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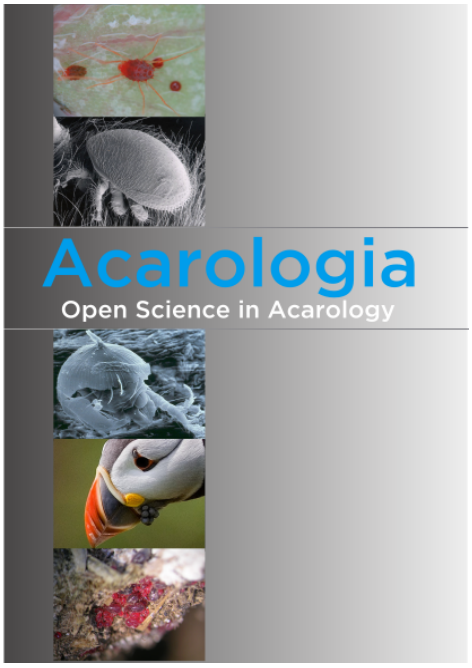

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Contribution to systematics of the genus *Eustigmaeus* (Acari: Stigmaeidae) of Russia

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Original research

ABSTRACT

Two new species of *Eustigmaeus*: *E. bochkovi* n. sp., collected from rotten log in Khabarovsky Kray, and *E. grandis* n. sp., collected from soil in Primorsky Kray, are described from Russia. The genus *Paravillersia* Kuznetsov, 1978 is considered as a junior synonym of *Eustigmaeus* Berlese, 1910; *Paravillersia grata* Kuznetsov, 1978 is considered as a junior synonym of *Eustigmaeus ottavii* (Berlese, 1910), *E. ioanninensis* Kapaxidi and Papadoulis, 1999 is considered as a junior synonym of *E. pinnata* Kuznetsov, 1977a, and *Paravillersia jamaliensis* Khaustov, 2014 moved to the genus *Villersia* Oudemans, 1927.

Keywords new species; description; new synonymies; *Paravillersia*; *Villersia*
Zoobank http://zoobank.org/0554C6FA-E817-4CA9-858A-FF34D9109467

Introduction

The predatory mite family Stigmaeidae (Acari: Prostigmata) is the largest in the superfamily Raphignathoidea and includes about 598 species of 34 valid genera (Doğan *et al.* 2015; Fan & Ueckermann 2016; Fan *et al.* 2016; Khaustov 2016b; Paktinat-Saeij *et al.* 2016; Stathakis *et al.* 2016; Bingül & Doğan 2017; Bingül *et al.* 2017; Doğan *et al.* 2017; Khanjani *et al.* 2017; Khaustov *et al.* 2017; Nazari & Khanjani 2017; Akyol & Gül 2018; Da-Costa *et al.* 2018; Rehman *et al.* 2018; Khaustov & Tsurikov 2018). Among them, the genus *Eustigmaeus* Berlese, 1910 is the second largest genus with 128 species (Fan *et al.*, 2016; Khaustov 2016b; Stathakis *et al.* 2016; Karasu *et al.* 2018; Khaustov & Tsurikov 2018).

In Russia 13 species of *Eustigmaeus* were recorded: *E. anauniensis* (Canestrini, 1889), *E. clavatus* (Canestrini and Fanzago, 1876), *Eustigmaeus collarti* (Cooreman, 1955), *E. coronarius* (Kuznetsov, 1977b), *E. extremiorientalis* Khaustov, 2016a, *E. ioanninensis* Kapaxidi and Papadoulis, 1999, *E. jiangxiensis* Hu, Chen and Huang, 1996, *E. parvisetus* (Chaudhri, 1965), *E. pinnatus* (Kuznetsov, 1977a), *E. plumifer* (Halbert, 1923), *E. rhodomela* (Koch, 1841), *E. segnis* (Koch, 1836), and *E. tjumeniensis* Khaustov and Tolstikov, 2014 (Wainstein & Kuznetsov 1978; Khaustov & Tolstikov 2014; Khaustov 2016a).

During this study two new species, *Eustigmaeus bochkovi* **n. sp.** and *E. grandis* **n. sp.** were found from Khabarovsky and Primorsky Kray of Russia, respectively. The new species are described in this paper and new generic and species synonymies are also provided.

Materials and methods

The type materials of *Eustigmaeus pinnatus* and *Paravillersia grata* as well as specimens of *Paravillersia grata* and *Eustigmaeus ioanninensis* deposited in the collection of the Tyumen State University Museum of Zoology were examined. Specimens of *Eustigmaeus bochkovi*

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n. sp. and *E. grandis* **n. sp.** were collected from rotten wood and soil, respectively, using Berlese funnels and mounted on slides in Hoyer's medium.

Mite morphology was studied using a Carl Zeiss AxioImager A2 compound microscope with phase contrast and DIC objectives. Photomicrographs were taken with an AxioCam ICc5 digital camera. For SEM microscopy, alcohol-preserved mites were dried in freeze drying device JFD 320 (JEOL, Japan), dusted with gold and scanned with aid of a JEOL-JSM-6510LV SEM microscope.

In the description below, the palpal, idiosomal and the leg setation follows Grandjean (1939, 1944, 1946). The nomenclature of prodorsal setae follows Kethley (1990). All measurements are given in micrometers (µm) for the holotype and paratypes (in parentheses). In descriptions of leg setation the number of solenidia is given in parenthesis.

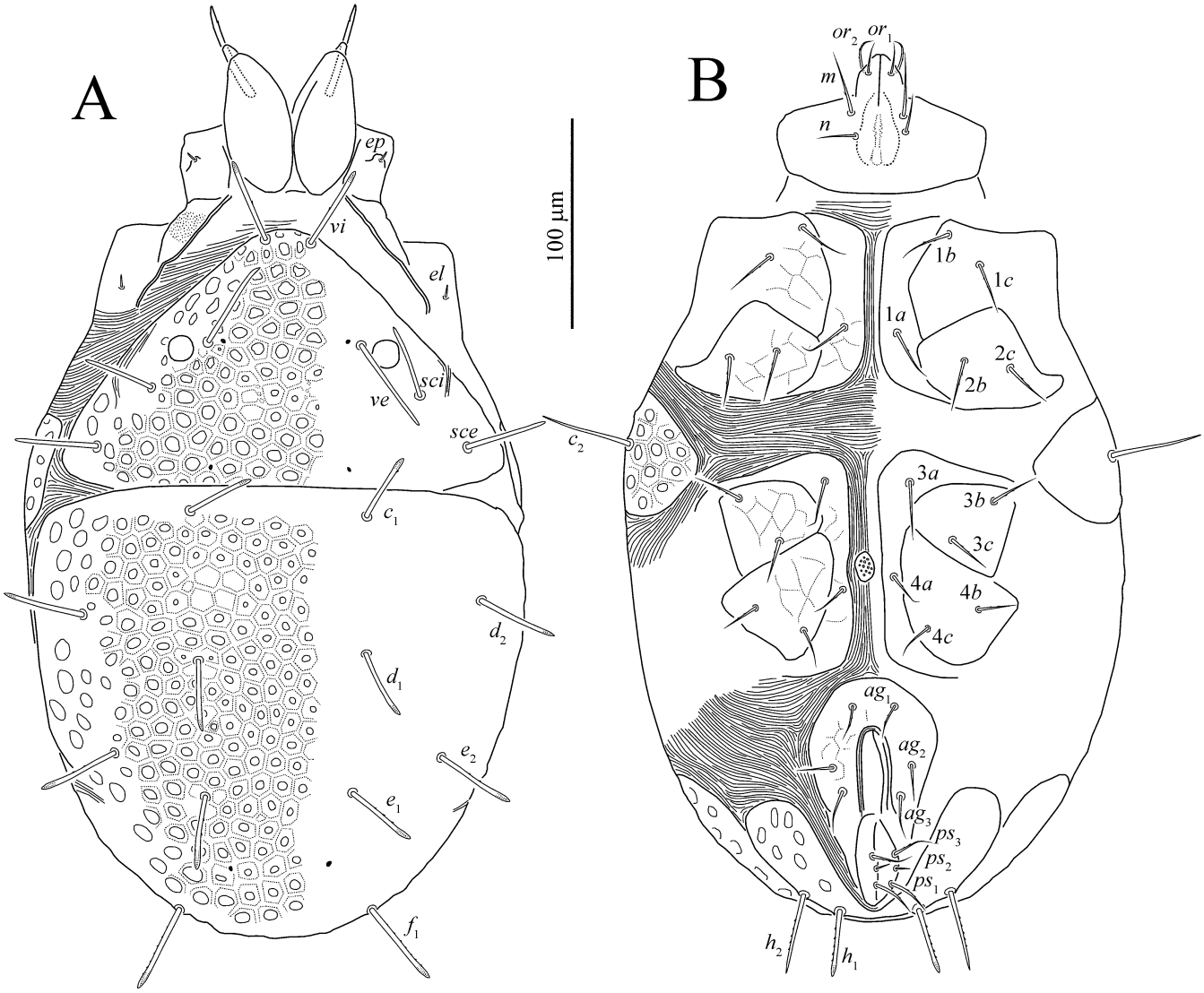

Figure 1 *Eustigmaeus bochkovi* **n. sp.**, female: A – dorsum of the body, B – venter of the body. Legs omitted.

