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Two new species and a new record of mites of the family Stigmaeidae (Acari: Prostigmata) collected from mosses in Russia

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ABSTRACT — Two new species of the family Stigmaeidae (Acari: Prostigmata), *Eustigmaeus extremiorientalis* n. sp. and *Stigmaeus mollibus* n. sp., are described from mosses in the Far East and Western Siberia, Russia. *Stigmaeus mimus* is reported from Russia for the first time.

KEYWORDS — Acari; Prostigmata; Raphignathoidea; systematics; predatory mites; mosses

INTRODUCTION

The predatory mite family Stigmaeidae (Acari: Prostigmata) is the largest in the superfamily Raphignathoidea and includes more than 500 species in 30 valid genera (Zhang *et al.* 2011). Among them, the genera *Eustigmaeus* Berlese, 1910 and *Stigmaeus* Koch, 1836 are the largest in the family and include more than 100 and about 140 species, respectively, and distributed worldwide (Khaustov and Tolstikov 2014; Dogan *et al.* 2015; Khaustov 2015; Maake *et al.* 2015). The lists of mites of the genera *Eustigmaeus* and *Stigmaeus* from Russia were recently provided by Khaustov and Tolstikov (2014) and Khaustov (2015), respectively. During the study of mites associated with mosses in Russia two new species of stigmaeid mites were revealed. *Stigmaeus mimus* Summers, 1962 is reported from Russia for the first time.

MATERIALS AND METHODS

Mites were collected from mosses using Berlese funnels and mounted in Hoyer's medium. In the description below, the palpal, idiosomal and the leg setations follow those of Grandjean (1939, 1944, 1946). Prodorsal nomenclature follows that of Kethley (1990). All measurements are given in micrometres (μm) for holotype and 5 paratypes (in parentheses). In descriptions of leg setation the number of solenidia is given in parentheses. The type material is deposited in the mite collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. SEM photos were made with the aid of JEOL –JSM-6510LV SEM microscope. Photographs were taken with a digital camera AxioCam ICc5 via compound microscope Carl Zeiss AxioImager. A2 with phase-contrast illumination.

RESULTS

Family Stigmaeidae Oudemans, 1931
Genus *Eustigmaeus* Berlese, 1910

Type species: *Stigmaeus kermesinus* Koch, 1841, by original designation.

Eustigmaeus extremiorientalis n. sp.
(Figures 1-6)

Description *Female* (Figures 1-6) — Idiosoma almost round in outline. Length of idiosoma 340 (320 – 340), width 270 (270 – 280).

Idiosomal dorsum (Figures 1A, 5A, B, 6A, B) — Idiosoma completely covered by 2 large and well sclerotized plates. Plates with large round dimples (Figures 1A, 5A, 6B) and weak subcuticular reticulation. Dorsal setae situated on short protuberances, subequal, widened distally and strongly barbed (Figures 5A, B). Setae e_2 absent. Setae h_1 and h_2 situated ventrally. Setae h_2 only slightly thickened, not widened distally and weakly barbed. Lengths of dorsal setae: *vi* 42 (40 – 43), *ve* 50 (48 – 51), *sci* 38 (37 – 40), *sce* 31 (30 – 33), c_1 40 (39 – 41), c_2 28 (27 – 29), d_1 41 (40 – 43), d_2 35 (34 – 36), e_1 43 (42 – 44), f_1 46 (43 – 46), h_1 33 (31 – 34), h_2 19 (17 – 20).

Idiosomal venter (Figures 1B, 5C, 6C, D) — With 2 pairs of callosities between idiosomal plate and humeral plate. Anterior callosity slightly larger than posterior one (Figure 5C). Suranal plate situated ventrally, with distinct large dimples. Endopodal plates separated medially distinctly reticulated. Humeral plate subtriangular, with distinct large dimples. Most of ventral setae weakly barbed; with 2 pairs of simple subequal aggenital, and 3 pairs of simple pseudanal setae; setae ps_2 clearly shorter than subequal ps_1 and ps_3. Lengths of ventral setae: 1*a* 23 (21 – 24), 1*b* 22 (20 – 23), 1*c* 16 (15 – 19), 2*b* 16 (15 – 18), 2*c* 17 (14 – 17), 3*a* 20 (18 – 22), 3*b* 16 (13 – 17), 3*c* 16 (13 – 17), 4*a* 19 (17 – 20), 4*b* 17 (16 – 18), 4*c* 15 (13 – 16), ag_1 16 (15 – 17), ag_2 18 (16 – 19), ps_1 14 (14 – 16), ps_2 11 (10 – 11), ps_3 16 (15 – 17).

Gnathosoma (Figures 2, 5B, D, 6E, F) — Tibial claw well-developed. Setae *l′* on palpal tibia very short, spine-like (Figure 2B). Setae *d* and *l′* of palpal femur widened distally and strongly barbed; other palpal setae of femur, genu and tibia (except *l′Ti*) pointed and barbed; seta *va* of palp-tarsus weakly barbed; other setae of palp-tarsus smooth. Number of setae on palpal segments: Tr 0, Fe 3 (*d*, *l′*, *v″*), Ge 2 (*d*, *l″*), Ti 3 (*d*, *l′*, *l″*), Ta 8(1) (fused eupathidia *ul′*, *ul″*, *sul*, eupathidion *acm*, *ba*, *bp*, *lp*, 1 solenidion ω). Palpal supracoxal setae (*ep*) needle-like. Rostrum of subcapitulum (Figure 2C) short and wide. Subcapitular setae or_1 smooth, distinctly thickened, curved and blunt-ended; other subcapitular setae simple, pointed. Basal part of subcapitulum with numerous small dimples and weak subcuticular reticulation (Figure 5D). Length of subcapitular setae: *m* 19 (18 – 22), *n* 18 (17 – 21), or_1 12 (11 – 12), or_2 12 (11 – 12). Chelicerae dorsally with numerous small dimples (Figure 5B).

Legs (Figures 3, 4) — Empodial raylets capitate. Leg I (Figure 3A). Coxae I posterodorsally with needle-like leg supracoxal setae (*el*). Leg setation: Tr 1 (*v′*), Fe 6 (*d*, *l′*, *l″*, *v′*, *v″*, *bv″*), Ge 4 (*d*, *l′*, *l″*, *k*), Ti 5(2) (*d*, *l′*, *l″*, *v′*, *v″*, ϕ, ϕp), T*a* 13(1) (*p′*, *p″*, *tc′*, *tc″*, *ft′*, *ft″*, *u′*, *u″*, *a′*, *a″*, *pl′*, *pl″*, *vs*, ω). Setae (*p*) and (*tc*) of tarsus are eupathidia. Setae *d*, *l′*, *l″* of tibia, *l′*, *l″*, *d* of genu, *l″* and *d* of femur distinctly thickened distally and strongly barbed, situated on protuberances. Seta *k* 8 (8 – 9). Solenidion ω short 15 (13 – 15), finger-shaped; solenidia ϕ 8 (8 – 9) and ϕp 11 (10 – 11) baculiform. Setae (*ft*), (*pl*) and *vs* of tarsus weakly barbed; (*a*), (*u*) smooth. Leg II (Figure 3B). Leg setation: Tr 1 (*v′*), Fe 5 (*d*, *l′*, *l″*, *v′*, *bv″*), Ge 4 (*d*, *l′*, *l″*, *k*), Ti 5(1) (*d*, *l′*, *l″*, *v′*, *v″*, ϕ), Ta 9(1) (*p′*, *tc′*, *tc″*, *u′*, *u″*, *a′*, *a″*, *pl′*, *vs*, ω). Setae *p′* and *tc′* of tarsus represented by eupathidia. Setae *d*, *l′* and *l″* of tibia, *d*, *l′* and *l″* of genu, *d* and *l″* of femur distinctly thickened distally and strongly barbed, situated on protuberances. Solenidion ω 9 (9 – 10) finger-shaped; solenidion ϕp 7 (7 – 8) baculiform. Seta *k* 6 (5 – 6). Setae *tc″* and *vs* of tarsus weakly barbed; (*a*), (*u*) and *pl′* of tarsus smooth. Leg III (Figure 4A). Leg setation: Tr 1 (*v′*), Fe 3 (*d*, *l′*, *ev′*), Ge 1 (*d*), Ti 5(1) (*d*, *l′*, *l″*, *v′*, *v″*, ϕ), Ta 7(1) (*tc′*, *tc″*, *u′*, *u″*, *a′*, *a″*, *vs*, ω). Solenidion ω 5 (4 – 5) baculiform; solenidion ϕp 6 (5 – 6) baculiform. Setae *d*, *l′* of tibia, *d* of genu, *d* and *l′* of femur distinctly thickened distally and strongly barbed, situated on protuberances. Setae (*u*) of tarsus smooth, other tarsal setae weakly barbed. Leg

