

## A NEW SPECIES OF THE GENUS *PROTOPENTHALODES* (ACARI: PENTHALODIDAE) FROM CRIMEA

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ABSTRACT: A new species, *Protopenthalodes reticulatus* sp. n. (Acari: Penthalodidae) is described from moss in Crimea. The taxonomic position of the genus *Halotydeus* is discussed and this genus is moved from the family Penthaleidae to Penthalodidae.

KEY WORDS: Acarina, Eupodoidea, *Protopenthalodes*, *Halotydeus*, systematics, moss, Crimea

### INTRODUCTION

Mites of the cosmopolitan superfamily Eupodoidea Koch, 1842 are fungivorous, phytophagous and predatory. The classification of the superfamily lacks stability (Baker and Lindquist 2002). The superfamily Eupodoidea currently includes nine families: Eupodidae Koch, 1842, Penthaleidae Oudemans, 1931, Penthalodidae Thor, 1933, Rhagidiidae Oudemans, 1922, Strandmanniidae Zacharda, 1979, Eriorhynchidae Qin and Halliday, 1997, Pentapalpidae Oliver and Theron, 2000 and Dendrochaetidae Oliver, 2008 (Khaustov 2014). The family Penthalodidae includes five genera: *Penthalodes* Murray, 1877, *Stereotydeus* Berlese, 1901, *Hawaiieupodes* Strandmann and Goff, 1978, *Callipenthalodes* Qin, 1998 and *Protopenthalodes* Jesionowska, 1998 (Qin 1998; Jesionowska 2008). The genus *Turanopenthalodes* Barilo, 1988 originally described in the family Penthalodidae, was recently replaced to Penthaleidae (Khaustov 2014). The monotypic genus *Protopenthalodes* was described from Poland (Jesionowska 1998) and placed in the family Penthalodidae. Qin (1997) reconsidered the taxonomic position of *Protopenthalodes* and suggested that this genus is more appropriately placed in the family Eupodidae because of soft body integument. Finally, Khaustov (2014) returned *Protopenthalodes* to Penthalodidae based on several important synapomorphic characters discussed in Khaustov (2014).

This paper presents a description of a new mite species, *Protopenthalodes reticulatus* sp. n., collected from moss in Crimea, and discusses the taxonomic position of the genus *Halotydeus* Berlese, 1891.

### MATERIALS AND METHODS

Mites were collected from moss using Berlese funnels and mounted in Hoyer's medium. No-

tations for the prodorsal and leg setae follow Lindquist and Zacharda (1987) and Baker (1995), and the remaining nomenclature, as applied to eupodoids, follows Baker (1990). All measurements are given in micrometres ( $\mu\text{m}$ ) for the holotype and five paratypes (in parentheses). In descriptions of leg setation, the number of solenidia is given in parentheses. Photographs were taken with a digital camera AxioCam ICc5 via compound microscope Carl Zeiss AxioImager A2, equipped with phase contrast and DIC optics. The type material is deposited in the mite collection of the Tyumen State University, Tyumen, Russia.

### SYSTEMATICS

#### Family Penthalodidae Thor, 1933

#### Genus *Protopenthalodes* Jesionowska, 1989

Type species: *Protopenthalodes coniunctus* Jesionowska, 1989. By original designation.

#### *Protopenthalodes reticulatus* sp. n.

Figs 1–19

**Description. Female** (Figs 1–4, 12–15). Alive mites with black body, red legs and mouthparts. Body length 520 (510–605), greatest width (at level of setae  $c_2$ ) 365 (325–435).

Idiosomal dorsum (Figs 1A, 12, 13). Idiosoma oval. Sejugal furrow not discernable. Weak furrow visible in some specimens posteriorly to setae  $e_1$  (Fig. 13F). Prodorsal shield absent. Integument striate-spiculate, with weak subcuticular reticulate pattern (Figs 12, 13). Eyes located just posteriorly and laterally to setae ( $sc_2$ ), striations of hemispherical “lens” more densely packed and with shorter spicules than surrounding integument. Pair of well developed oblique apodemes located between bases of setae  $sc_1$  and base of naso (Fig. 13B). Setae: ( $v_1$ ) slender, with few fine branches, inserted at base of naso, trichobothridial; ( $sc_1$ ) filiform, finely spiculated, inserted in cy-

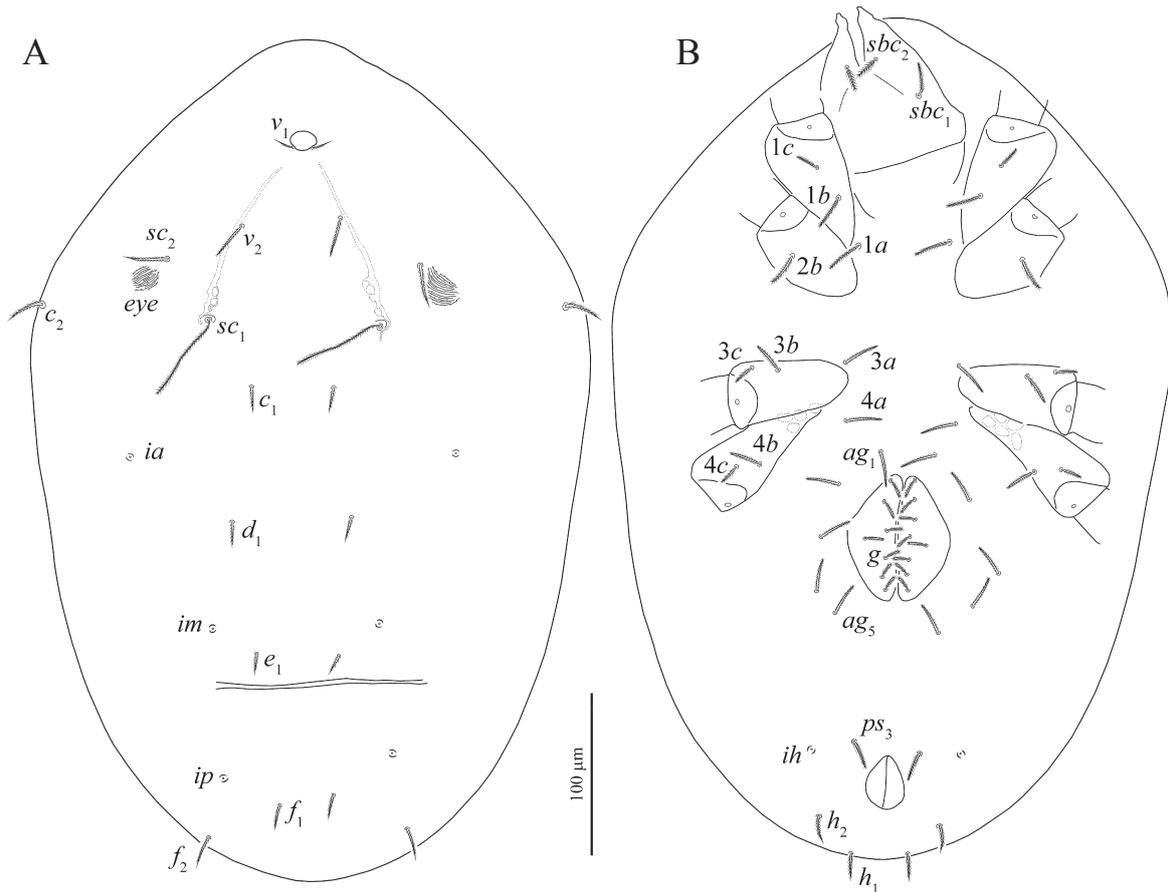


Fig. 1. *Protopenthalodes reticulatus*, sp. n., female: A — idiosomal dorsum, B — idiosomal venter.