Taxonomy

Family Stigmaeidae Oudemans, 1931

Genus *Eustigmaeus* Berlese, 1910

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

Eustigmaeus bochkovi n. sp.

(Figs 1–13)

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Description

Female (Figs 1–5) (n=4)

Idiosoma oval. Length of idiosoma 345 (325–375), width 235 (225–270).

Idiosomal dorsum (Figs 1A, 4A, C, 5) — Eyes present. Idiosoma almost completely covered by 2 large shields. Shields with large round dimples (Figs 1A, 4C, 5A, B) and distinct subcuticular reticulation. Dorsal setae baculiform, with weakly developed hyaline sheaths distally; setae *e*1, *f*1, *h*1, and *h*2 with many small bards (Fig. 5D), other dorsal setae smooth or with 1-2 minute barbs. Setae *h*1 and *h*2 situated ventrally. Prodorsal shield subtriangular, with weak incisions laterally to bases of setae *sci* and 2 pairs of small apodemal marks near bases of setae *ve* and near posterior margin. Hysterosomal shield with 1 pair of small apodemal marks posteriorly to setae *e*1 and narrow incisions posterolaterally to setae *e*2. Lengths of dorsal setae: *vi* 40 (36–39), *ve* 48 (42–45), *sci* 35 (31–37), *sce* 40 (37–44), *c*1 34 (31–34), *c*2 46 (42–45), *d*1 34 (31–34), *d*2 39 (37–42), *e*1 35 (34–37), *e*2 39 (36–41), *f*1 44 (46–49), *h*1 34 (34–43), *h*2 39 (34–38).

Idiosomal venter (Figs 1B, 4B, E, F, 5C) — With 1 small oval callosity located on soft striated cuticle between endopodal plates of legs III and IV (Fig. 4E). Suranal plate situated ventrally, with distinct large dimples. Endopodal plates separated medially. Humeral plate subtriangular, with distinct large dimples. Most of ventral setae weakly barbed and pointed;

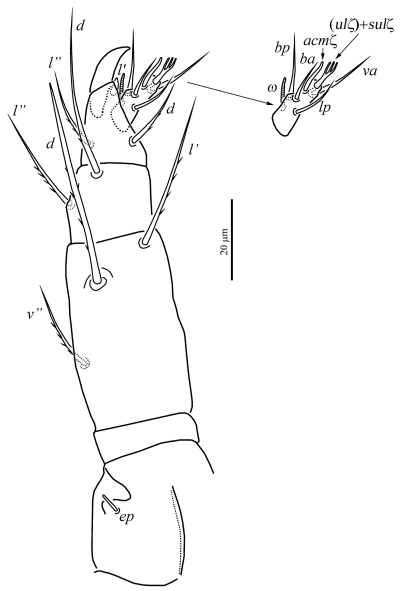

Figure 2 *Eustigmaeus bochkovi* **n. sp.**, female: left palp in dorsal view.

with 3 pairs of simple subequal aggenital and 3 pairs of pseudanal setae, of which setae *ps*2 short, blunt-ended and smooth. Aggenital plate smooth, with very weak subcuticular reticulation posteriorly to setae *ag*1 (Fig. 4F). Coxal and endopodal plates of legs I-IV with weak subcuticular reticulation. Lengths of ventral setae: 1*a* 26 (22–24), 1*b* 27 (22–27), 1*c* 26 (20–24), 2*b* 26 (21–24), 2*c* 23 (21–23), 3*a* 28 (24–26), 3*b* 25 (22–25), 3*c* 22 (17–20), 4*a* 22 (20–23), 4*b* 21 (17–21), 4*c* 20 (18–19), *ag*1 17 (15–18), *ag*2 21 (18–20), *ag*3 24 (20–22), *ps*1 25 (23–25), *ps*2 7 (7–8), *ps*3 24 (18–20).

Gnathosoma (Figs 2, 4D) — Tibial claw well-developed. Seta *l'* on palpal tibia short, spine-like. Seta *d* of palpal femur blunt-ended, barbed; other palpal setae of femur, genu and tibia (except *l'Ti*) pointed and barbed; all setae of palptarsus 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, located dorsally (Fig. 5C). Rostrum of subcapitulum distinctly elongate. All subcapitular setae pointed; setae *or*1 and *m* smooth, other setae with 1-2 weak barbs. Basal part of subcapitulum weakly punctate and with subcuticular reticulation posterolaterally to setae *n* (Fig. 4D). Length of subcapitular setae: *m* 29 (27–30), *n* 20 (17–20), *or*1 13 (15–16), *or*2 20 (19–20). Chelicerae dorsally smooth, with long stylets.

Legs (Fig. 3) — Empodial raylets not capitate. Leg I (Fig. 3A). Coxae I posterodorsally