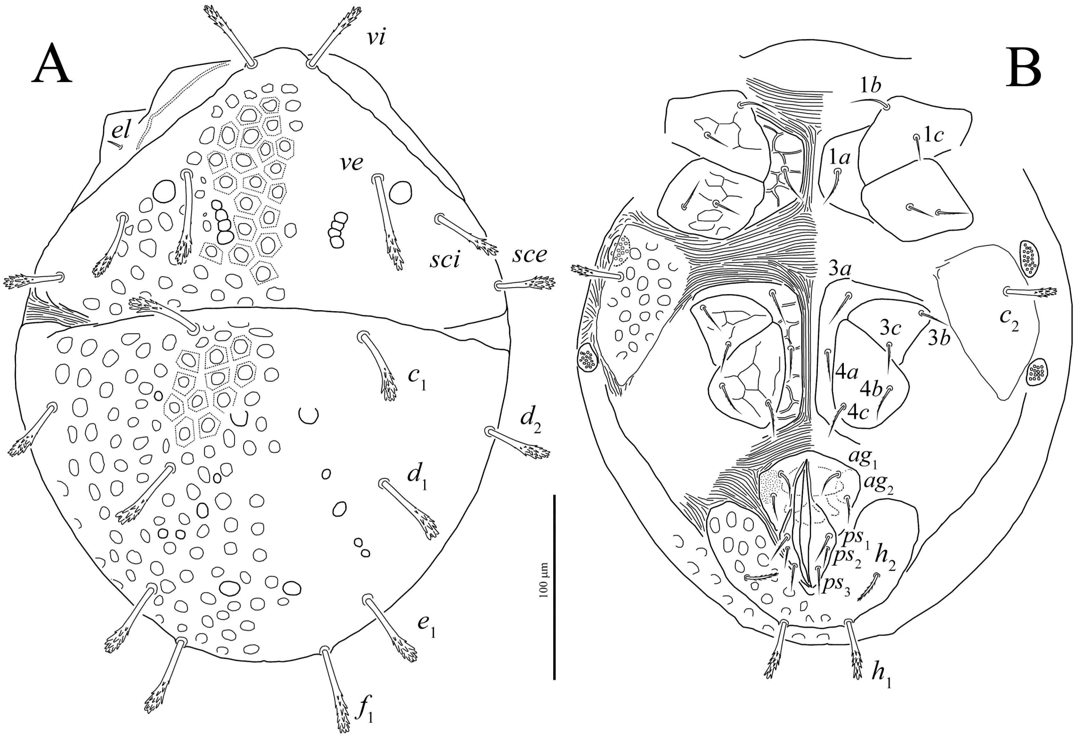

FIGURE 1: *Eustigmaeus extremiorientalis* **n. sp.**, female: A – idiosomal dorsum, B – idiosomal venter.

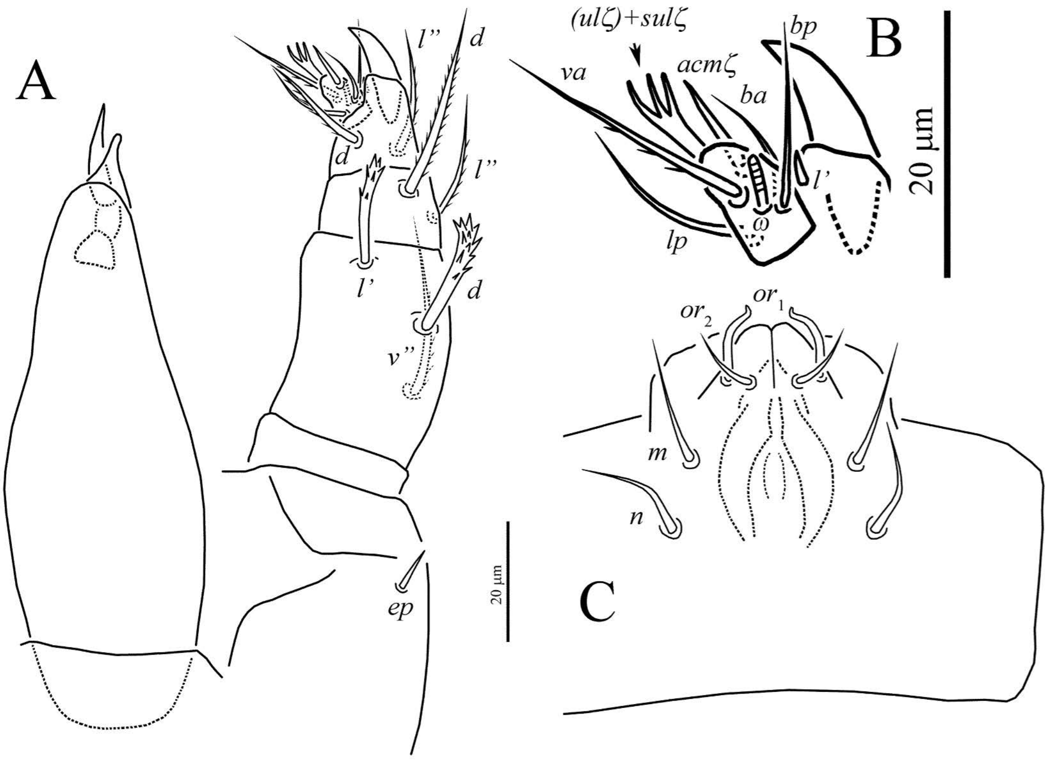

FIGURE 2: *Eustigmaeus extremiorientalis* **n. sp.**, female: A – gnathosoma dorsally, B – distal part of tibia and tarsus of palp, C – subcapitulum.

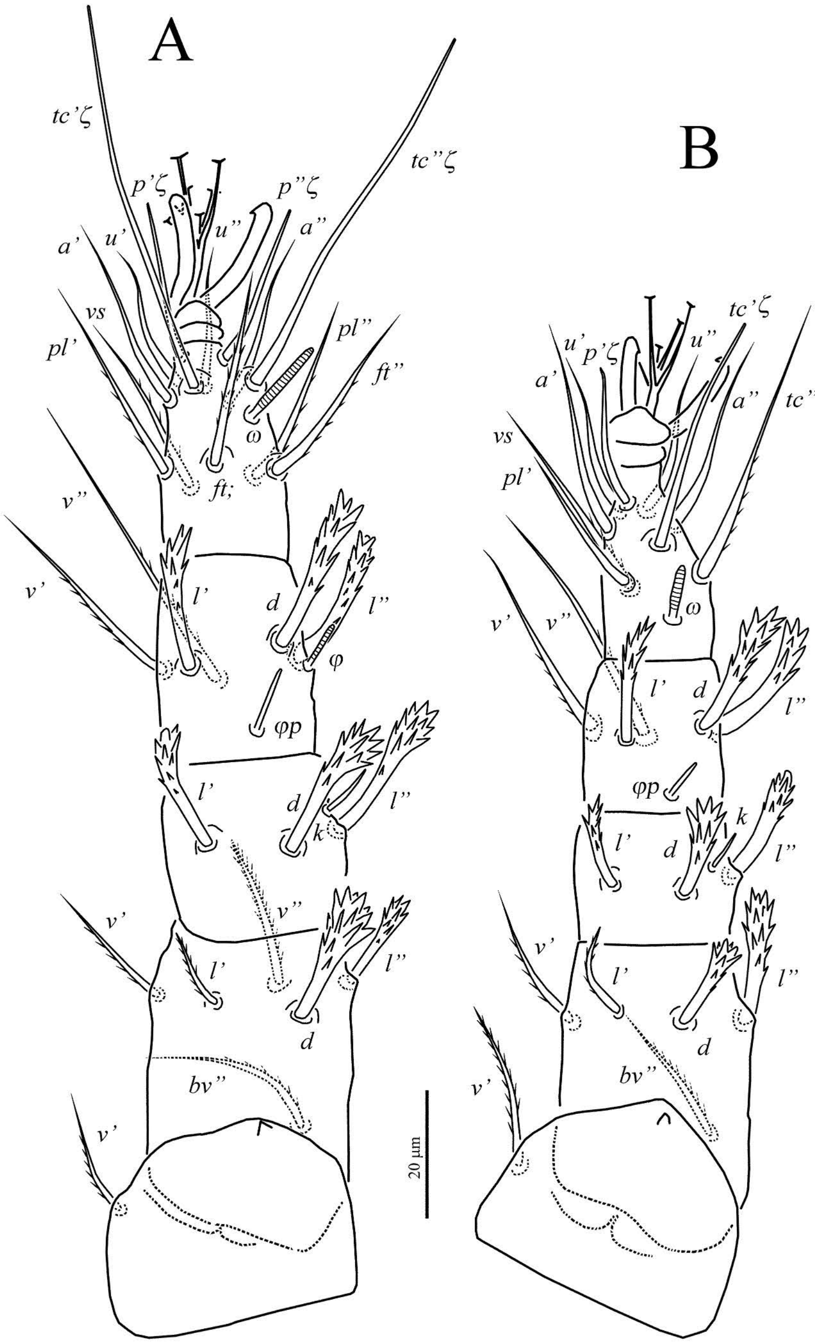

FIGURE 3: *Eustigmaeus extremiorientalis* **n. sp.**, female: A – leg I, B – leg II.

