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Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d’avenir » programme (Labex Agro: ANR-10-LABX-0001-01)

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Two new species of Neophysobates (Acari, Oribatida, Tegoribatidae) from New Zealand

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(Received 03 June 2015; accepted 27 June 2015; published online 30 September 2015)

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ABSTRACT — Two new species of oribatid mites of the monotypic genus Neophysobates (Oribatida, Tegoribatidae) from high alpine cushion fields in the Pisa Range, South Island, New Zealand are described. Neophysobates zealandicus n. sp. differs from N. monodactylus by the presence of bothridial seta with simple stalk and clavate, rounded distally head, a short adanal lyrifissure, and thickened seta pv" with attenuate tip on tarsus II. Neophysobates incrassatus n. sp. differs from N. monodactylus by the presence of bidactylous legs, three pairs of notogastral porose areas, thin rostral seta and tutorium without free tip. An identification key to the known species of Neophysobates is provided.

KEYWORDS — oribatid mites; Tegoribatidae; Neophysobates; new species; morphology; systematics; key; alpine fauna; New Zealand

INTRODUCTION

Neophysobates is a monotypic oribatid mite genus (Acari, Oribatida, Tegoribatidae), which was proposed by Luxton (1985) under the name Paraphysobates, with Physobates monodactylus Hammer, 1966 as type species. Later, Luxton (1987) proposed the replacement name (Neophysobates), because the name Paraphysobates was preoccupied (see Mahunka 1985). Apparently unaware of this action, Fujikawa (1991) proposed another replacement name – Pseudophysobates. As it has the same type species, Pseudophysobates is an objective junior synonym of Neophysobates, and the synonymy was first noted by Subías (2004).

Subías (2004) also included Tegoribates montana Engelbrecht, 1986 and T. nuda Engelbrecht, 1986 (both from South Africa) in Neophysobates. However, these species have lamellae with anterior incision, three pairs of adanal setae, and very long bothridial setae with stalk not enclosed by bothridia (also, T. nuda has sacculi on notogaster), therefore, the inclusion of these species in Neophysobates seems to be problematic and their systematic position should be investigated further.

The main generic characters of Neophysobates are (based on data from Luxton (1985) and including our additions): fused lamellae broadly rounded anteriorly, without anterior incision; interlamellar seta and its alveolus absent; bothridial seta clavate or fusiform, stalk enclosed in bothridium; anterior part of pteromorph at the same level as anterior notogastral margin; three or four pairs of porose areas on notogaster; ten pairs of minute notogastral setae; five or six pairs of genital setae; aggenital se-
tae present or absent; two pairs of adanal setae; legs mono- or bidactylous.

During a recent study of the oribatid mite fauna of the high alpine zone of several mountain ranges in Central Otago, South Island, New Zealand (Ermilov and Minor 2015a-c), we discovered two new species of the genus Neophysobates. The main goal of our paper is to describe and illustrate these taxa. Additionally, we provide an identification key for the three known species of Neophysobates.

**MATERIALS AND METHODS**

The new species were found in the high alpine zone of Central Otago mountains, at elevations ranging 1700 – 1800 m a.s.l. The area is an exposed alpine environment with low mean annual temperatures (ca. 2 degrees C) and frequent freeze-thaw cycles (Mark and Bliss 1970). The vegetation is dominated by dwarf cushion shrubs Dracophyllum muscoides (Ericaceae) and Raoulia spp. (Compositae) on crests of small (15 – 30 cm) cryogenic earth hummocks and stripes; between hummocks and stripes there is bare soil with some herbaceous plants and lichens (Mark and Bliss 1970). The collection locality and habitat for each new species are given in the respective "Material examined" sections. 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 (famulus included). Formulas for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus. General terminology used in this paper follows that of Grandjean (summarized by Norton and Behan-Pelletier 2009). Drawings were made with a drawing tube using a Carl Zeiss transmission light microscope "Axioskop-2 Plus".

**Neophysobates zealandicus n. sp.** (Figures 1-3)


Description: Measurements — Body length: 241 (holotype: male), 233 – 254 (five paratypes: two females and three males); body width: 164 (holotype), 143 – 172 (five paratypes). Without sexual dimorphism.

Integument — Body color light brown to brown. Body surface smooth, but notogaster covered by cerotegumental microgranules (their diameter up to 2, well visible under high magnification in dissected specimens). Tutorium and pedotectum I partially striate.