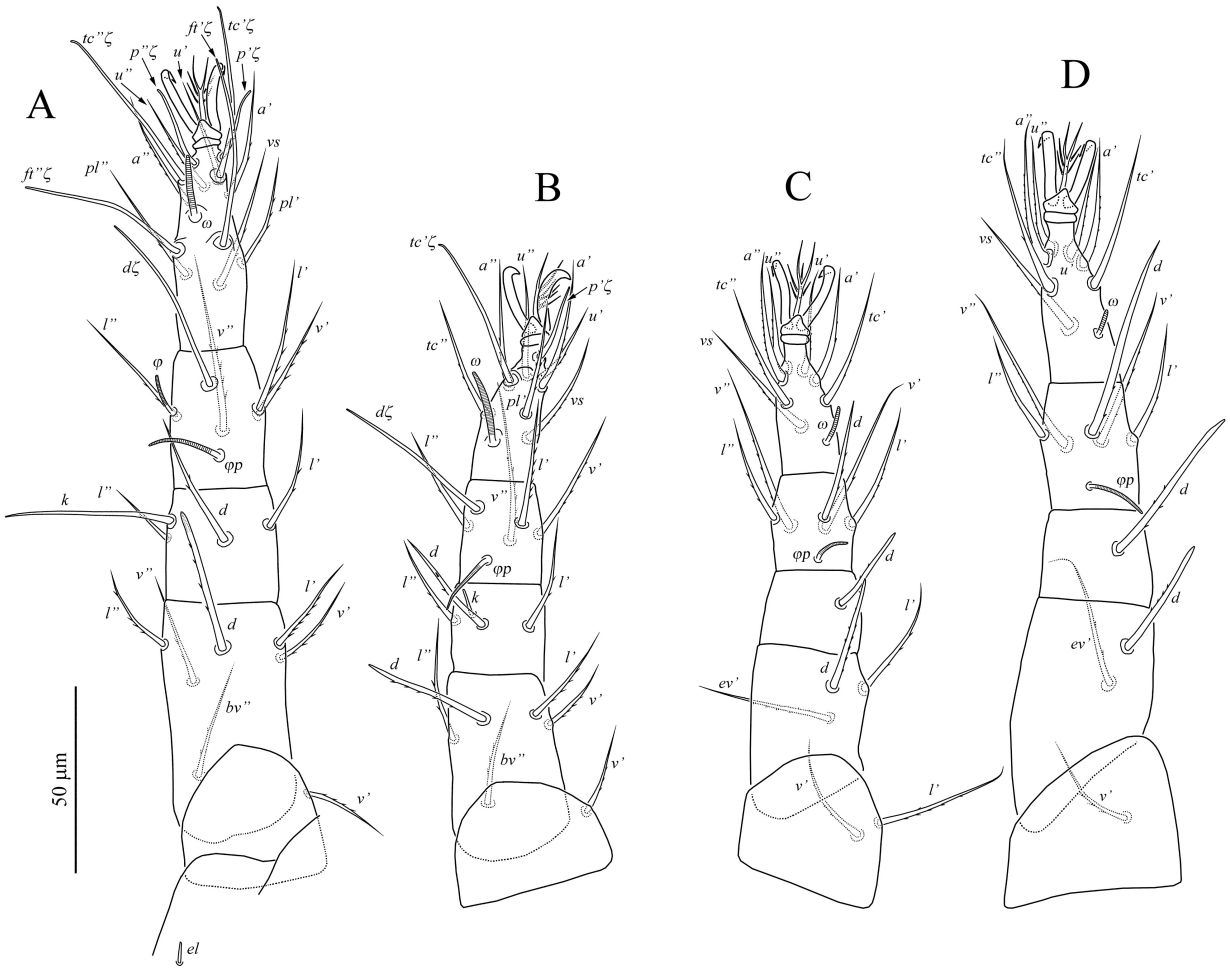

Figure 3 *Eustigmaeus bochkovi* **n. sp.**, female: A – left leg I in dorsal view, B – left leg II in dorsal view, C – left leg III in dorsal view, D – left leg IV in dorsal view.

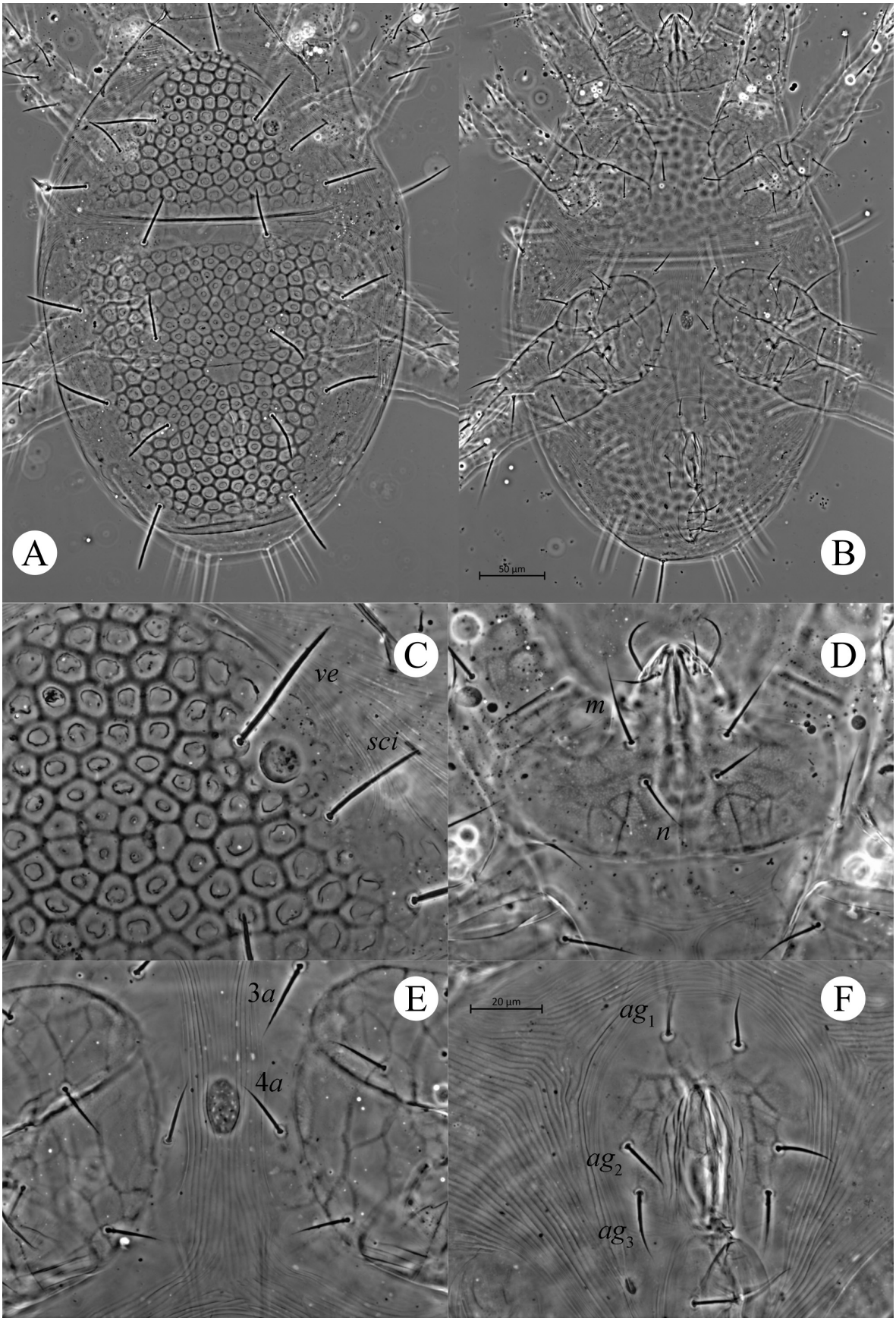

Figure 4 Phase-contrast micrographs of *Eustigmaeus bochkovi* **n. sp.**, female (paratype): A – idiosoma in dorsal view, B – idiosoma in ventral view, C – prodorsum, D – subcapitulum, E – callosity and coxal plates III, IV, F – aggenital plate.