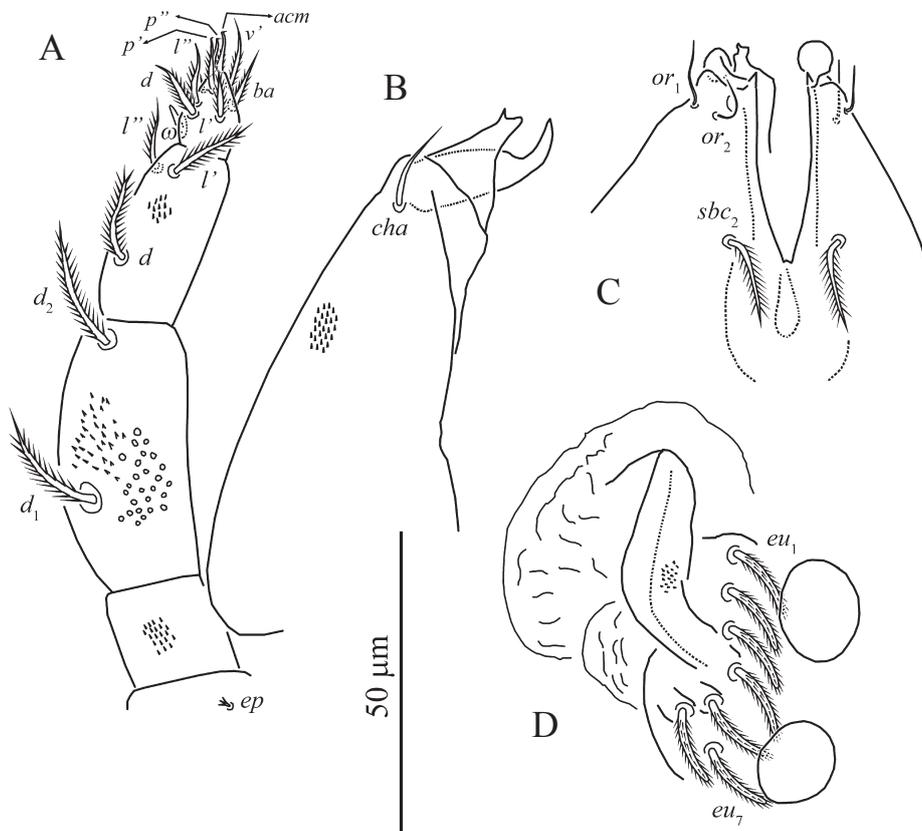


Fig. 2. *Protopenthalodes reticulatus*, sp. n., female: A — palp, B — chelicera, C — distal part of subcapitulum; male: D — genital area.

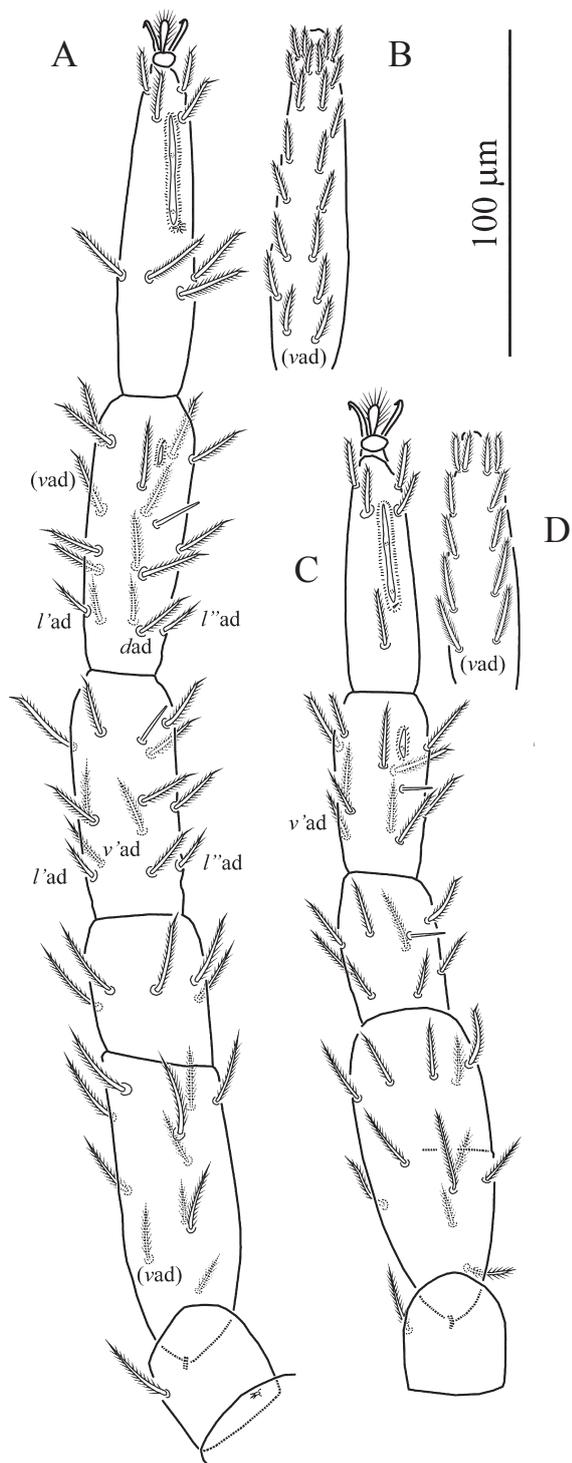


Fig. 3. *Protenthalodes reticulatus*, sp. n., female: A— leg I in dorsal view, B — tarsus I in ventral view, C — leg II in dorsal view, D — tarsus I in ventral view.

lindrical bothridia; remainder, plumose, slightly swollen near base, with smooth fine tip;  $h_1$  and  $h_2$  inserted ventrally (Fig. 1B). Lyrifissures: three pairs, *ia*, *im*, *ip* associated with, respectively, *d*, *e* and *f* setal rows; roughly circular in dorsal view, cup-shaped with pore perforating base in lateral

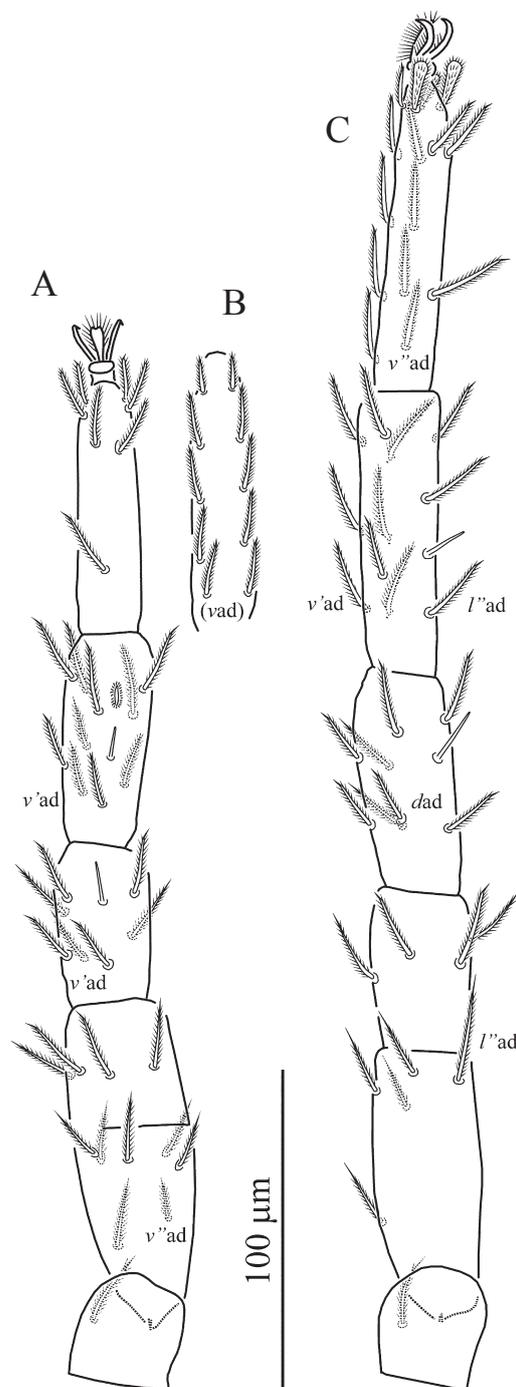


Fig. 4. *Protenthalodes reticulatus*, sp. n., female: A — leg III in dorsal view, B — tarsus III in ventral view, C — leg IV in dorsal view.

view. Lengths of dorsal setae:  $v_1$  11,  $v_2$  25,  $sc_1$  51,  $sc_2$  26,  $c_1$  16,  $c_2$  23,  $d_1$  16,  $e_1$  15,  $f_1$  17,  $f_2$  21,  $h_1$  17,  $h_2$  17.