Prodorsum — Rostrum rounded. Lamella (lam) covering almost all prodorsum, but pedotectum I (Pd I) partially visible in dorsal view. Rostral seta (ro, 10 – 12) thickened, heavily barbed. Lamellar seta (le, 10 – 12) setiform, thin, smooth. Bothridial seta (bs, 57 – 69 – including portion within bothridia) clavate. Stalk thin, smooth. Head elongated, rounded distally, slightly barbed. Tutorium (tu) long, of medium width, with one knife-like tooth anteriorly. Exobothridial seta and its alveolus not found.

Notogaster — Anterior margin straight. Pteromorph broadly rounded, without teeth or incisions. Hinge (hi) clearly developed. Dorsophragmata of medium size, fused into narrowly tringular structure. Four pairs (in all specimens) of rounded porose areas: Aa (8 – 12) larger than A1 (6 – 8) and A2, A3 (both 6). Ten pairs of short (4), thin, smooth notogastral setae. Lyrifissures ia, im, ip, ih and ips and opisthonal gland opening (gla) distinct.

Gnathosoma — Subcapitulum longer than wide (61 – 65 × 49 – 57). Subcapitular setae setiform, smooth, a and m (both 8) slightly longer and thicker than h (6). Two pairs of thin, smooth adoral setae (or1, or2, 8). Axillary saccule (sac) slightly elon-
FIGURE 1: Neophysobates zealandicus n. sp.: A – dorsal view; B – ventral view (gnathosoma and legs not illustrated); C – posterior view. Scale bar 50 µm.
**FIGURE 2**: *Neophysobates zealandicus* n. sp.: A – antero-medial part of prodorsum, dorso-frontal view; B – anterior part of body, lateral view; C – subcapitulum, ventral view; D – palp; E – chelicera (Tg was damaged during dissection), left, paraxial view. Scale bar (A, B) 50 µm, scale bar (C, E) 20 µm, scale bar (D) 10 µm.
FIGURE 3: Neophysobates zealandicus n. sp.: A – leg I, right, paraxial view; B – femur and genu of leg II, right, paraxial view; C – trochanter, femur and genu of leg III, left, antiaxial view; D – leg IV, left, antiaxial view. Scale bar 20 µm.
TABLE 1: Leg setation and solenidia of *Neophysobates zealandicus* n. sp.

<table>
<thead>
<tr>
<th>Leg</th>
<th>Trochanter</th>
<th>Femur</th>
<th>Genu</th>
<th>Tibia</th>
<th>Tarsus</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>v'</td>
<td>d, (l), v'</td>
<td>(l), v', σ</td>
<td>(l), v', ϕ₁, ϕ₂</td>
<td>ft', (tc), (it), (p), (u), (a), s, (pv), (pl), (v), ω₁, ω₂</td>
</tr>
<tr>
<td>II</td>
<td>v'</td>
<td>d, (l), v'</td>
<td>(l), v', σ</td>
<td>(l), (v), ϕ</td>
<td>ft', (tc), (it), (p), (u), (a), s, (pv), ω₁, ω₂</td>
</tr>
<tr>
<td>III</td>
<td>l', v'</td>
<td>d, ev'</td>
<td>l', σ</td>
<td>l', (v), ϕ</td>
<td>ft'', (tc), (it), (p), (u), (a), s, (pv)</td>
</tr>
<tr>
<td>IV</td>
<td>v'</td>
<td>d, ev'</td>
<td>d</td>
<td>(v), ϕ</td>
<td>ft'', (tc), (p), (u), a', s, (pv)</td>
</tr>
</tbody>
</table>

Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus). Single prime (’) marks setae on anterior and double prime (’’) setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

Type deposition — The holotype (alcohol) and two paratypes (alcohol) are deposited in the New Zealand National Arthropod Collection, Auckland, New Zealand; two paratypes (alcohol) are deposited in the collection of the Senckenberg Institution, Frankfurt, Germany; one paratype (alcohol) is deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Etymology — The specific name "zealandicus" refers to the country of origin, New Zealand.