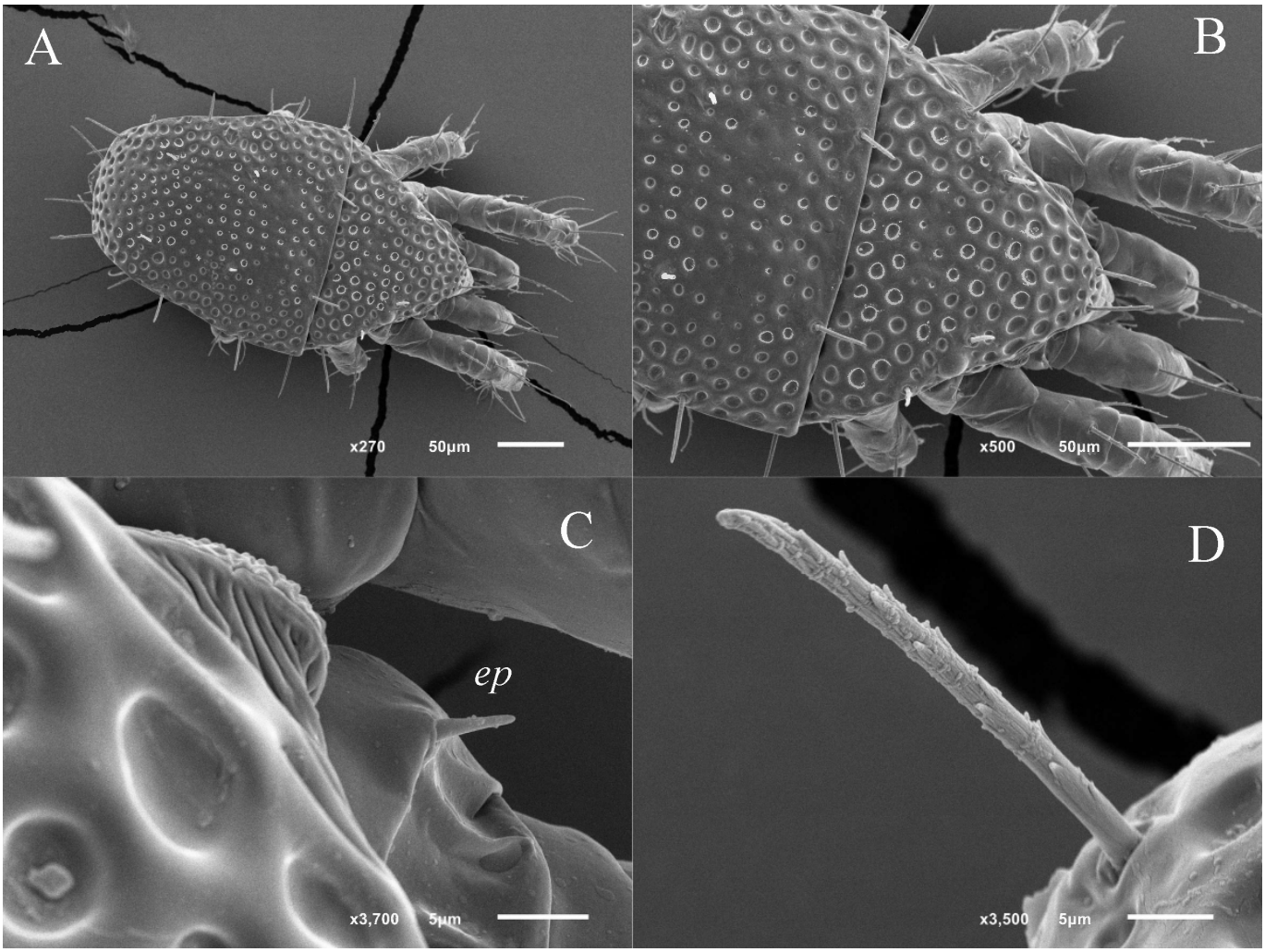

Figure 5 SEM images of *Eustigmaeus bochkovi* **n. sp.**, female: A – dorsal view, B – anterior half of the body in dorsal view, C – palpal supracoxal seta, D – seta *f* 1.

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) (*dξ*, *l'*, *l''*, *v'*, *v''*, *φ*, *φp*), T*a* 13(1) (*p'ξ*, *p'' ξ*, *tc' ξ*, *tc'' ξ*, *ft' ξ*, *ft'' ξ*, *u'*, *u''*, *a'*, *a''*, *pl'*, *pl''*, *vs*, *ω*). Setae *d* of tibia, (*p*), (*tc*) and (*ft*) of tarsus are eupathidia. Seta *d* of femur barbed, with weak hyaline sheath; seta *k* 45 (45–48) smooth, blunt-ended, subequal with seta *d* of genu; other dorsal setae (except eupathidia) pointed and barbed. Solenidion *ω* short 17 (17–18), finger-shaped; solenidion *φ* 11 (10–11) baculiform, solenidion *φp* 21 (18–22) attenuate. Leg II (Fig. 3B). Leg setation: Tr 1 (*v'*), Fe 5 (*d*, *l'*, *l''*, *v'*, *bv''*), Ge 4 (*d*, *l'*, *l''*, *k*), Ti 5(1) (*dξ*, *l'*, *l''*, *v'*, *v''*, *φ*), Ta 9(1) (*p'ξ*, *tc'ξ*, *tc''*, *u'*, *u''*, *a'*, *a''*, *pl'*, *vs*, *ω*). Setae *d* of tibia, *p'* and *tc'* of tarsus represented by eupathidia. Seta *d* of femur blunt-ended and barbed; seta k 7 (7) of genu short, rod-like; other setae (except eupathidia) pointed and barbed. Solenidion *ω* 19 (19–21) finger-shaped; solenidion *φp* 17 (17–19) attenuate. Leg III (Fig. 3C). 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* 10 (9–10) finger-shaped; solenidion *φp* 12 (12–15) attenuate. All leg setae barbed. Setae *d* of femur and genu distinctly blunt-ended, seta *d* of tibia weakly blunt-ended; other setae pointed. Setae (*u*) of tarsus smooth, other tarsal setae weakly barbed. Leg IV (Fig. 3D). 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* 7 (5–6) baculiform; solenidion *φp* 18 (16–18) attenuate.

All leg setae barbed (sometimes *tc'* smooth). Setae *d* of femur and genu distinctly blunt-ended, seta *d* of tibia weakly blunt-ended; other setae pointed.

Male(Figs 6–7) (n=3)

Idiosoma oval, but opisthosoma more narrower than in female. Length of idiosoma 260–280, width 165–185.

Idiosomal dorsum (Fig. 6A) — In general similar to female, but hysterosomal shield transversely divided into 2 shields; anterior shield more clearly reticulated than posterior, with setae *c*1, *d*1, *d*2; posterior shield with setae *e*1, *e*2, *f*1. Suranal shield and genital opening located dorsally. Genital opening with 2 well-sclerotized projections. Aedeagus long and narrow, weakly sclerotized. Setae *ps*1-3 short, smooth, spiniform, other dorsal setae weakly barbed, baculiform, without distinct hyaline sheaths. Lengths of dorsal setae: *vi* 26–29, *ve* 32–36, *sci* 23–32, *sce* 31–33, *c*1 25–27, *c*2 34–37, *d*1 26–27, *d*2 31–33, *e*1 21–22, *e*2 30–33, *f*1 32–35, *h*1 10–12, *h*2 32– 35, *ps*1 3–4, *ps*2 4–5, *ps*3 7–8.

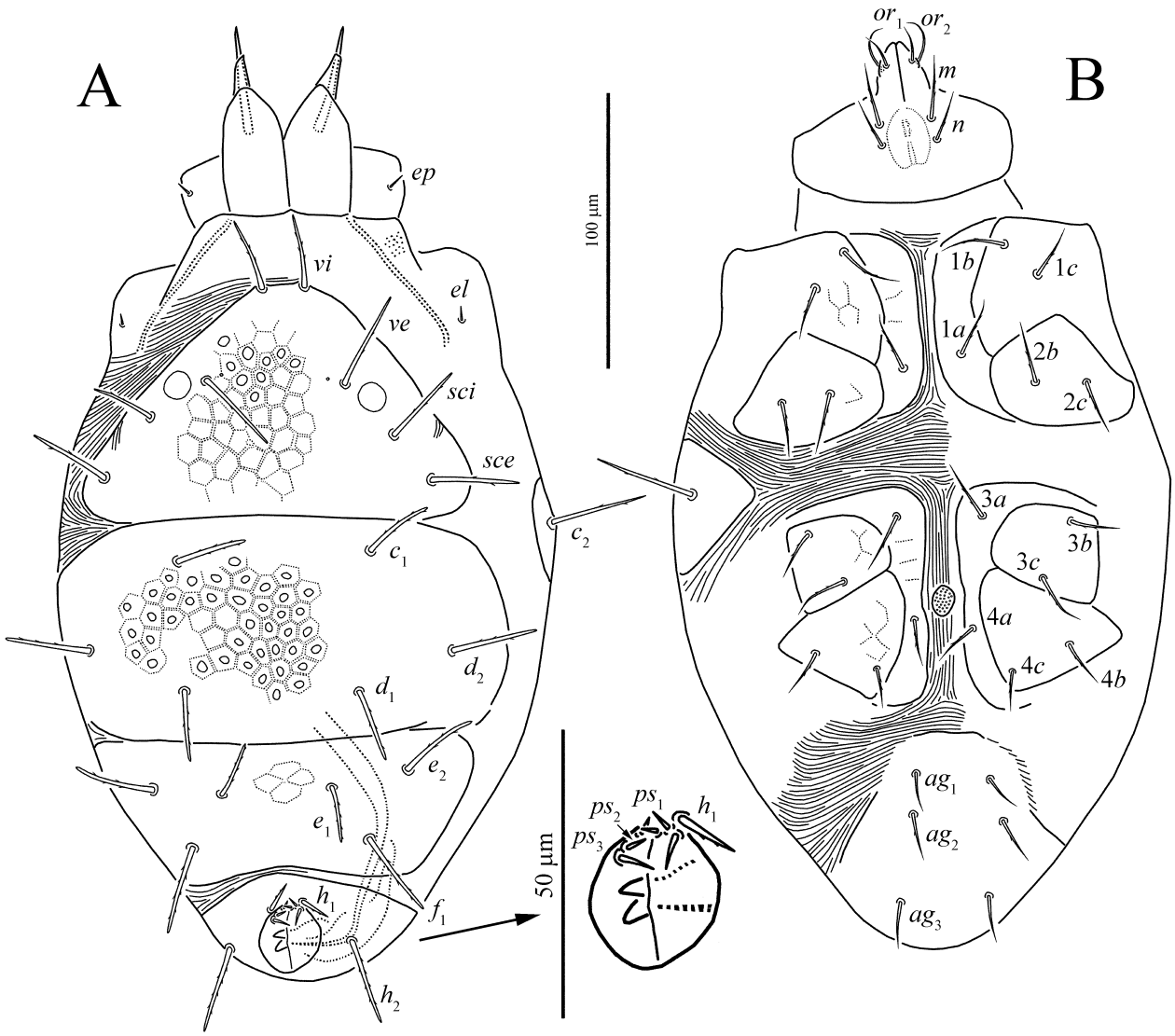

Figure 6 *Eustigmaeus bochkovi* **n. sp.**, male: A – dorsum of the body, B – venter of the body. Legs omitted.