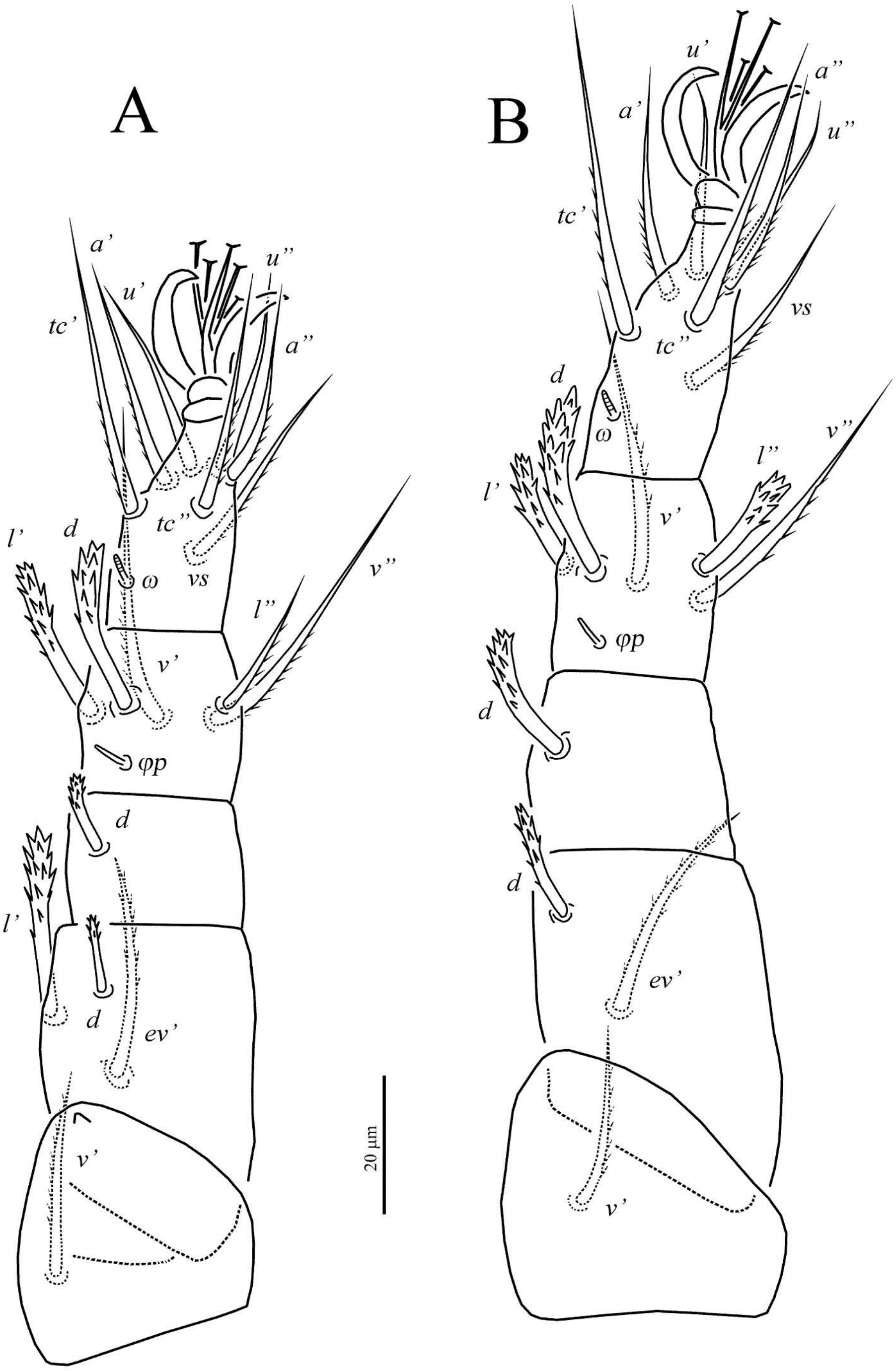

FIGURE 4: *Eustigmaeus extremiorientalis* **n. sp.**, female., female: A – leg III, B – leg IV.

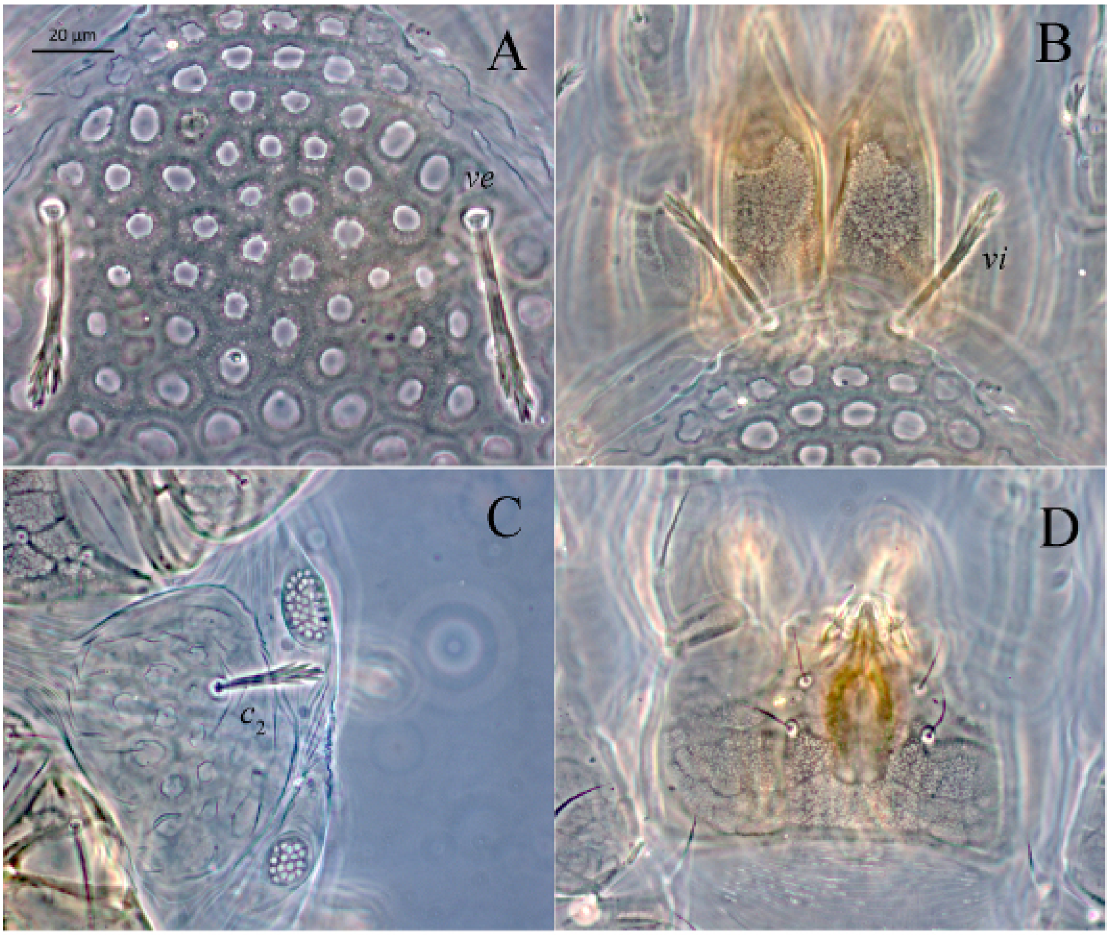

FIGURE 5: Phase-contrast micrographs of *Eustigmaeus extremiorientalis* **n. sp.**, female: A – central part of prodorsum, B – anterior part of prodorsum and chelicerae, C – humeral plate and callosities, D – subcapitulum.