Comparison — *Neophysobates zealandicus* n. sp. is similar to *N. monodactylus* Hammer, 1966 also from New Zealand (see Hammer 1967) in having monodactylous legs, four pairs of notogastral porose areas, thickened rostral seta, and tutorium with free knife-like tip. However, it differs from the latter by the presence of simple bothridial stalk (vs. with strong mid-length swelling), bothridial head rounded distally (vs. pointed), short adanal lyrifissure (vs. comparatively long) and seta pv' on tarsus II thickened, with attenuated tip (vs. short, thick, thorn-like).

*Neophysobates incrassatus* n. sp. (Figures 4-5)

FIGURE 4: Neophysobates incrassatus n. sp.: A – dorsal view; B – ventral view (gnathosoma and legs not illustrated); C – posterior view. Scale bar 50 µm.
FIGURE 5: Neophysobates incrassatus n. sp.: A – antero-medial part of prodorsum, dorso-frontal view; B – anterior part of body, lateral view; C – bothridial seta; D – right half of subcapitulum, ventral view; E – genu, tibia and tarsus of leg II, right, paraxial view. Scale bar (A, B) 50 µm, scale bar (C-E) 20 µm.
Table 2: Leg setation and solenidia of *Neophysobates incrassatus* n. sp.

<table>
<thead>
<tr>
<th>Leg</th>
<th>Trochanter</th>
<th>Femur</th>
<th>Genu</th>
<th>Tibia</th>
<th>Tarsus</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>$v'$</td>
<td>$d, (l), v''$</td>
<td>(l), $\sigma$</td>
<td>(l), $v'$, $\varphi_1$, $\varphi_2$</td>
<td>($f_1$), ($i_c$), ($i_t$), ($p$), ($u$), (a), ($s$), ($pv$), ($p_t$), $\epsilon$, $\omega_1$, $\omega_2$</td>
</tr>
<tr>
<td>II</td>
<td>$v'$</td>
<td>$d, (l), v''$</td>
<td>(l), ($v$)</td>
<td>(l), ($v$), $\varphi$</td>
<td>($f_1$), ($i_c$), ($i_t$), (p), ($u$), (a), ($s$), ($pv$), $\omega_1$, $\omega_2$</td>
</tr>
<tr>
<td>III</td>
<td>$l', v'$</td>
<td>$d$, $ev'$</td>
<td>$l'$, $\sigma$</td>
<td>(v), $\varphi$</td>
<td>($f_1$), ($i_c$), ($i_t$), ($p$), ($u$), (a), ($s$), ($pv$)</td>
</tr>
<tr>
<td>IV</td>
<td>$v'$</td>
<td>$d$, $ev'$</td>
<td>$d$</td>
<td>(v), $\varphi$</td>
<td>$f_1''$, ($i_c$), ($p$), ($u$), (a), ($s$), ($pv$)</td>
</tr>
</tbody>
</table>

Roman letters refer to normal setae, Greek letters to solenidia (except $\epsilon$ = famulus). Single prime (’) marks setae on anterior and double prime (’’) setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

without free tip. Three pairs of notogastral porose areas. Five pairs of genital setae. Aggenital setae absent. Legs bidactylous.


Integument — Body color light brown to brown. Body surface smooth, except anterior margins of pteromorph (with several transverse striae) and epimeral region (with numerous longitudinal striae). Cerotegumental microgranules absent.

Prodorsum — Rostrum rounded. Lamella covering entire prodorsum; no parts of pterodactyl visible in dorsal view. Rostral (8 – 10) and lamellar (10 – 12) setae setiform, thin, smooth. Bothridial seta (49 – 57) fusiform. Stalk with strong mid-length swelling ($sw$). Head elongated, slightly or distinctly pointed, barbed. Tutorium of medium width, ridge-like, curving backwards distally, without free tip anteriorly. Exobothridial seta and its alveolus not found.

Notogaster — Anterior margin straight. Pteromorph broadly rounded, without teeth and incisions. Hinge clearly developed. Dorsosphenosternum of medium size, fused into narrowly triangular structure. Three pairs (in all specimens; $A_2$ apparently absent) of rounded porose areas: $A_4$ (8) larger than $A_1$ and $A_3$ (both 6). Ten pairs of short (2 – 4), thin, smooth notogastral setae. All lyrifissures and opisthodonal gland opening distinct.