Idiosomal venter (Fig. 6B) — Podosoma as in female. Opisthosoma with smooth, weakly sclerotized aggenital plate fused posteriorly with suranal plate. Aggenital plate with 3 pairs of smooth or weakly barbed aggenital setae. Lengths of ventral setae: 1*a* 23–24, 1*b* 23–24, 1*c* 20–21, 2*b* 21–24, 2*c* 22–23, 3*a* 24–25, 3*b* 23–24, 3*c* 19–20, 4*a* 19, 4*b* 19–20, 4*c* 18–19, *ag*1 17–18, *ag*2 18–20, *ag*3 19–20.

Gnathosoma — As in female.

Legs (Fig. 7) — In general similar to those of female except presence of male solenidia on tarsi I–IV. Leg I (Fig. 7A). Seta *d* of femur barbed, blunt-ended, without hyaline sheath. Lengths of seta *k* 43 and solenidia: ω 16–17, ω♂ 44–46, ϕ 10, ϕp 18–20. Leg II (Fig. 7B). Lengths of seta *k* 8 and solenidia: ω 21–22, ω♂ 37–38, ϕp 15–16. Leg III (Fig. 7C). Lengths solenidia: ω 10, ω♂ 34–35, ϕp 13–14. Leg IV (Fig. 7D). Lengths solenidia: ω 6–7, ω♂ 35–36, ϕp 14–16.

Female deutonymph (Figs 8–10) (n=1)

Length of idiosoma 275, width 185.

Idiosomal dorsum (Figs 8A, 10A) — In general similar to female, but setae *sce*, *d*2, *e*2, *f*1

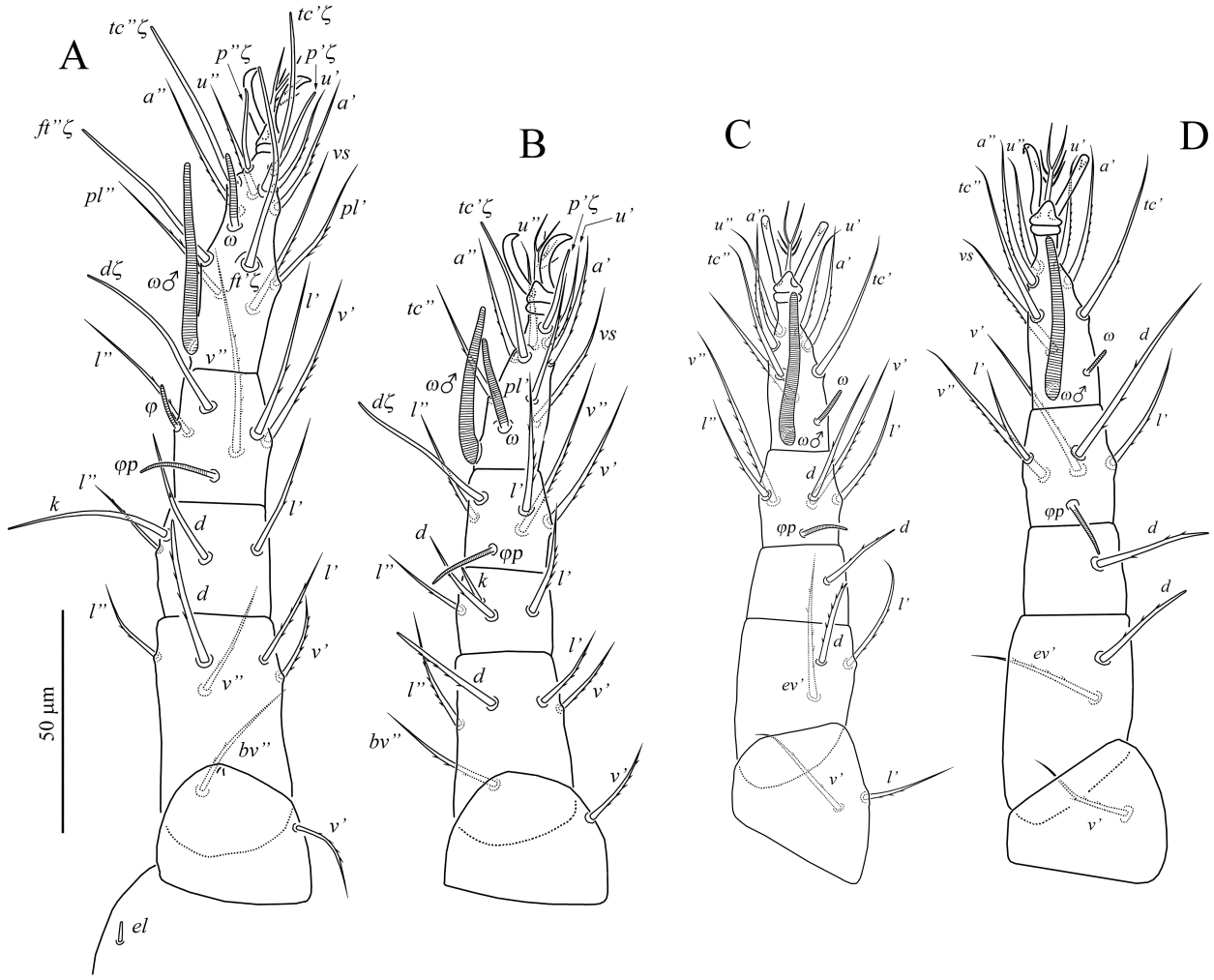

Figure 7 *Eustigmaeus bochkovi* **n. sp.**, male: A – left leg I in dorsal view, B – left leg II in dorsal view, C – left leg III in dorsal view, D – left leg IV in dorsal view.

each located on separate plates; setae *c*1 and *d*1 on subrectangular central hysterosomal shield; setae *e*1 on unpaired shield. Suranal shield located dorsally. Dorsal setae weakly barbed or smooth, baculiform, without distinct hyaline sheaths, setae *h*2 pointed. Lengths of dorsal setae: *vi* 30, *ve* 37, *sci* 25, *sce* 34, *c*1 29, *c*2 36, *d*1 29, *d*2 31, *e*1 29, *e*2 33, *f*1 44, *h*1 34, *h*2 29.

Idiosomal venter (Figs 8B, 10B–D) — As in female. Lengths of ventral setae: 1*a* 23, 1*b* 23, 1*c* 23, 2*b* 20, 2*c* 20, 3*a* 20, 3*b* 19, 3*c* 19, 4*a* 18, 4*b* 19, 4*c* 17, *ag*1 14, *ag*2 13, *ag*3 16, *ps*1 23, *ps*2 4, *ps*3 15.

Gnathosoma — As in female.

Legs (Fig. 9) — In general similar to those of female except the absence of setae *d* on genu II, v' on femur II, *d* on genua III and IV, and *v'* on trochanter IV. Leg I (Fig. 9A). Lengths of seta *k* 37 and solenidia: ω 15, ϕ 8, ϕp 16. Leg II (Fig. 9B). Lengths of seta *k* 8 and solenidia: ω 19, ϕp 16. Leg III (Fig. 9C). Lengths solenidia: ω 8, ϕp 12. Leg IV (Fig. 9D). Lengths solenidia: ω 6, ϕp 13.