Idiosomal venter (Figs 1B, 14). Integument striate-spiculate; all setae plumose. Coxal fields faintly defined. Coxisternal setal formula 3–1–3–3; Genital area: usually six pairs subequal eugenital setae, each inserted on separate tubercle, sometimes six pairs of eugenital setae on one side and



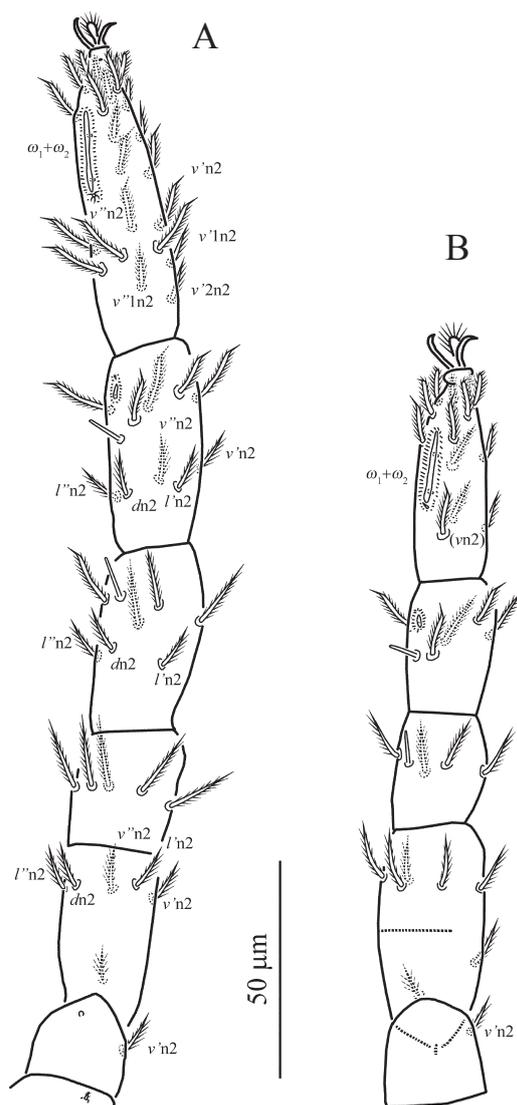


Fig. 7. *Protopenthalodes reticulatus*, sp. n., deutonymph: A — leg I in dorsal view, B — leg II in ventral view.

ulate over remainder, seta *cha* smooth, pointed; fixed digit slightly forked in lateral view.

Legs (Figs 3, 4). All segments slender, integument spiculate. Relative lengths of legs: I>IV>III>II. All leg setae densely pilose. Eupathidial setae with characteristically curved and smooth tip. Leg I (Fig. 3A): Supracoxal setae *ep* of the same shape and length as palpal supracoxal setae *ep*. Femur incompletely divided into basi- and telofemur. Setal formula: Tr — 1, Fe — 11/5, Ge — 13 (1 $\sigma$ ), Ti — 17 (2 $\phi$ , 1*k*), Ta — 29 (2 $\omega$ , 1 $\epsilon$ ). Famulus  $\epsilon$  (stellate seta) located in shallow depression basally to rhagidial solenidion  $\omega_1$ . Rhagidial solenidia  $\omega_1$  and  $\omega_2$  fused (Fig. 15A). Rhagidial solenidion  $\phi_1$  and famulus *k* located anterodorsally and situated in shallow depression; solenidion  $\phi_2$  erect, located mediodorsally; solenidion  $\sigma$  erect, located anterodorsally, slight-

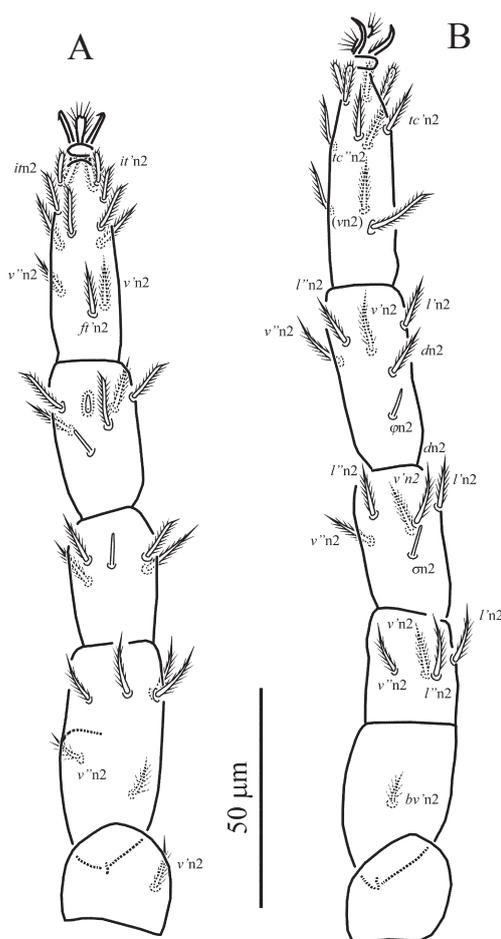


Fig. 8. *Protopenthalodes reticulatus*, sp. n., deutonymph: A — leg III in dorsal view, B — leg IV in dorsal view.

ly shorter than  $\phi_2$ . Leg II (Fig. 3B): Femur incompletely divided into basi- and telofemur. Setal formula: Tr — 1, Fe — 7/5, Ge — 8(1 $\sigma$ ), Ti — 11 (2 $\phi$ ), Ta — 17 (2 $\omega$ , 1 $\epsilon$ ). Famulus  $\epsilon$  spine-like, located just near to base of rhagidial solenidion  $\omega_1$ . Rhagidial solenidia  $\omega_1$  and  $\omega_2$  fused (Fig. 15B). Rhagidial solenidion  $\phi_1$  located anterodorsally and situated in shallow depression; solenidion  $\phi_2$  erect, located mediodorsally; solenidion  $\sigma$  erect, located mediodorsally, subequal to  $\phi_2$ . Leg III (Fig. 4A): Setal formula: Tr — 1, Fe — 7/4, Ge — 7 (1 $\sigma$ ), Ti — 10 (2 $\phi$ ), Ta — 17; femur completely divided into basi- and telofemur; Rhagidial solenidion  $\phi_1$  located anterodorsally and situated in shallow depression; solenidion  $\phi_2$  erect, located mediodorsally; solenidion  $\sigma$  erect, located mediodorsally, subequal to  $\phi_2$ . Leg IV (Fig. 4B): Setal formula: Tr — 1, Fe — 5/4, Ge — 8 (1 $\sigma$ ), Ti — 11 (1 $\phi$ ), Ta — 15; femur completely divided into basi- and telofemur; solenidion  $\phi$  erect, located mediodorsally; solenidion  $\sigma$  erect, located mediodorsally, subequal to  $\phi$ ; setae (*p*) of tarsus distinctly widened distally. Soft cuti-

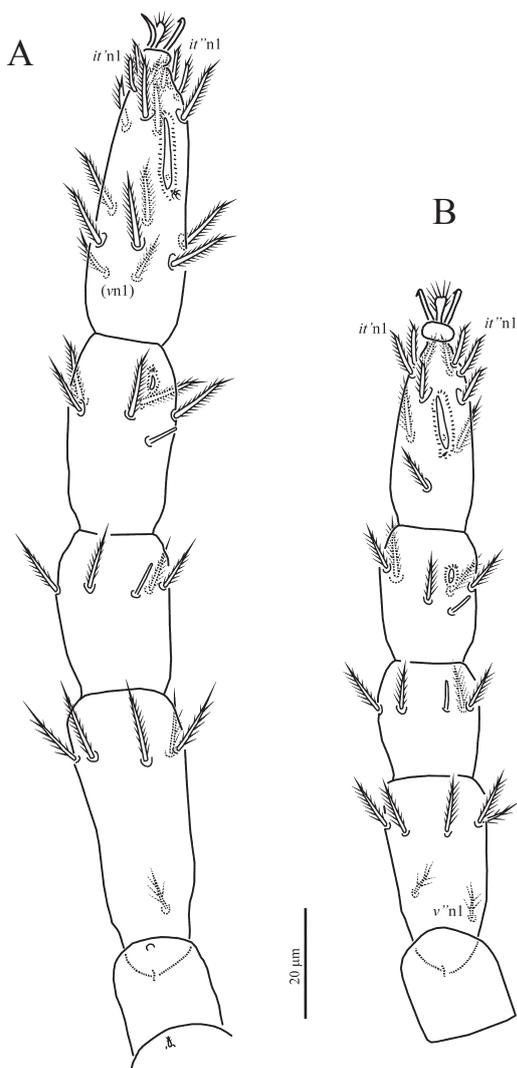


Fig. 9. *Protopenthalodes reticulatus*, sp. n., protonymph: A — leg I in dorsal view, B — leg II in ventral view.

cle separating trochanters and coxae of legs I–IV with distinct pore-like structure (Fig. 14C).