Gnathosoma — Generally, similar to *N. zealandicus* n. sp. Subcapitulum longer than wide (53 – 57 × 45). Subcapitular setae setiform, smooth, $a$ and $m$ (both 6) little longer and thicker than $h$ (4). Two pairs of adoral setae (4) thin, smooth. Axillary sac-cule elongated. Palp (34 – 36) with setation 0-2-1-3-9(+\$). Solenidion straight. Chelicera (53 – 57) with two barbed setae; $cha$ (16) longer than $chb$ (10). Trägårdh’s organ long, tapered.

Lateral podosomal and epimeral regions — Genal tooth narrowly triangular, long, reaching rostrum. Pedotectum I large, rounded anteriorly, pedo-tectum II small, scale-like in lateral view. Epimeral setal formula: 3-1-2-2; all setae short (4), thin, smooth. Custodium strong, directed anteriorly to the pedotectum II. Discidium triangular. Circum-pedal carina distinct.

Anogenital region — Five pairs of genital, two pairs of anal and two pairs of adanal setae similar in length (4), thin, smooth. Aggenital seta absent. Lyrifissure $iad$ long, about 1/4 length of anal plates, located in parapodial position. Ovipositor slightly elongated (52 × 41), lobe (32) distinctly longer than distal section (beyond middle fold; 20). Each of three lobes with four straight, smooth setae; $\psi_1 \approx \tau_1$ (16) longer than $\psi_2 \approx \tau_s \approx \tau_b \approx \tau_c$ (12). Six pairs of coronal setae (8 – 10) straight, smooth, inserted in medial part of distal section.

Legs — Generally, similar to *N. zealandicus* n. sp.
Heterobidactylous. Formulas of leg setation and solenia: I (1-4-2-3-18) [1-2-2], II (1-4-2-4-15) [1-1-2], III (2-2-1-2-15) [1-1-0], IV (1-2-1-2-12) [0-1-0]; homology of setae and solenia indicated in Table 2. Seta $p^v$ on tarsi II short, thick, thorn-like, with several strong spines.

Material examined — Holotype (male) and nine paratypes (five females and four males): New Zealand, South Island, Central Otago, Pisa Range, 44°52’11”S, 169°10’9”E, 1797 m a.s.l., in soil and debris under Raoulia sp. cushion plant (Compositae), 18 February 2014, collected by M. Minor.

Type deposition — The holotype (alcohol) and three paratypes (alcohol) are deposited in the New Zealand National Arthropod Collection, Auckland, New Zealand; three paratypes (alcohol) are deposited in the collection of the Senckenberg Institution, Frankfurt, Germany; three paratypes (alcohol) are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Etymology — The specific name “incrassatus” refers to the mid-length swelling of bothridial setae.

Comparison — Neophysobates incrassatus n. sp. is similar to N. monodactylus in having bothridial seta with a mid-length swelling in medial part of the stalk and in having five pairs of genital setae. However, it differs from the latter by the presence of bidactylous legs (vs. monodactylous), three pairs of notogastral porose areas (vs. four), rostral setae thin, similar to lamellar setae in thickness (vs. thicker than lamellar setae), and tutorium without free tip (vs. with knife-like tip). The three known species of Neophysobates can be distinguished by the key presented below.

**Key to known species Neophysobates**

1. Legs bidactylous; three pairs of notogastral porose areas; rostral seta thin, similar to lamellar seta in thickness; tutorium ridge-like, without free tip; body size: 196 – 217 × 115 – 147

   N. incrassatus n. sp.

2. Bothridial seta simple, without mid-length swelling, head rounded distally; adanal lyrifissure short, about 1/7-1/8 length of anal plate; leg seta $p^v$ on tarsi II elongated, thickened, with attenuate tip; body size: 233 – 254 × 143 – 172

   — Bothridial seta with strong mid-length swelling, head pointed distally; adanal lyrifissure long, about 1/4 length of anal plate; leg seta $p^v$ on tarsi II short, thick, thorn-like; body length: 230

   — Neophysobates zealandicus (Hammer, 1966).

   N. monodactylus (Hammer, 1966).

**Acknowledgements**

We cordially thank Prof. Dr. Roy A. Norton (State University of New York, Syracuse, U.S.A.) and one anonymous reviewers for the valuable comments, Dr. Alastair Robertson (Institute of Agriculture & Environment, Massey University, NZ) for help with fieldwork, the staff of the Snow Farm (Cardrona, NZ) for facilitating access to Pisa Range sites, and the New Zealand Department of Conservation for sampling permit (national authorization # 38116-GEO). The project was supported by the Massey University Research Fund.

**References**


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