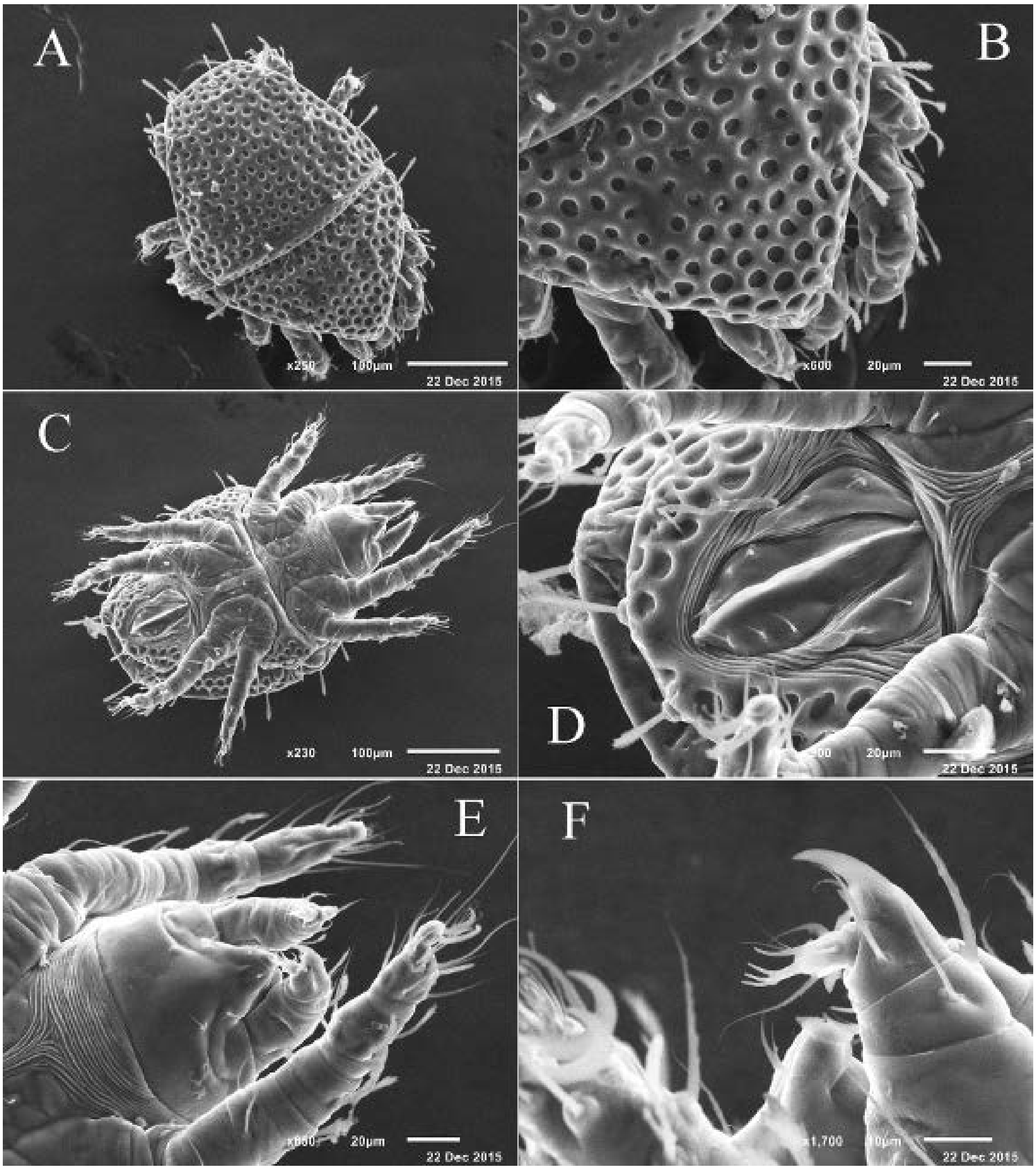

FIGURE 6: SEM photos of *Eustigmaeus extremiorientalis* **n. sp.**, female: A – dorsal view of body, B – prodorsum, C – ventral view of body, D – ano-genital area, E – gnathosoma ventrally, F – palp laterally.

IV (Figure 4B). Leg setation: Tr 1 (v'), Fe 2 (d, ev'), Ge 1 (d), Ti 5(1) (d, l', l'', v', v'', ϕ), Ta 7(1) (tc', tc'', u', u'', a', a'', vs, ω). Solenidion ω 4 (4 – 5) baculiform; solenidion ϕp 6 (5 – 6) baculiform. Setae d, l', l'' of tibia, d of genu and femur distinctly thickened distally and strongly barbed, situated on protuberances. Setae (u) of tarsus smooth, other tarsal setae weakly barbed.

Male and immatures: unknown.

Type material — Female holotype, slide N° ST181215, Russia: Primorskiy kray, Vladivostok, Botanical Garden-Institute, Far Eastern Branch of the Russian Academy of Sciences, 43°13′26.3"N, 131°59′34.6"E, from mosses on log, 18 December 2015, coll. S. Tupitsyn. Paratypes: 17 females, same data as holotype.

Etymology — The new species name refers to its distribution in the Far East of Russia.

Differential diagnosis — The new species is most similar to *E. absens* Doğan, 2005, described from Turkey (Doğan 2005), by the absence of setae e_2, presence of two callosities, only one seta on trochanter III and two pairs of aggenital setae. The new species differs from *E. absens* by distinctly thickened distally and strongly barbed dorsal idiosomal setae (vs. baculiform and weakly barbed in *E. absens*) and by setae *sci* longer than *sce* (vs. *sci* about two times shorter than *sce* in *E. absens*).

Genus *Stigmaeus* Koch, 1836

Type species: *Stigmaeus cruentus* Koch, 1836, by subsequent designation by Berlese (1910).

Stigmaeus mollibus n. sp. (Figures 7-15)

Description *Female* (Figsures 7-10, 15) — Length of idiosoma 350 (350 – 390), width 175 (175 – 230).

Idiosomal dorsum (Figures 7A, 15A, C, D) — Idiosoma fusiform, soft, mostly striated. Eyes absent. Propodosomal plate with setae *vi* and *ve*, weakly defined by more narrow striae than outside ones; with distinct median propodosomal apodeme. Area anteriorly and anterolaterally to propodosomal plate with numerous microtubercles. Setae *ve*, c_2, and h_3 pointed, sparsely barbed. Other dorsal setae distinctly blunt-ended and barbed. Setae c_2 situated ventrally. Ratio *ve/sci* = 3.3. Suranal plate divided, with three pairs of setae. Setae e_1 and f_1 situated on platelets (Figure 15D), remaining surface of hysterosoma without plates. Lengths of dorsal setae: *vi* 11 (11 – 14), *ve* 43 (43 – 45), *sci* 13 (13 – 15), *sce* 16 (15 – 16), c_1 12 (12 – 15), c_2 45 (45 – 53), d_1 11 (11 – 12), d_2 10 (10 – 11), e_1 12 (11 – 13), e_2 10 (10 – 12), f_1 16 (16 – 17), h_1 16 (16 – 18), h_2 31 (27 – 31), h_3 18 (18 – 23).

Idiosomal venter (Figures 7B, 15B) — Ventral setae weakly barbed and pointed, except for ps_1-ps_3 which are barbed and blunt-ended. Four pairs of aggenital setae; ag_1 situated on separate small platelets; ag_2–ag_4 on weakly defined platelet. Two pairs of genital setae. Cuticle posteriad to gnathosomal base and posterolaterad to coxae IV with microtubercles. Lengths of ventral setae: 1*a* 22 (22 – 24), 1*b* 20 (20 – 22), 1*c* 29 (26 – 30), 2*b* 50 (47 – 54), 2*c* 27 (27 – 34), 3*a* 25 (25 – 29), 3*b* 20 (17 – 20), 3*c* 17 (17 – 19), 4*a* 20 (20 – 24), 4*b* 14 (14 – 15), 4*c* 12 (12 – 14), ag_1 18 (18 – 20), ag_2 18 (18 – 19), ag_3 20 (20 – 23), ag_4 22 (22 – 24), g_1 19 (19 – 20), g_2 22 (22 – 24), ps_1 20 (19 – 21), ps_2 23 (19 – 23), ps_3 15 (15 – 17).

Gnathosoma (Figure 8) — Tibial claw large. Setae l' of palpal tibia thin, seta-like (Figure 8A). All palpal setae pointed; setae of femur and genu weakly barbed. Number of setae on palpal segments: Tr 0, Fe 3 (d, l', v''), Ge 1 (d), Ti 3 (d, l', l''), Ta 8(1) (fused eupathidia ul', ul'', sul, eupathidion acm, ba, bp, lp, 1 solenidion ω). Palpal supracoxal setae (*ep*) small, thick, with distinctly rounded tip. Rostrum of subcapitulum (Fig. 8B) relatively long, with lateral lobes. Subcapitular setae pointed; *n* weakly barbed in basal part, other setae smooth. Basal part of subcapitulum without reticulation. Lengths of subcapitular setae: *m* 20 (20 – 22), *n* 63 (60 – 65), or_1 10 (10 – 11), or_2 11 (11 – 12).