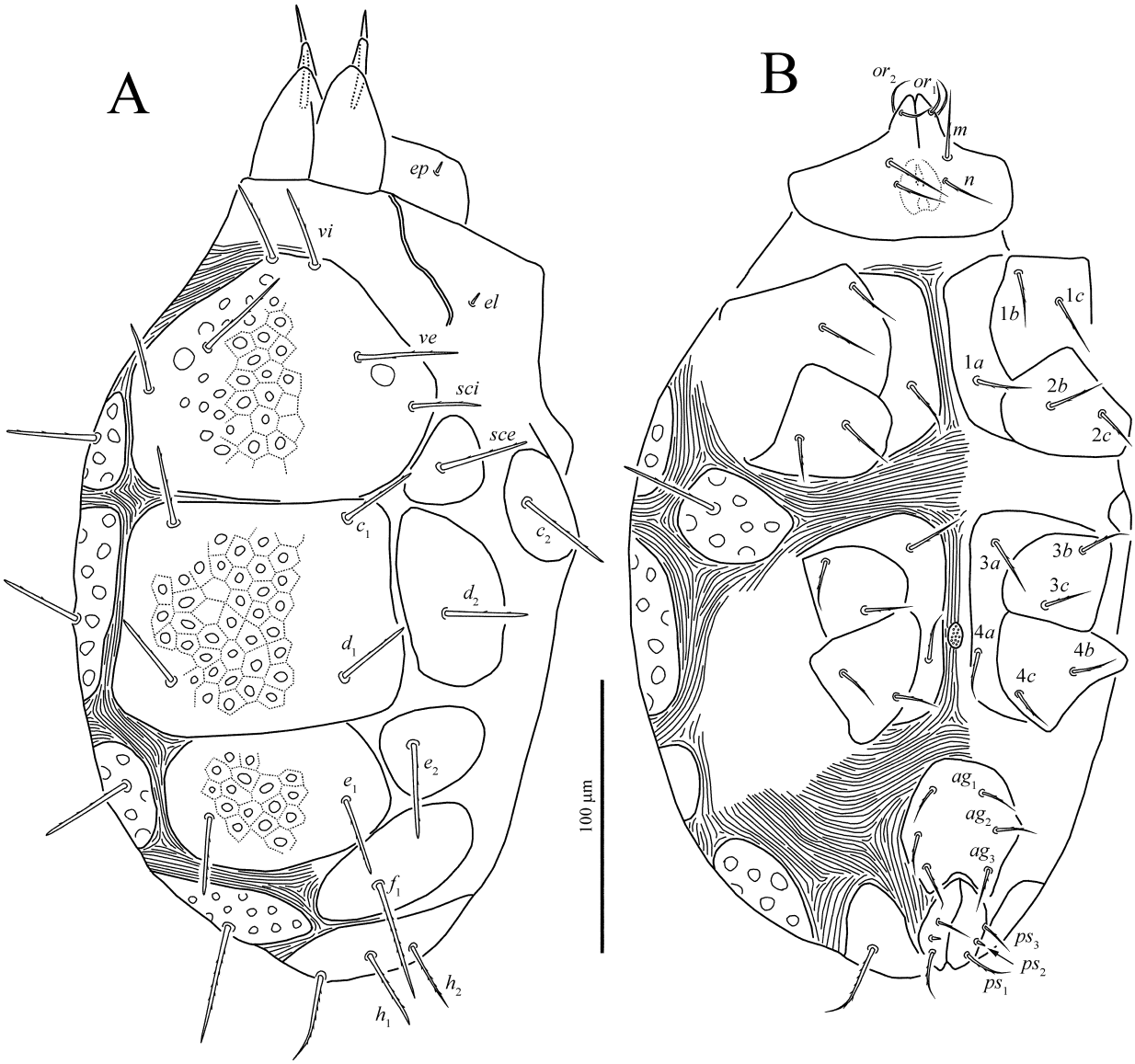

Figure 8 *Eustigmaeus bochkovi* **n. sp.**, female deutonymph: A – dorsum of the body, B – venter of the body. Legs omitted.

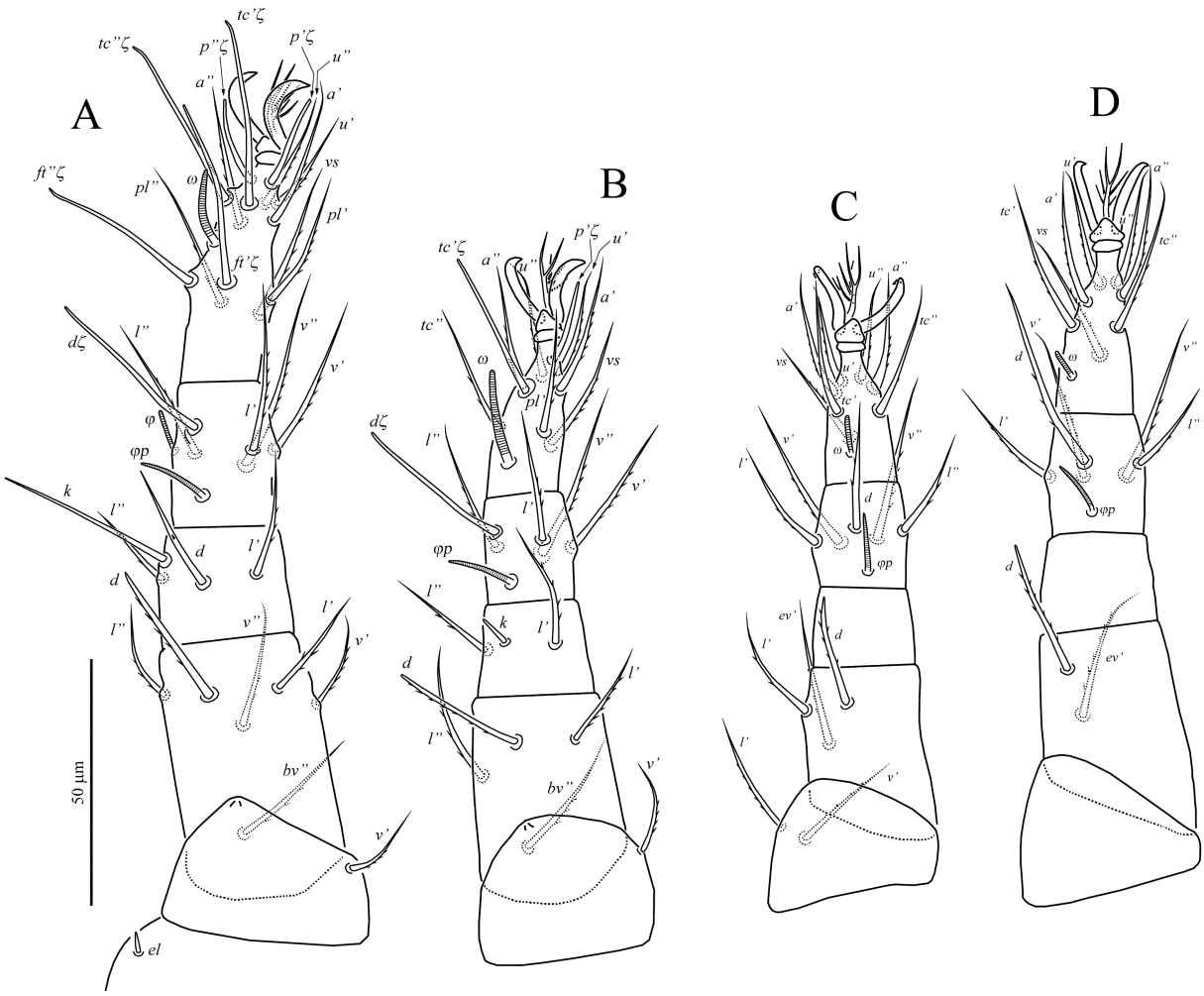

Figure 9 *Eustigmaeus bochkovi* **n. sp.**, female deutonymph: A – left leg I in dorsal view, B – left leg II in dorsal view, C – right leg III in dorsal view, D – right leg IV in dorsal view.