**Male** (Figs 2D, 14B, C). Similar with female, except genital area. Body length 510–570, width 345–395.

**Idiosoma venter.** Genital area (Figs 2D, 14B): seven pairs eugenital setae, aedeagus, wide, acuminate and ridged, directed anteriorly.

**Tritonymph** (Figs 5, 6, 16). Idiosomal dorsum as in adults, except presence of dehiscence line on prodorsum (Fig. 16A). Body length 425–470, width 295–335.

**Idiosoma venter** (Fig. 16B). Genital area: eugenital setae absent; three pairs genital setae.

**Legs** (Figs 5, 6). Leg I (Fig. 5A): Setal formula: Tr — 1, Fe — 9/5, Ge — 10 (1 $\sigma$ ), Ti — 13 (2 $\phi$ , 1k), Ta — 27 (2 $\omega$ , 1 $\epsilon$ ). Leg II (Fig. 5B): Setal formula: Tr — 1, Fe — 7/5, Ge — 8 (1 $\sigma$ ), Ti — 10

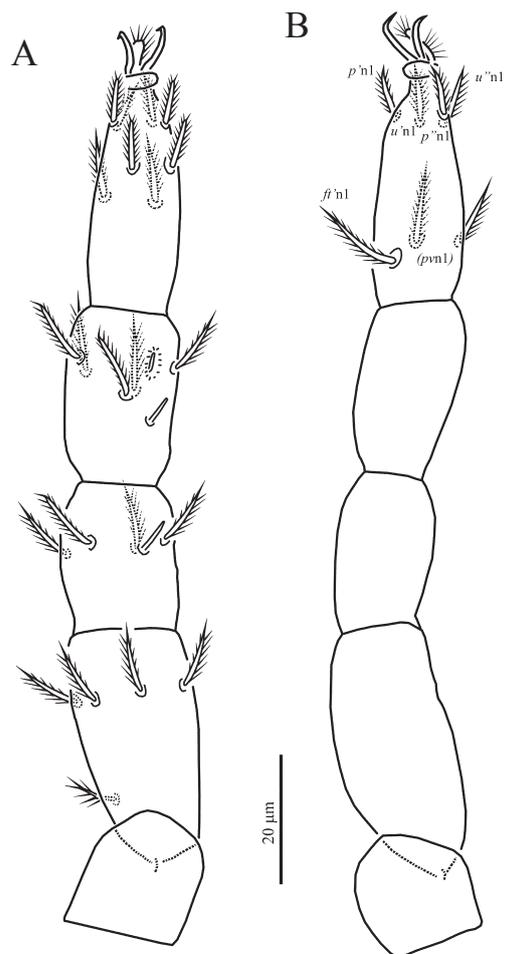


Fig. 10. *Protopenthalodes reticulatus*, sp. n., protonymph: A — leg III in dorsal view, B — leg IV in dorsal view.

(2 $\phi$ ), Ta — 15 (2 $\omega$ , 1 $\epsilon$ ). Leg III (Fig. 6A): Setal formula: Tr — 1, Fe — 6/4, Ge — 6 (1 $\sigma$ ), Ti — 9 (2 $\phi$ ), Ta — 15. Leg IV (Fig. 6B): Setal formula: Tr — 1, Fe — 4/4, Ge — 7 (1 $\sigma$ ), Ti — 9 (1 $\phi$ ), Ta — 14.

**Deuteronymph** (Figs, 7, 8, 17) Idiosomal dorsum (Fig. 17A) as in tritonymph. Body length 320–345, width 235–240.

**Idiosoma venter** (Figs 17B–D). Podosoma: coxa IV lacks seta 4c. Genital area (Figs 17C, D): two pairs genital and aggenital setae, sometimes one genital seta absent (Fig. 17D).

**Legs** (Figs 7, 8). Leg I (Fig. 7A): Setal formula: Tr — 1, Fe — 6/5, Ge — 7 (1 $\sigma$ ), Ti — 10 (2 $\phi$ , 1k), Ta — 23 (2 $\omega$ , 1 $\epsilon$ ). Leg II (Fig. 7B): Setal formula: Tr — 1, Fe — 2/5, Ge — 4 (1 $\sigma$ ), Ti — 5 (2 $\phi$ ), Ta — 13 (2 $\omega$ , 1 $\epsilon$ ). Leg III (Fig. 8A): Setal formula: Tr — 1, Fe — 2/4, Ge — 4 (1 $\sigma$ ), Ti — 5 (2 $\phi$ ), Ta — 13. Leg IV (Fig. 8B): Setal formula: Tr — 0, Fe — 1/4, Ge — 5 (1 $\sigma$ ), Ti — 5 (1 $\phi$ ), Ta — 11.

**Protonymph** (Figs 9, 10, 18) Body length 235–250, width 175–190; idiosoma narrows be-

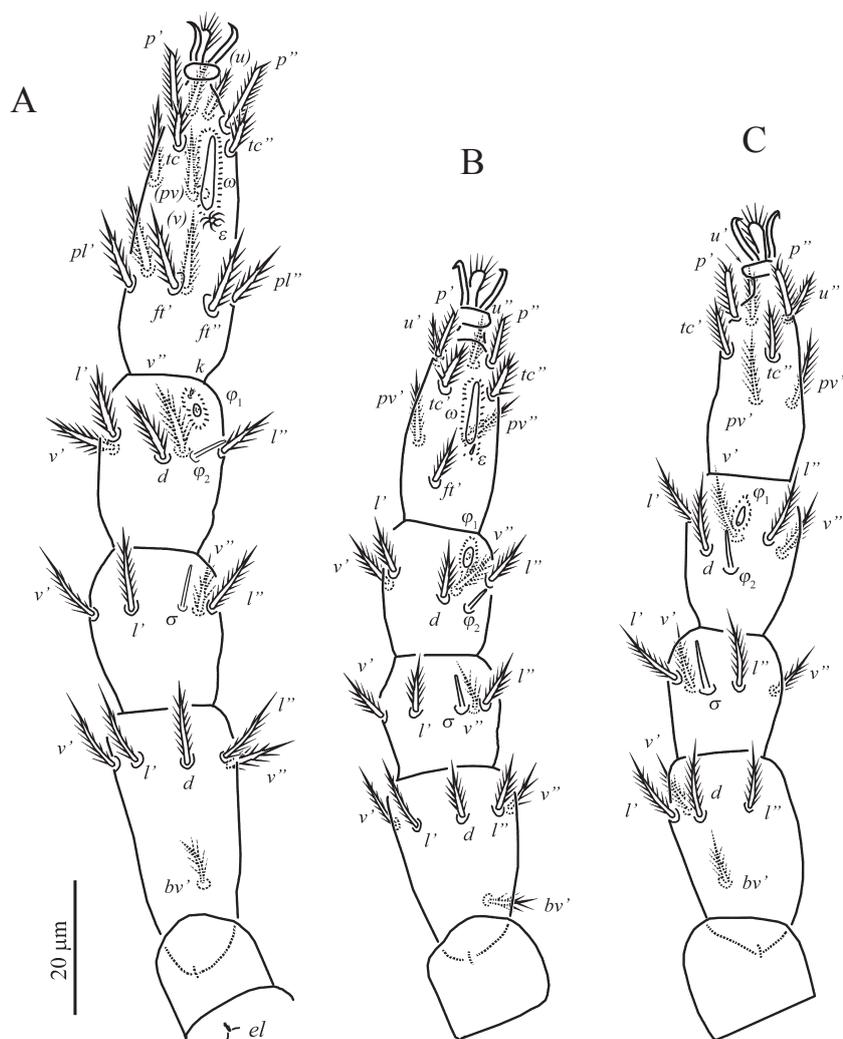


Fig. 11. *Protopenthalodes reticulatus*, sp. n., larva: A — leg I in dorsal view, B — leg II in dorsal view, C — leg III in dorsal view.

hind ( $c_2$ ), with evidence of segmental boundaries posteriorly (Figs 18B, C).