Legs (Figures 9-10) — Empodial raylets capitate. Leg segments without reticulation. Leg I (Figure 9A). Coxae I posterodorsally with small, thick, with distinctly rounded tip leg supracoxal setae (*el*). Leg setation: Tr 1 (v'), Fe 4 (d, l', l'', bv''), Ge 6 (d, l', l'', v', v'', k), Ti 5(1) (d, l', l'', v', v'', ϕp), Ta 13(1) (p', p'', tc', tc'', ft', ft'', u', u'', a', a'', pl', pl'', vs, ω). Setae d of tibia and (p), (tc) and ft' of tarsus are eupathidia. Seta

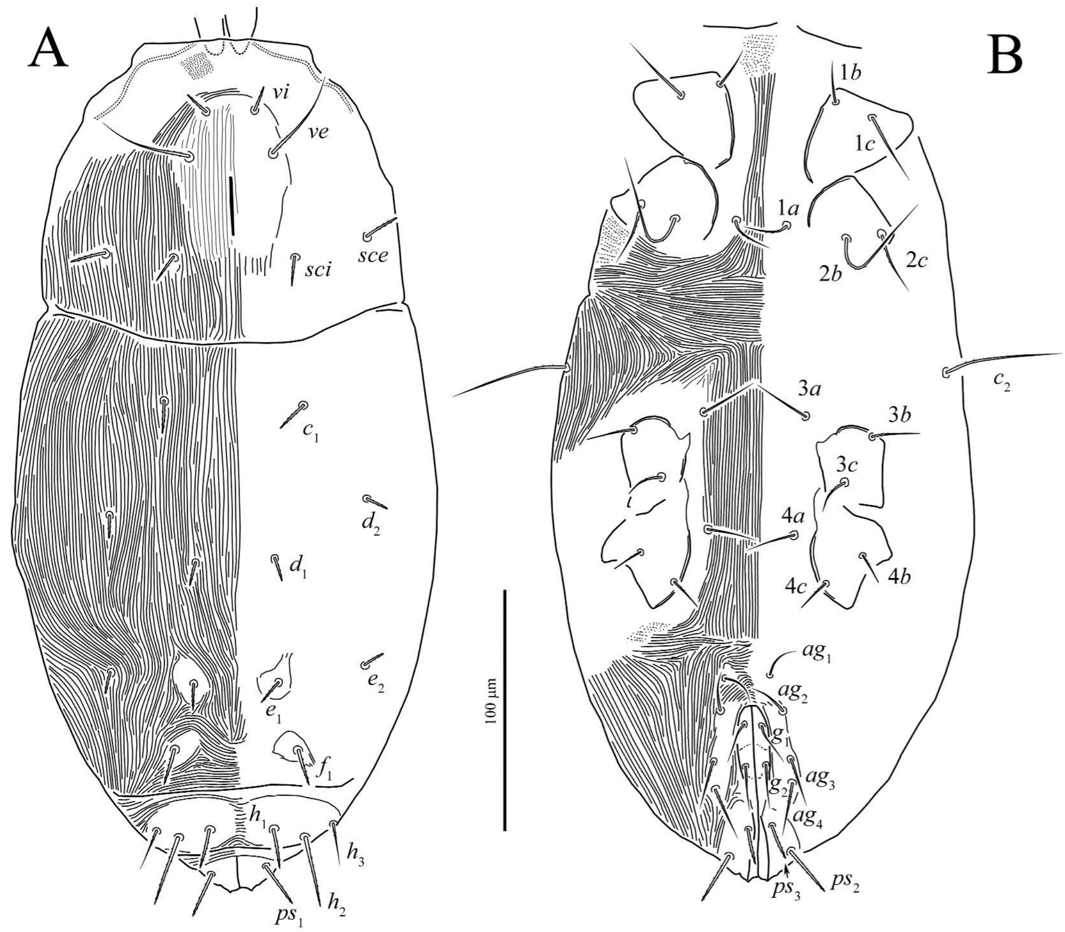

FIGURE 7: *Stigmaeus mollibus* **n. sp.**, female: A – idiosomal dorsum, B – idiosomal venter.

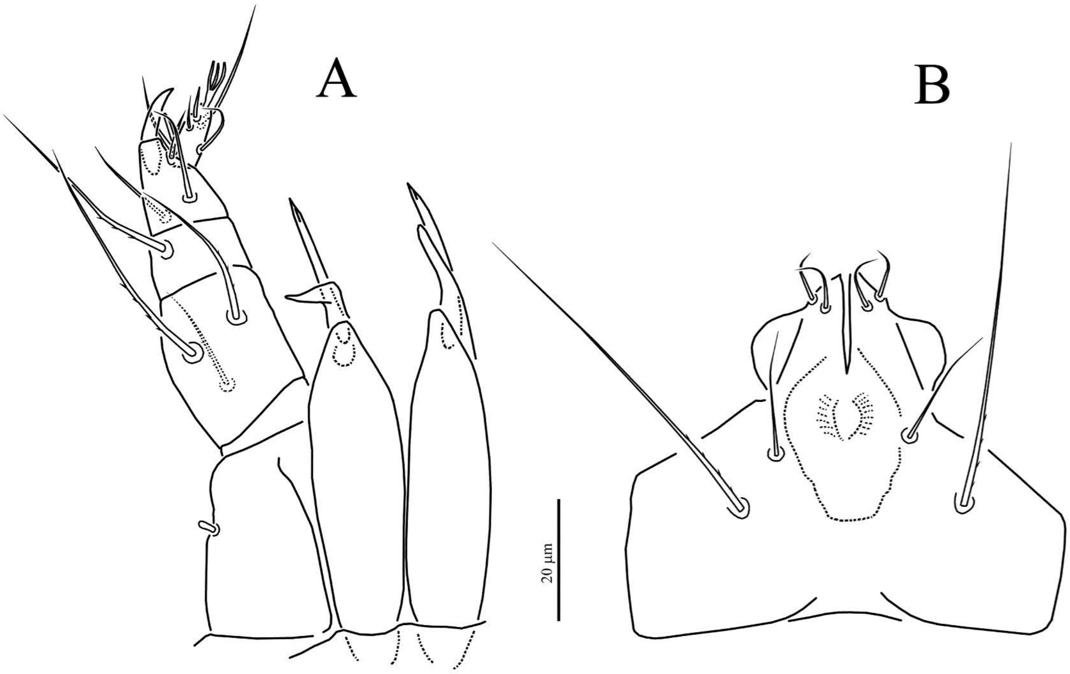

FIGURE 8: *Stigmaeus mollibus* **n. sp.**, female: A – gnathosoma dorsally, B – subcapitulum.