Male deutonymph (Fig. 11) (n=1)

Length of idiosoma 306, width 205.

In general, similar to female deutonymph except setae *h*1 short, smooth, spiniform and located dorsally (Fig. 11). Lengths of dorsal setae: *vi* 25, *ve* 33, *sci* 27, *sce* 28, *c*1 25, *c*2 30, *d*1 25, *d*2 27, *e*1 25, *e*2 26, *f*1 36, *h*1 28, *h*2 26. Lengths of ventral setae: 1*a* 24, 1*b* 19, 1*c* 16, 2*b* 17, 2*c* 17, 3*a* 21, 3*b* 17, 3*c* 17, 4*a* 15, 4*b* 14, 4*c* 14, *ag*1 12, *ag*2 13, *ag*3 15, *ps*1 3, *ps*2 3, *ps*3 9.

Leg I. Lengths of seta *k* 34 and solenidia: ω 12, ϕ 8, ϕp 14. Leg II. Lengths of seta *k* 8 and solenidia: ω 14, ϕp 12. Leg III. Lengths solenidia: ω 7, ϕp 11. Leg IV. Lengths solenidia: ω 4, ϕp 10.

Protonymph (Figs 12–13) (n=2)

Length of idiosoma 250–255, width 180.

Idiosomal dorsum (Fig. 12A) — In general similar to deutonymph, but suranal shield located ventrally, setae *h*1 pointed. Lengths of dorsal setae: *vi* 25–27, *ve* 30–33, *sci* 20–21, *sce* 27–30, *c*1 24–27, *c*2 30, *d*1 23–28, *d*2 28, *e*1 25–28, *e*2 27–29, *f*1 39–41, *h*1 28–31, *h*2 25.

Idiosomal venter (Fig. 12B) — Similar to deutonymph, except setae 4*a*, 4*b*, 4*c* absent, aggenital plate with 1 pair of setae. Lengths of ventral setae: 1*a* 20, 1*b* 20–21, 1*c* 18, 2*b* 16–18,

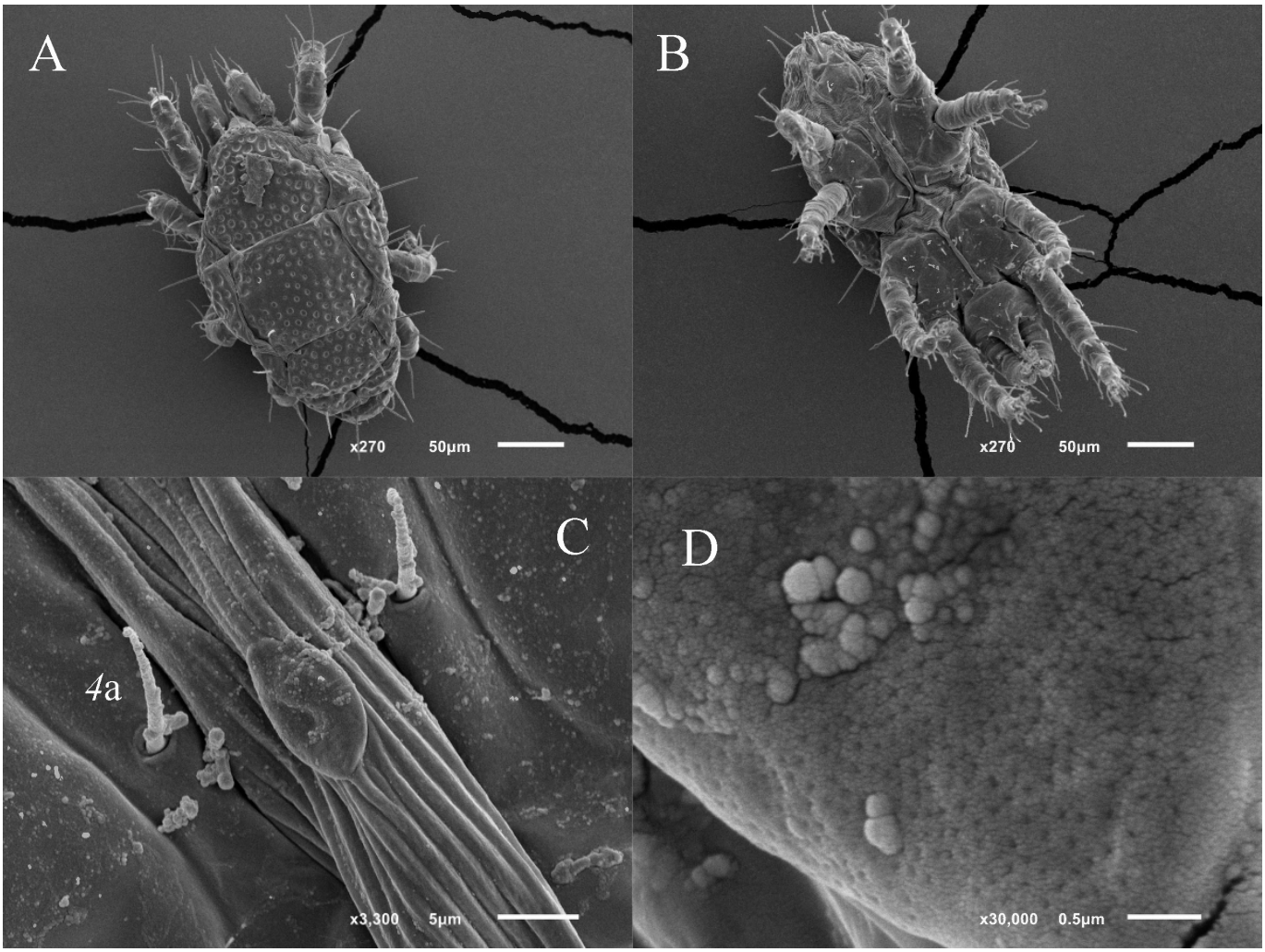

Figure 10 SEM images of *Eustigmaeus bochkovi* **n. sp.**, female deutonymph: A – dorsal view, B – ventral view, C – callosity, D – anterior part of callosity.

2*c* 16–17, 3*a* 21–24, 3*b* 17–19, 3*c* 17–19, *ag*1 16–21, *ps*1 12, *ps*2 3, *ps*3 11.

Gnathosoma — As in deutonymph, except absence of setae *m*.

Legs (Fig. 13) In general similar to those of deutonymph, except the absence of setae *v'*, *v''* on femur I, *v'* on trochanters I–III, and *d* on femur IV; also setae (*ft*) on tarsus I and *d* on tibia II not eupathidia. Leg I (Fig. 13A). Lengths of seta *k* 30–35 and solenidia: ω 14, ϕ 7–8, ϕp 14–15. Leg II (Fig. 13B). Lengths of seta *k* 7 and solenidia: ω 16–18, ϕp 12. Leg III (Fig. 13C). Lengths solenidia: ω 6–7, ϕp 11. Leg IV (Fig. 13D). Lengths solenidia: ω 5, ϕp 9.

Type material

Female holotype, slide N° ZISP T-St-002, Russia: Khabarovsky Kray, Nanayskiy region, 48°54'N, 136°17'E, in rotten log, 16 August 2018, coll. A.A. Khaustov. Paratypes: 3 females, 1 female deutonymph, 1 male deutonymph, 2 protonymphs, same data as holotype.

Etymology

The specific name is given after the prominent Russian acarologist, Andrey Bochkov who passed away in 2018.

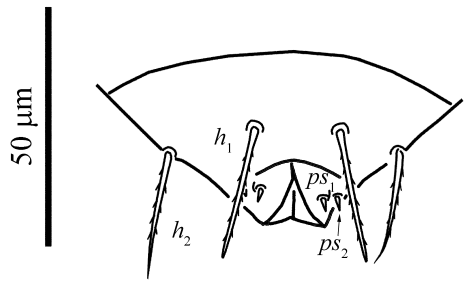

Figure 11 *Eustigmaeus bochkovi* **n. sp.**, male deutonymph: posterior part of opisthosoma in dorsal view.