Idiosoma venter (Figs 18D–F). Podosoma: coxa III lacks setae ( $3c$ ), coxa IV without setae. Genital area: one pair genital papillae and genital setae, aggenitals absent.

Legs (Figs 9, 10). Leg I (Fig. 9A): Setal formula: Tr — 0, Fe — 6, Ge — 4( $1\sigma$ ), Ti — 5( $2\varphi$ ,  $1k$ ), Ta — 14 ( $1\omega$ ,  $1\varepsilon$ ). Leg II (Fig. 9B): Setal formula: Tr — 0, Fe — 7, Ge — 4( $1\sigma$ ), Ti — 5 ( $2\varphi$ ), Ta — 11( $1\omega$ ,  $1\varepsilon$ ). Leg III (Fig. 10A): Setal formula: Tr — 0, Fe — 5, Ge — 4( $1\sigma$ ), Ti — 5( $2\varphi$ ), Ta — 8. Leg IV (Fig. 10B): Setal formula: Tr — 0, Fe — 0, Ge — 0, Ti — 0, Ta — 7. Femora I–IV undivided. Genu and tibia IV without erect solenidia.

**Larva** (Figs 11, 19). Body length 190–200, width 130–150. Idiosomal dorsum (Figs 19A, C) similar with that of protonymph.

Idiosoma reuter (Figs 19B, D). Podosoma: ( $1c$ ) absent; Claparrde organs between coxae I and II, integument of cap smooth on upper and lower surfaces. Genital area: external evidence of genitalia absent.

Legs (Figs 11A–C). Leg I (Fig. 11A): Setal formula: Tr — 0, Fe — 6, Ge — 4 ( $1\sigma$ ), Ti — 5 ( $2\varphi$ ,  $1k$ ), Ta — 14 ( $1\omega$ ,  $1\varepsilon$ ). Leg II (Fig. 11B): Setal formula: Tr — 0, Fe — 6, Ge — 4 ( $1\sigma$ ), Ti — 5 ( $2\varphi$ ), Ta — 9 ( $1\omega$ ,  $1\varepsilon$ ). Leg III (Fig. 11C): Setal formula: Tr — 0, Fe — 5, Ge — 4 ( $1\sigma$ ), Ti — 5 ( $2\varphi$ ), Ta — 8.

**Type material.** Holotype female, slide No. AK310794, Crimea: Yalta mountain-forest Nature Reserve, wet moss on soil near the stream, 31 July 1994, coll. A.A. Khaustov. Paratypes: 8 females, 7 males, 5 tritonymphs, 2 deutonymphs, 7 protonymphs, 4 larvae, same data as holotype; 2 females, 1 tritonymph, Crimea: Yalta, wet moss on

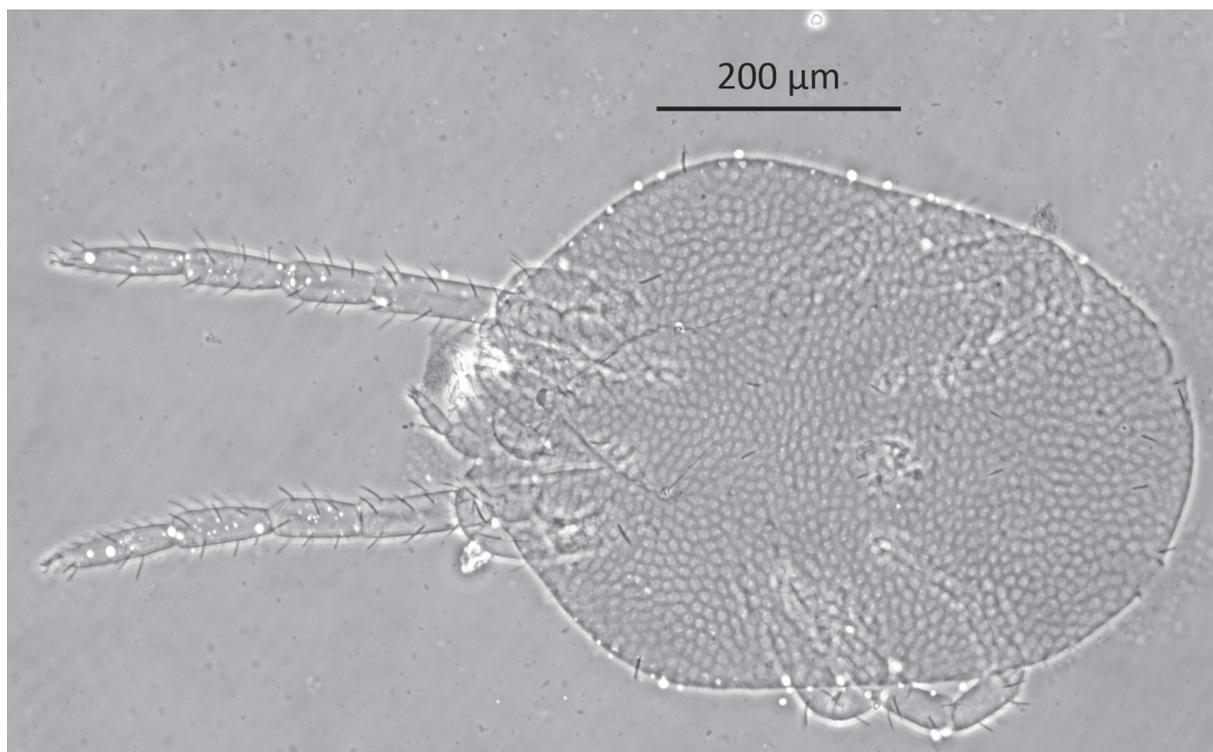


Fig. 12. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, female — general view.

soil, 5 March 1994, coll. A.A. Khaustov; 5 females, Crimea: Yalta mountain-forest Nature Reserve, wet moss on soil near the stream, 8 November 1995, coll. A.A. Khaustov.

**Etymology.** The name of the new species refers to the presence of the weak reticulate subcuticular pattern in adults.

**Differential diagnosis.** The new species differs from *P. coniunctus* Jesionowska, 1989 by the presence of the weak subcuticular idiosomal reticulate pattern (absent in *P. coniunctus*); by the presence of five pairs of aggenital setae (6 in *P. coniunctus*), famulus on tarsus I situated basally to rhagidial solenidion  $\omega_1$  (vs. laterally to  $\omega_1$  in *P. coniunctus*) and by much more rich setation on the leg segments.

## DISCUSSION

Mites of the genus *Protopenthalodes* are very similar to species of the genus *Halotydeus* Berlese, 1891. Both genera are characterized by the following synapomorphies: 1) setae  $ps_1$  and  $ps_2$  are absent, 2) lens-like eyes present near setae  $sc_2$ , 3) the naso very small, with short setae  $v_1$ , 4) sejugal furrow is absent, 5) rhagidial solenidia in rhagidial organs I and II are fused, 6) the body is soft, cuticle is striate-spiculate, 7) there is at least one pair of genital seta situated laterally to other geni-

tal setae. *Protopenthalodes* differs from *Halotydeus* by the ventral anal opening (vs. terminal in *Halotydeus*), the presence of prodorsal apodemes (vs. absent in *Halotydeus*), the ventral idiosoma with orthotrichous setation (vs. neotrichous in *Halotydeus*). At present the genus *Halotydeus* is placed in the family Penthaleidae based on single character state — the terminal anal opening, while in other genera of Penthaleidae, the anal opening is dorsal, and in the remaining families of Eupodoidea, the anal opening ventral. Qin and Halliday (1997), after a cladistic analysis of Australian and New Zealand Eupodoidea, also noted that *Halotydeus* could not be considered as a genus in the family Penthaleidae and a new family should be created for this genus. In my opinion, *Halotydeus* mites should be removed from Penthaleidae to Penthalodidae based on synapomorphic characters 1–4 and 7 (see the second sentence of this paragraph), which are also characteristic for the type genus of Penthalodidae.

