (Plenotocepheus) crinitus* Grobler, 1995(b).
— Adanal setae shorter than notogaster; interlamellar setae shorter than prodorsum; bothridial setae with lanceolate head; body length:

680..... *P. (Plenotocepheus) delicatissimus*
Hammer, 1966.

6. Four pairs of very long notogastral setae (*lm*, *lp*, *dp* and *h*₁); body length: 568 – 822 × 292 – 432.....*P. (Plenotocepheus) discrepans*
Grobler, 1995(a).

— Three pairs of very long notogastral setae (*lp*, *dp* and *h*₁); body length: 673 × 340.....*P. (Plenotocepheus) undatus*
Mahunka, 1973.

7. Medial notogastral condyles present.....(8)
— Medial notogastral condyles absent.....(9)

8. Bothridial setae long, with narrowly elongated head and thin apex; interlamellar setae shorter than rostral and lamellar setae; notogastral setae *c*₁, *da*, *dm* and *dp* distinctly shorter than *c*₂, *la*, *lm* and *lp* and posterior setae *p*₁ and *p*₂ long, setiform; body length: 679 – 737 × 284 – 290*P. (Plenotocepheus) dentatus*
Grobler, 1995(b).

— Bothridial setae short, clavate; interlamellar setae longer than rostral and lamellar setae; dorsal notogastral setae similar in length, and posterior setae *p*₁ and *p*₂ short, thickened, erect; body length: 780 × 402 *P. (Plenotocepheus) africanus*
Mahunka, 1984.

9. Notogastral setae ensiform, short, not reaching insertions of setae in subsequent rows; interlamellar setae ensiform, similar in length to rostral and lamellar setae; body length: 600 – 758 × 225 – 417.....*P. (Plenotocepheus) verrucosus*
Grobler, 1995(a).

— Notogastral setae setiform, long, reaching insertions of setae in subsequent rows; interlamellar setae setiform, distinctly longer or shorter than rostral and lamellar setae (10)

10. Bothridial setae with narrowly elongated head and thin apex; interlamellar setae shorter than rostral and lamellar setae; body length: 830..... *P. (Plenotocepheus) mollicoma*
Hammer, 1966.

— Bothridial setae fusiform or clavate, without thin apex; interlamellar setae longer than rostral and lamellar setae (11)

11. Notogastral setae *c*₁ and *da* distinctly shorter than *c*₂ and *la*; lateral notogastral condyles not developed; body length: 597 – 630 × 315 – 332*P. (Plenotocepheus) trinidadensis* **n. sp.**
— Dorsal notogastral setae similar in length; lateral notogastral condyles developed (12)

12. Bothridial setae long, with elongate fusiform head; medial prodorsal condyles present; notogastral setae *p*₁ setiform; body length: 581 – 763 × 249 – 332 *P. (Plenotocepheus) neotropicus*
Ermilov, Sandmann, Marian and Maraun, 2013.
— Bothridial setae short, clavate; medial prodorsal condyles absent; notogastral setae *p*₁ thickened, blunt-ended; body length: 581 – 763 × 249 – 332..... *P. (Plenotocepheus) sinarmatus*
(Mahunka, 1985).

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