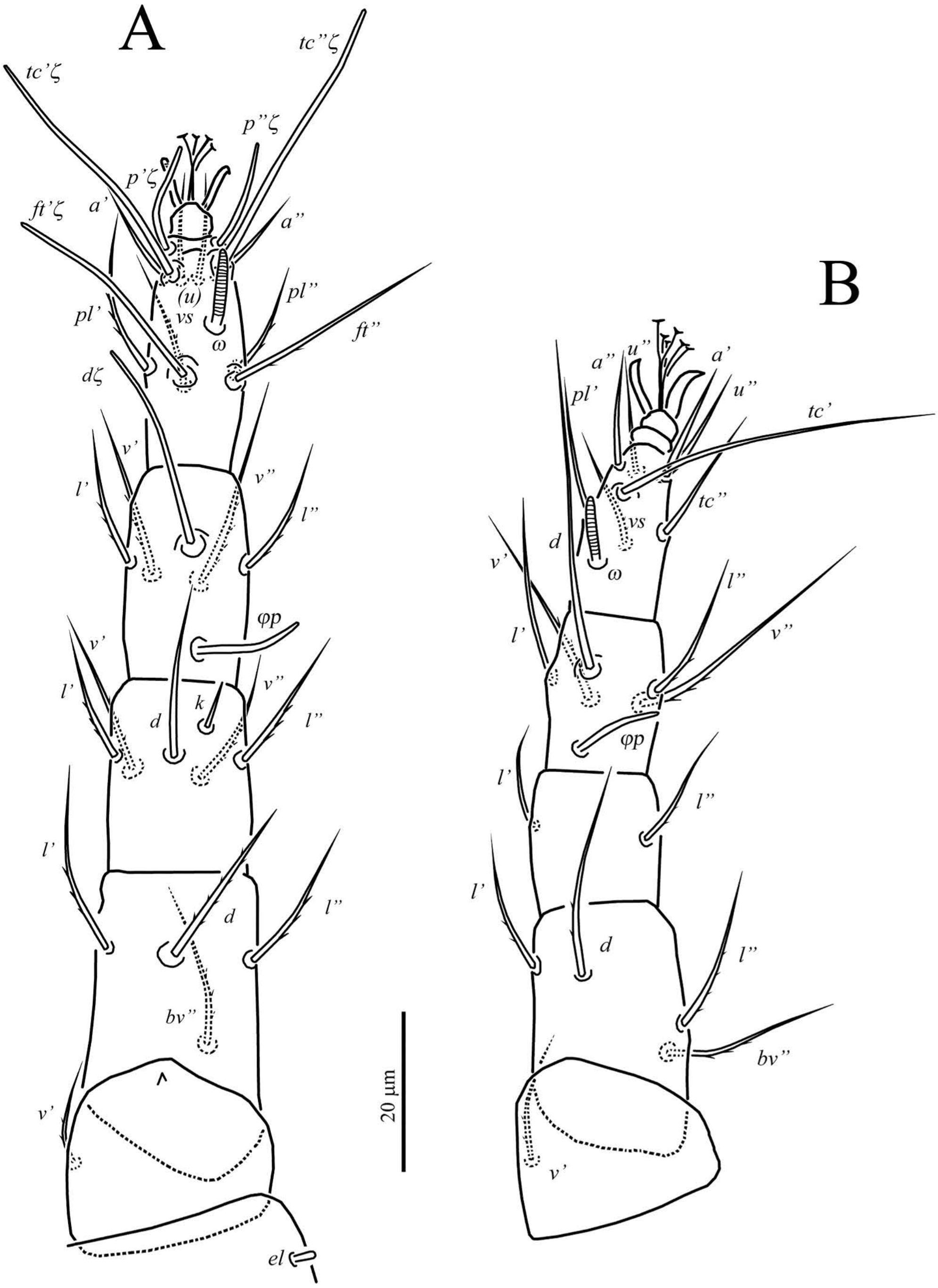

FIGURE 9: *Stigmaeus mollibus* **n. sp.**, female: A – leg I, B – leg II.

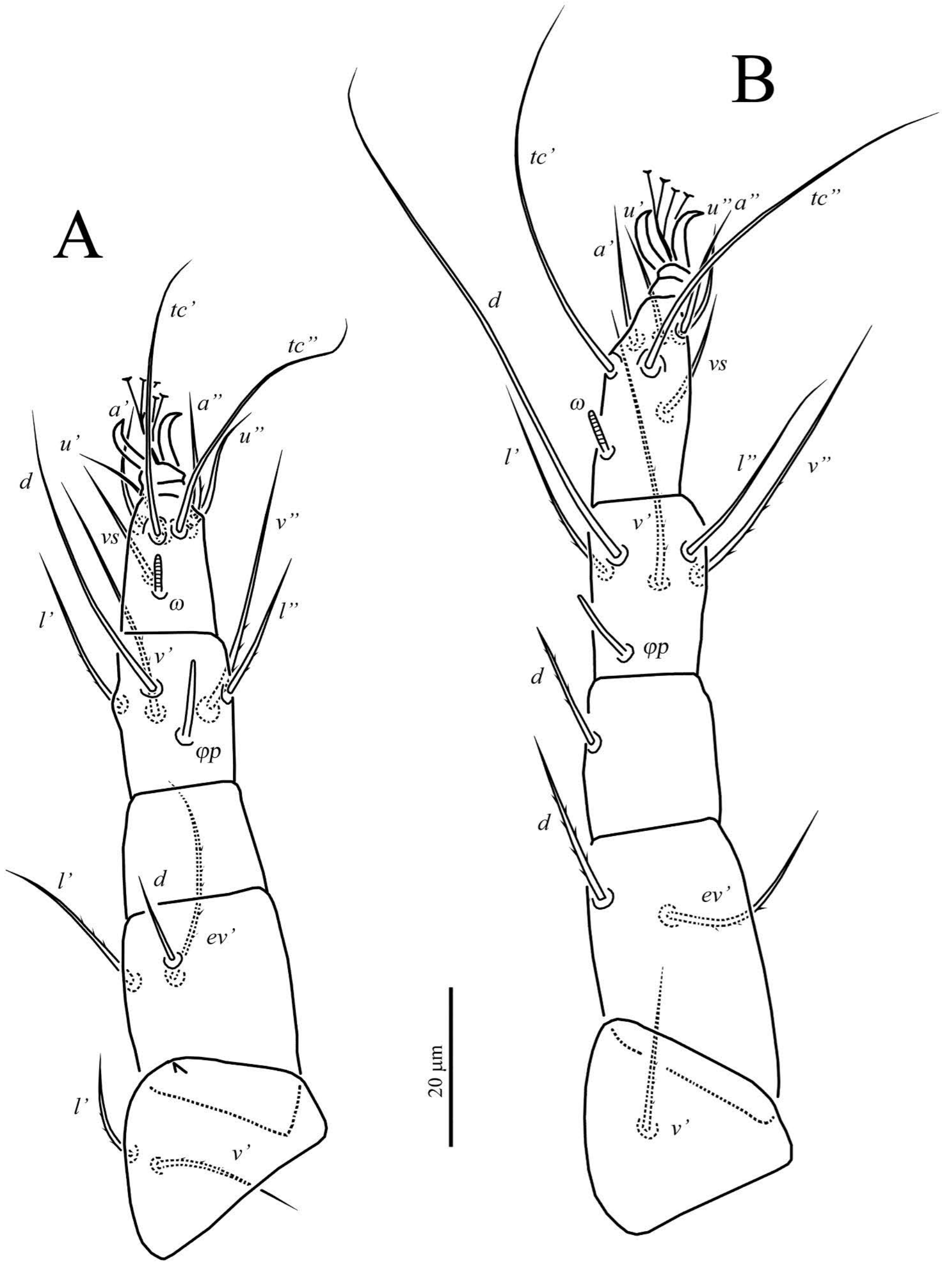

FIGURE 10: *Stigmaeus mollibus* **n. sp.**, female: A – leg III, B – leg IV.

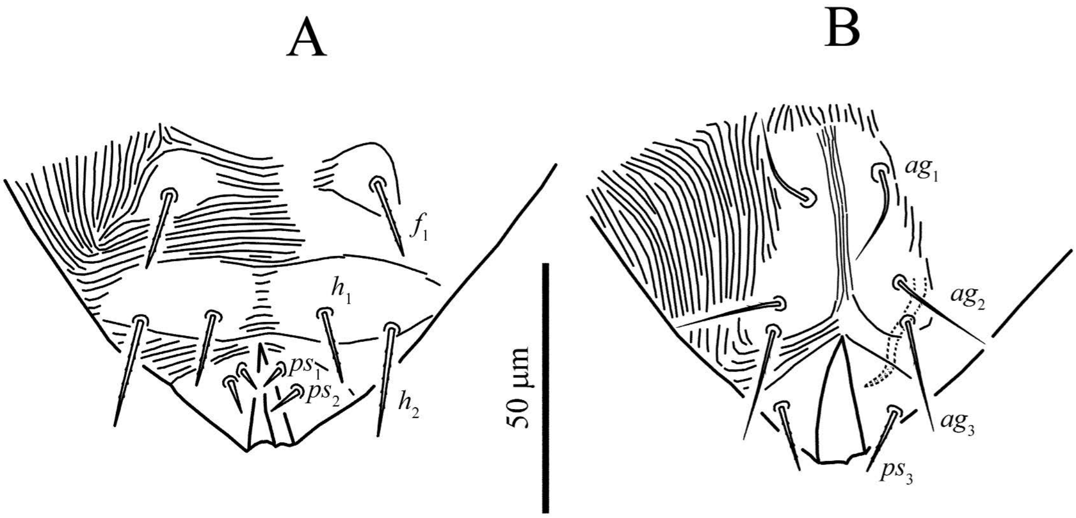

FIGURE 11: *Stigmaeus mollibus* **n. sp.**, female, male: A – opisthosoma dorsally, B – opisthosoma ventrally.