During my study of the morphology of *Protopenthalodes reticulatus* sp. n. I found pore-like structures of unknown homology situated on the soft cuticle between coxae and trochanters of legs I–IV (Fig. 14C). These pore-like structures were recently discovered in the genus *Pseudoeupodes* Khaustov, 2014 of the family Eupodidae (Khaus-

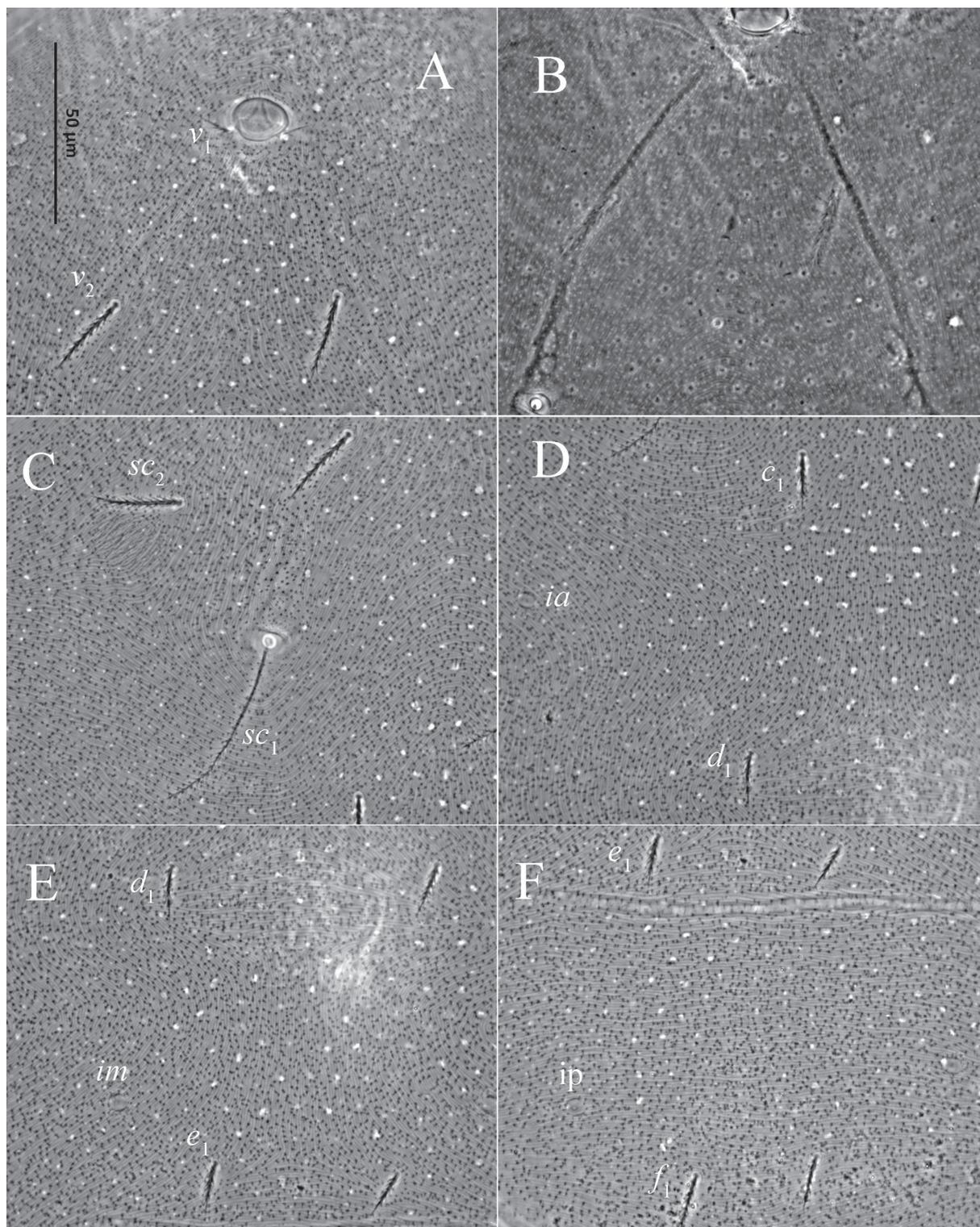


Fig. 13. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, female: A — anterior part of prodorsum, B — prodorsal apodemes, C — posterior part of prodorsum, D — anterior part of hysterosoma, E — hysterosoma between setae  $d_1$  and  $e_1$ , F — hysterosoma between setae  $e_1$  and  $f_1$ .

tov 2014). Probably these pore-like structures are presented in other genera of eupodoid mites and additional studies are required for understanding of their distribution within Eupodoidea.

#### ACKNOWLEDGEMENTS

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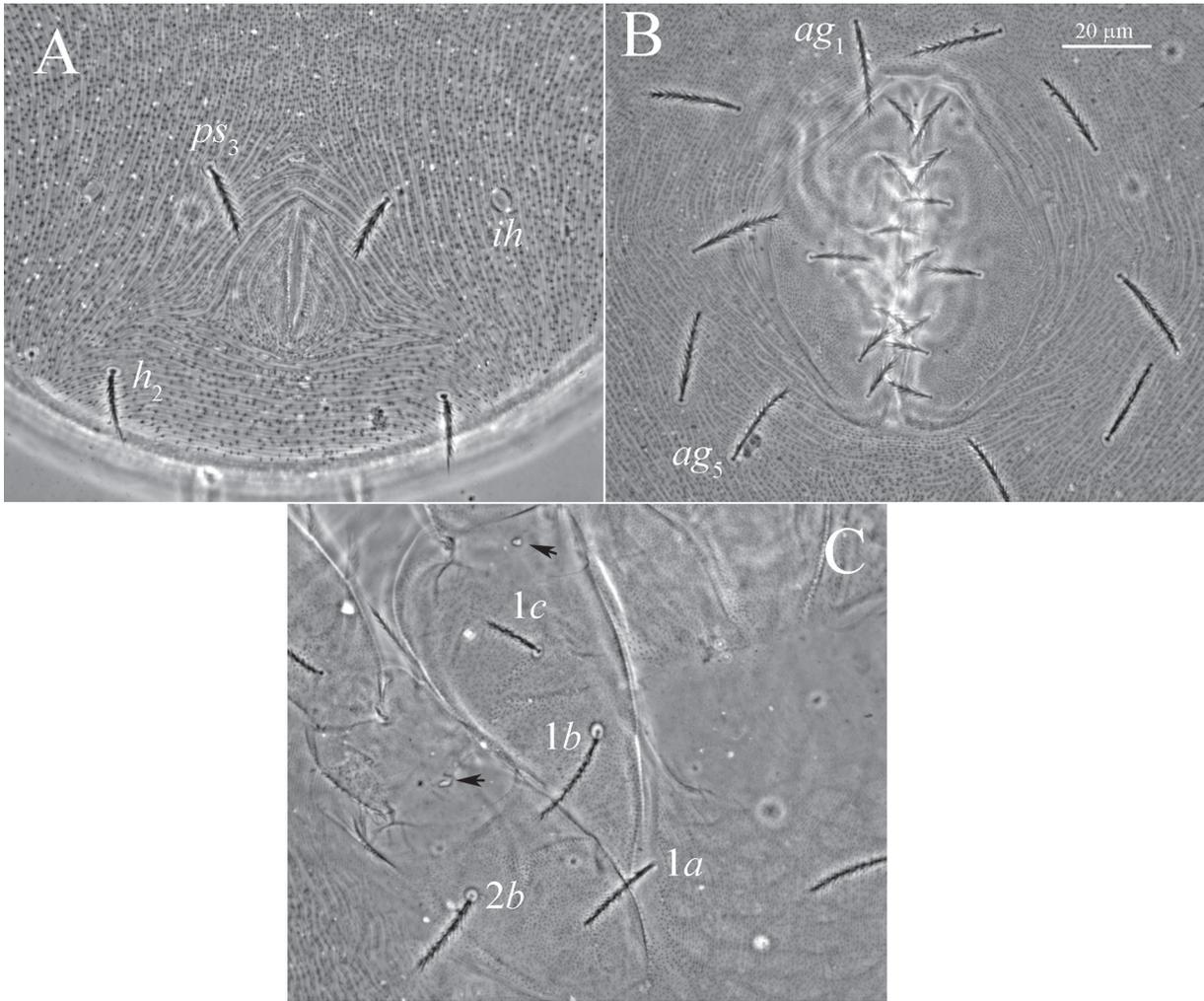


Fig. 14. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, female: A — anal region; male: B — genital area, C — coxae I and II, arrows point to pore-like structures.

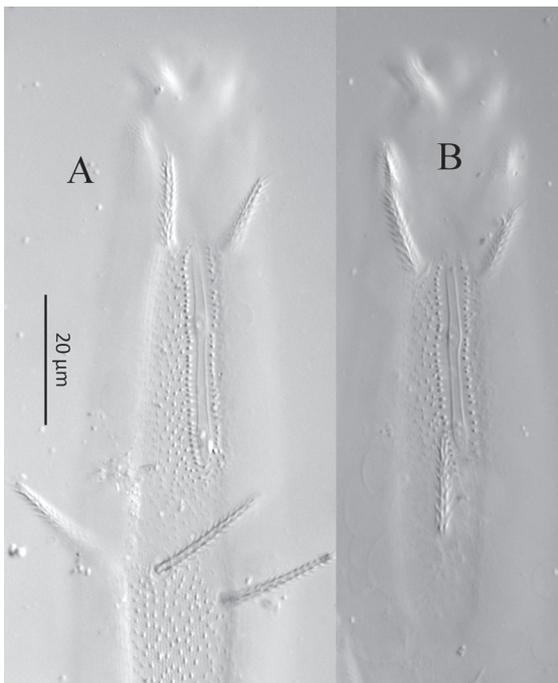


Fig. 15. *Protopenthalodes reticulatus*, sp. n., DIC photos, female: A — rhagial organ I, B — rhagial organ II.

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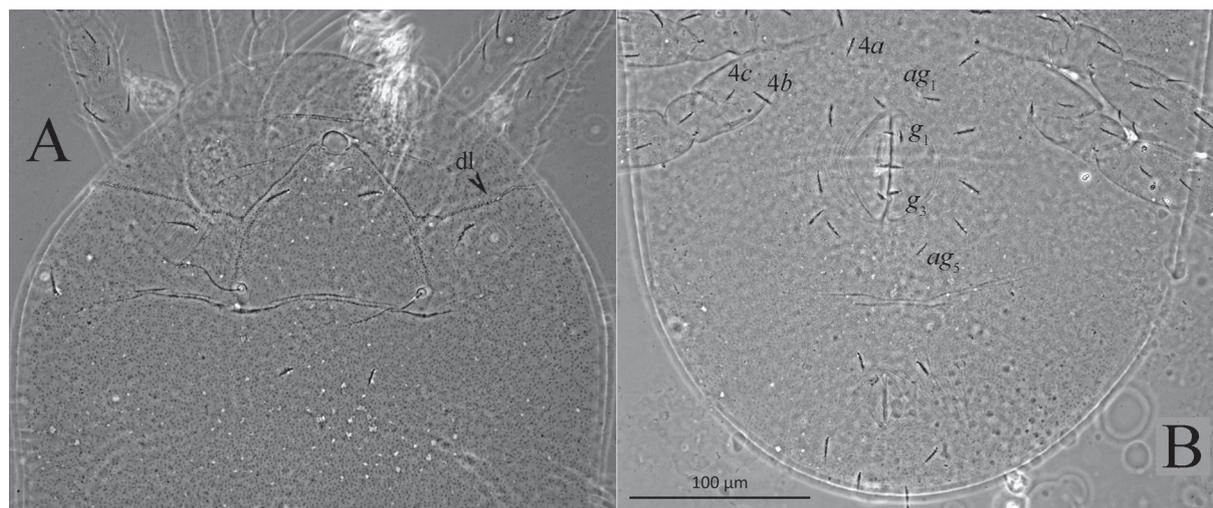


Fig. 16. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, tritonymph: A — prodorsum and anterior part of hysterosoma, dl — dehiscent line, B — anogenital area.

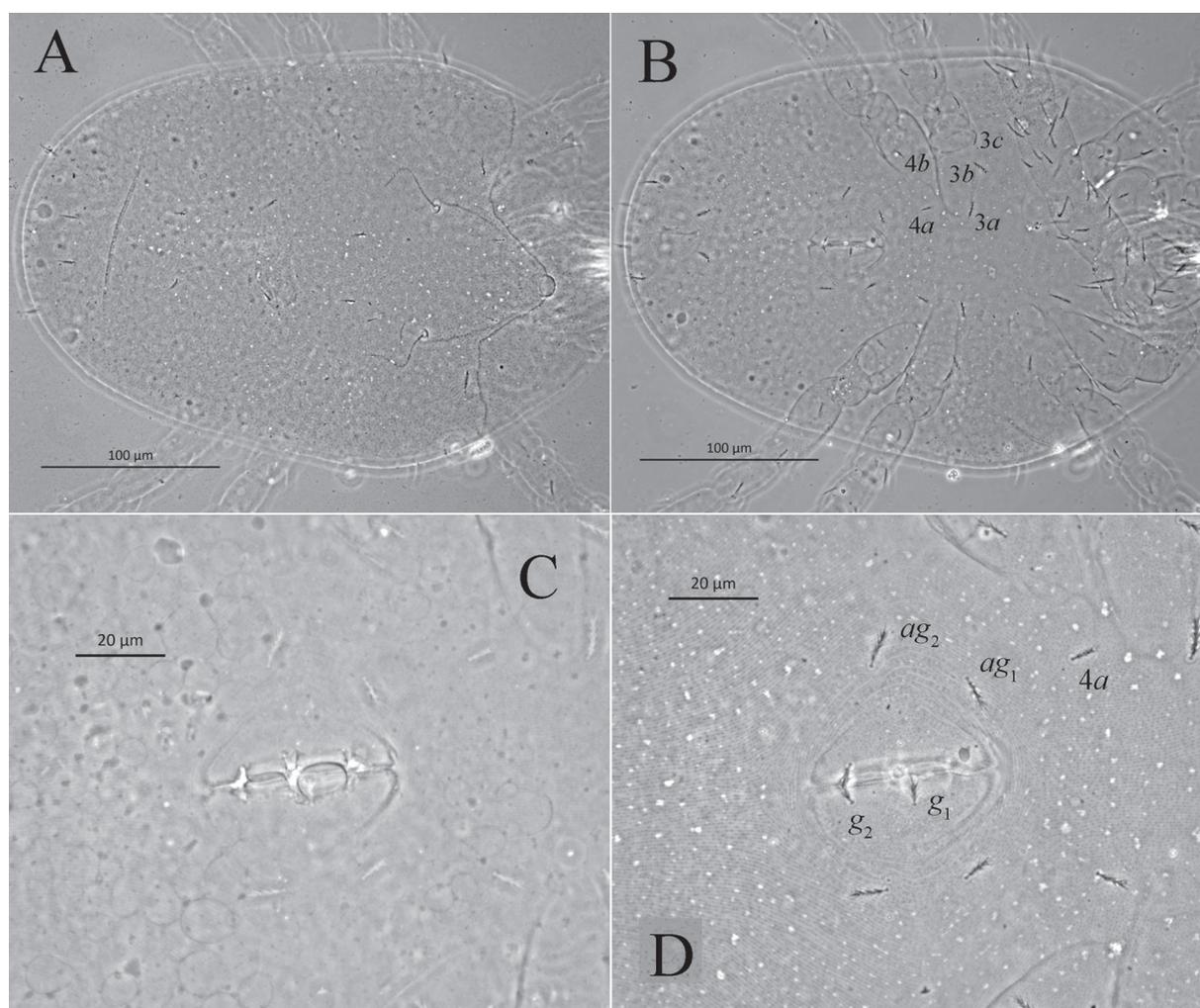


Fig. 17. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, deutonymph: A — idiosomal dorsum, B — idiosomal venter, C — genital acetabulae, D — genital area.