k 6 (6 – 7). Solenidion ω short 12 (11 – 12), finger-shaped; solenidion ϕp 15 (14 – 15) uniformly thin. solenidion ϕ absent. Setae *ft″*, (*pl*) and *vs* of tarsus weakly barbed; (*u*) and (*a*) smooth. Leg II (Figure 9B). Leg setation: Tr 1 (*v′*), Fe 4 (*d*, *l′*, *l″*, *bv″*), Ge 2 (*l′*, *l″*), Ti 5(1) (*d*, *l′*, *l″*, *v′*, *v″*, ϕp), Ta 8(1) (*tc′*, *tc″*, *u′*, *u″*, *a′*, *a″*, *pl′*, *vs*, ω). Setae *p′* of tarsus absent. Solenidion ω 9 (8 – 9) finger-shaped; solenidion ϕp 10 (10 – 11) uniformly thin. All tarsal setae smooth. Setae *d* of tibia and *tc′* of tarsus very long and smooth. Leg III (Figure 10A). Leg setation: Tr 2 (*v′*, *l′*), Fe 3 (*d*, *l′*, *ev′*), Ge 0, Ti 5(1) (*d*, *l′*, *l″*, *v′*, *v″*, ϕp), Ta 7(1) (*tc′*, *tc″*, *u′*, *u″*, *a′*, *a″*, *vs*, ω). Solenidion ω 5 (5 – 6) baculiform; solenidion ϕp 9 (9 – 10) uniformly thin. Setae *d* of tibia and (*tc*) of tarsus very long and smooth. Leg IV (Figure 10B). Leg setation: Tr 1 (*v′*), Fe 2 (*d*, *ev′*), Ge 1 (*d*), Ti 5(1) (*d*, *l′*, *l″*, *v′*, *v″*, ϕp), Ta 7(1) (*tc′*, *tc″*, *u′*, *u″*, *a′*, *a″*, *vs*, ω). Solenidion ω 5 (4 – 5) baculiform; solenidion ϕp 9 (9 – 11) uniformly thin. Setae *d* of tibia and (*ts*) of tarsus extra-long and smooth.

Male (Figure 11) — Similar with female, but smaller and with more narrow posterior end of the body. Length of idiosoma 290, width 155. *Idiosomal dorsum* (Figure 11A) — As in female, except absence of setae h_3. Lengths of dorsal setae: *vi* 9, *ve* 38, *sci* 10, *sce* 13, c_1 11, c_2 37, d_1 10, d_2 10, e_1 11, e_2 10, f_1 16, h_1 17, h_2 23.

Idiosomal venter (Figure 11B) — Podosoma as in female. Opisthosomal venter with three pairs of aggenital setae situated on longitudinal platelets. Pseudanal setae $ps_{1\text{-}2}$ spine-like, smooth, ps_3 blunt-ended and weakly barbed. Penis short, thin, weakly sclerotized. *Legs* (Figures 12-13) — Leg setation as in female, except presence of large male solenidia ω♂ on tarsi I-IV.

Deutonymph (Figure 14) — In general similar with female, but little smaller. Length of idiosoma 335, width 175.

Idiosomal dorsum (Figure 14A) — As in female, except absence of setae h_3 and undivided suranal plate. Lengths of dorsal setae: *vi* 12, *ve* 45, *sci* 11, *sce* 18, c_1 15, c_2 45, d_1 9, d_2 11, e_1 10, e_2 9, f_1 17, h_1 18, h_2 24.

Idiosomal venter (Figure 14B) — Podosoma as in female. Opisthosomal venter with three pairs of aggenital setae; setae ag_3 situated on small platelets.

Legs (Figure 12-13) — Leg setation as in female, except absence of setae on trochanter and genu IV.

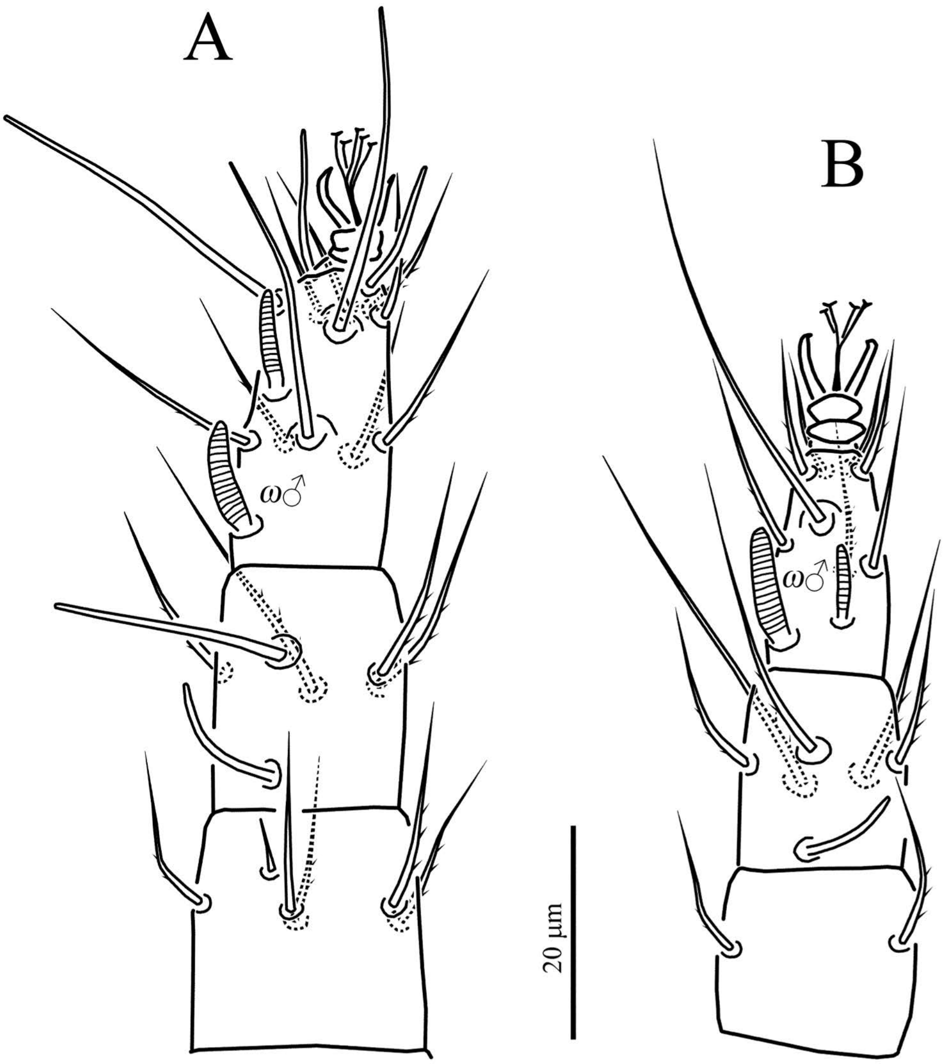

FIGURE 12: *Stigmaeus mollibus* **n. sp.**, female, male: A – leg I, B – leg II.

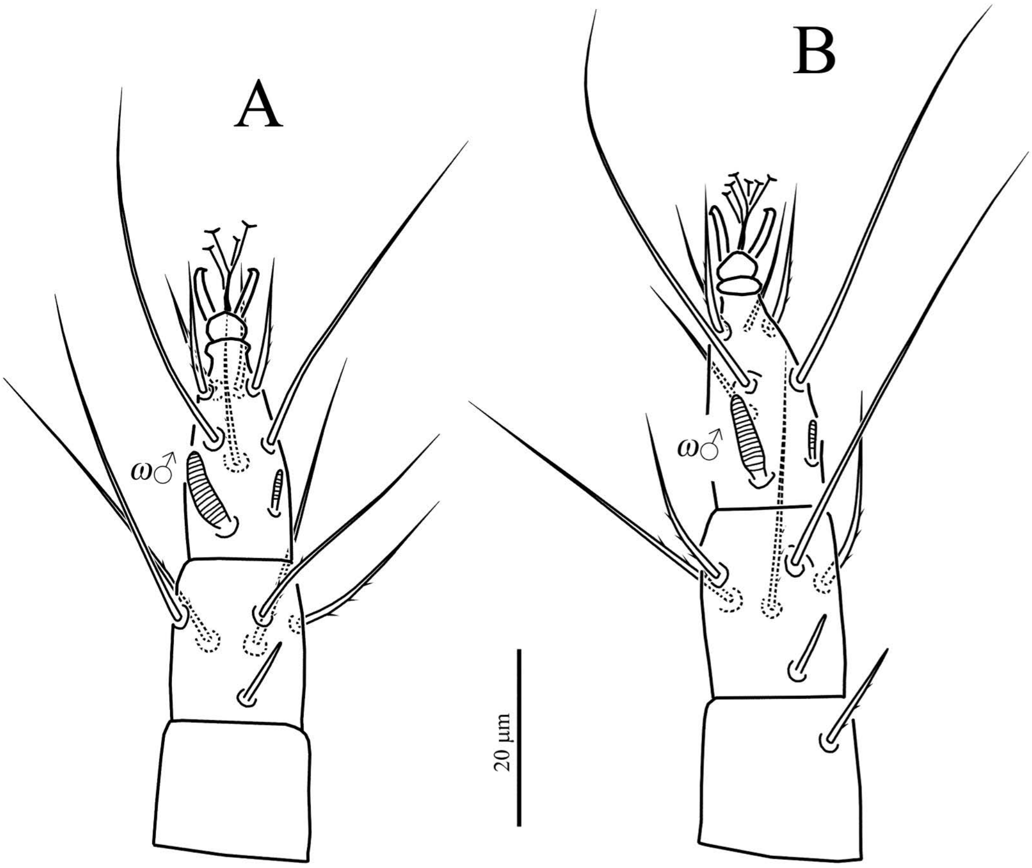

FIGURE 13: *Stigmaeus mollibus* **n. sp.**, female, male: A – leg III, B – leg IV.

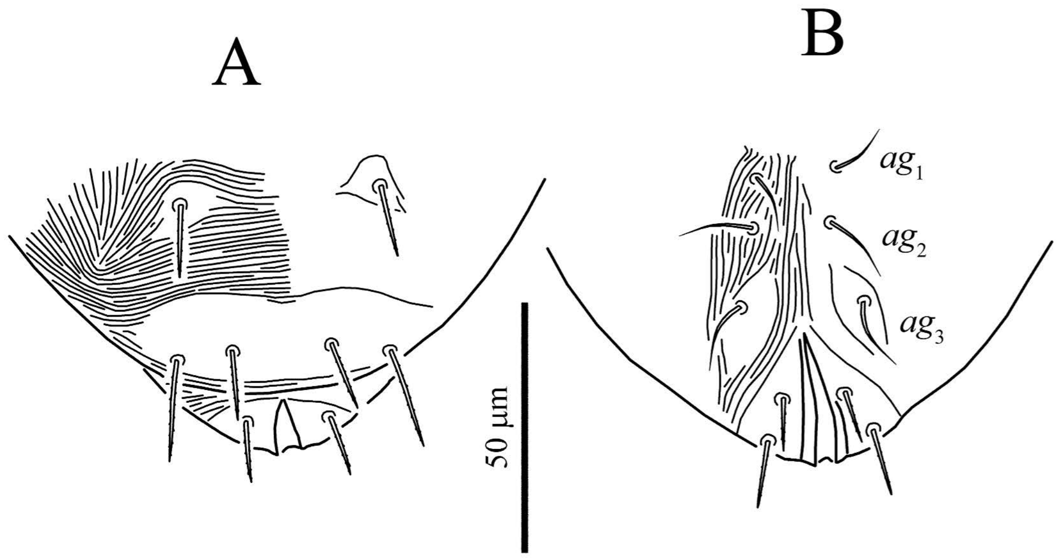

FIGURE 14: *Stigmaeus mollibus* **n. sp.**, female, deutonymph: A – opisthosoma dorsally, B – opisthosoma ventrally.

Type material — Female holotype, slide N° AK040415, Russia, Tyumen Province, Tyumen Province, vicinities of lake Kuchak, 57°20′05.3"N 66°03′08.9"E, 4 April 2015, moss on soil, coll. A.A. Khaustov. Paratypes: 9 females, 1 male, 1 deutonymph, same data.

Etymology — The name of the new species is derived from Latin word *mollibus* meaning *soft* and refers to soft and weakly sclerotized body.

Differential diagnosis — The new species is most similar to *S. shendabadiensis* Haddad, Akbari and Lotfollahi, 2010, described from Iran (Haddad *et al*. 2010), by soft and finely striated body, divided suranal plate with three pairs of setae and similar leg setation. However, it differs from the latter by absence of seta l'' of palpgenu (vs. present in *S. shendabadiensis*), absence of solenidion ϕ of tibia I (vs. present in *S. shendabadiensis*), setae d_2 and e_2 situated on striated cuticle (vs. d_2 and e_2 situated on platelets in *S. shendabadiensis*).

Stigmaeus mimus Summers, 1962 *Stigmaeus mimus*, Summers 1962, p. 511, figs. 19-20.

Material examined — Seven females, Russia, Leningrad Province, vicinity of Sestroretsk station, Sestroretsk swamp, in wet moss *Sphagnum magellanicum* Brid. (Bryophyta: Sphagnaceae), 28 June 2015, 60°07′22,8"N, 30°02′36,9"E, coll. D.A. Filippov.

Remarks — This species was described in the U.S.A. (Arizona) from litter under *Juglans rupestris* (Summers 1962). It was also recorded from litter in Latvia (Kuznetsov and Petrov 1984). This is a new record for the fauna of Russia.

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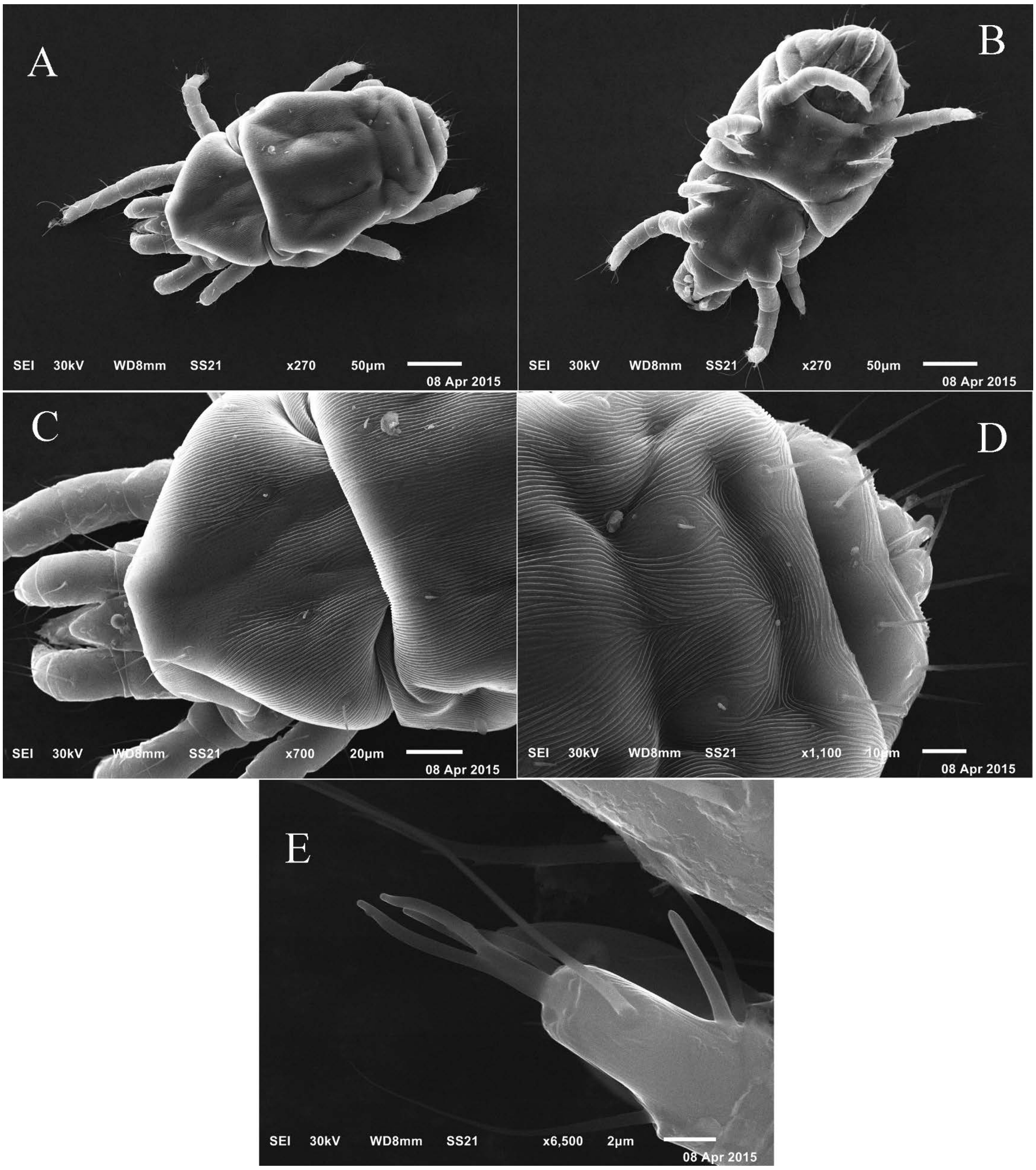

FIGURE 15: SEM photos of *Stigmaeus mollibus* **n. sp.**, female: A – dorsal view of body, B – ventral view of body, C – prodorsum, D – opisthosoma dorsally, E – palptarsus.

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