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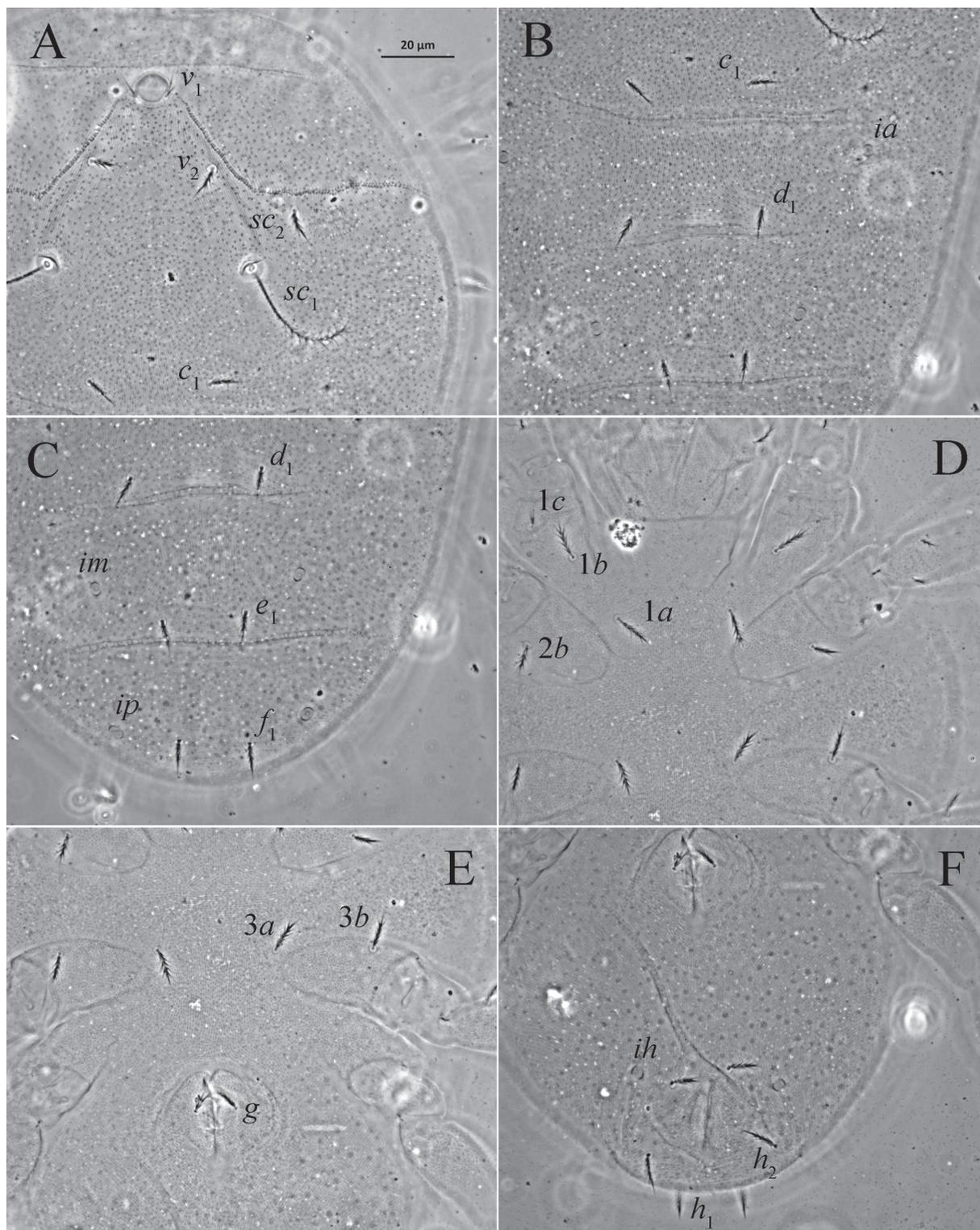


Fig. 18. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, protonymph: A — prodorsum, B — anterior part of hysterosoma, C — posterior part of hysterosoma, D — podosoma in ventral view, E — genital area, F — anogenital area.

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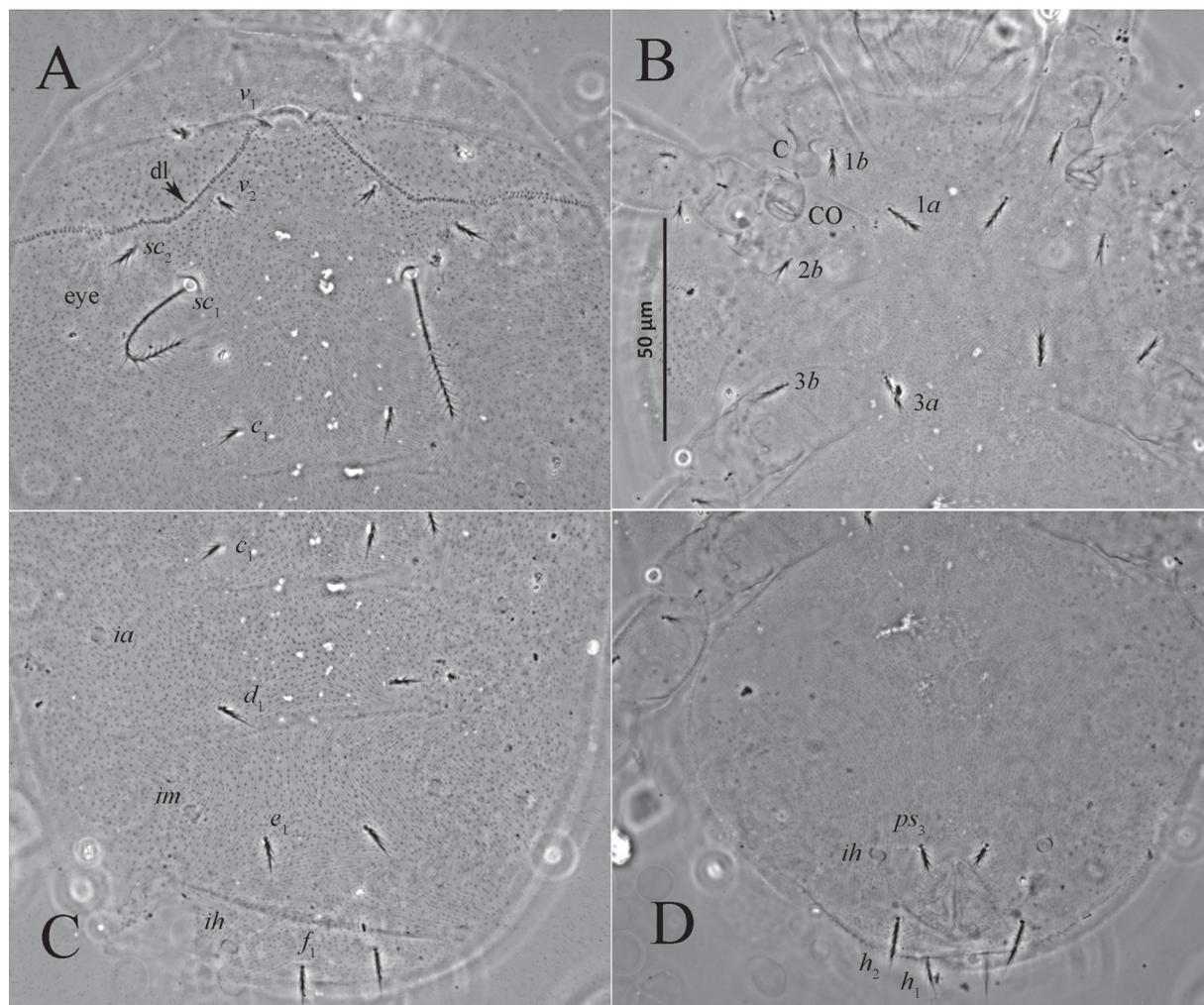


Fig. 19. *Protopenthalodes reticulatus*, sp. n., phase contrast photos, larva: A — prodorsum and anterior part of hysterosoma, B — podosoma in ventral view C — cap of Claparede organ, CO — Claparede organ, C — posterior part of hysterosoma, D — anal area.