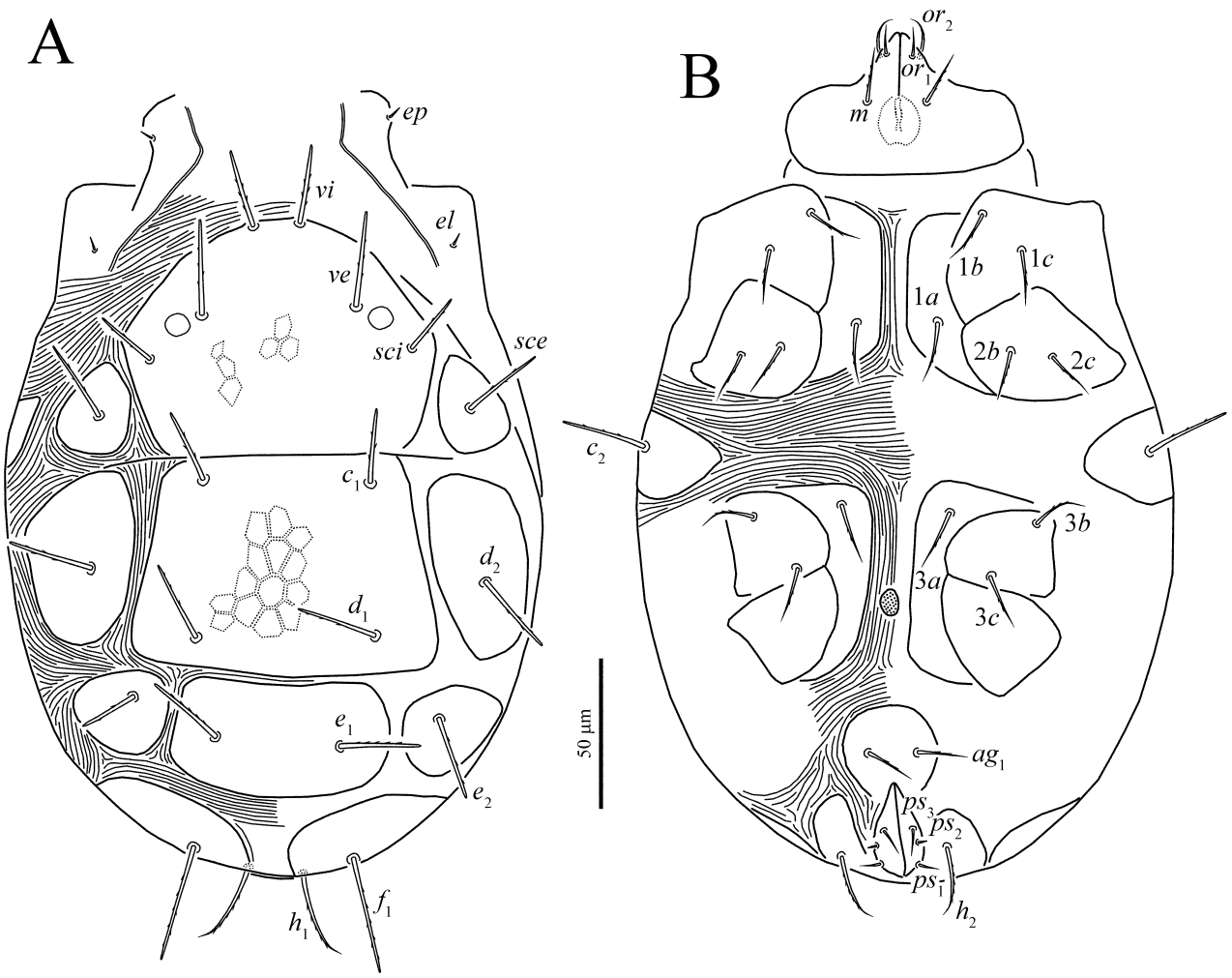

Figure 12 *Eustigmaeus bochkovi* **n. sp.**, protonymph: A – dorsum of the idiosoma, B – venter of the body. Legs omitted.

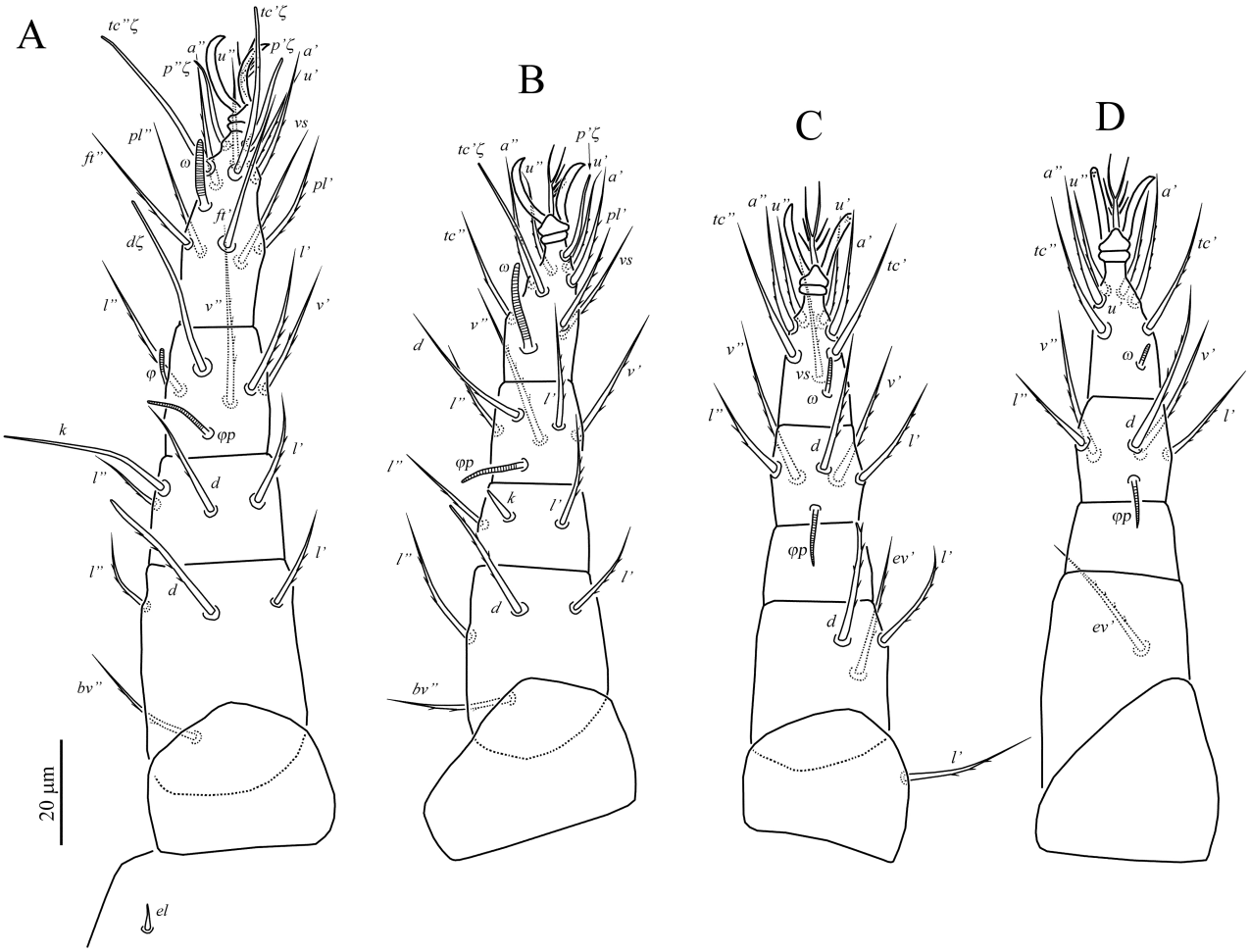

Figure 13 *Eustigmaeus bochkovi* **n. sp.**, protonymph: A – left leg I in dorsal view, B – left leg II in dorsal view, C – left leg III in dorsal view, D – left leg IV in dorsal view.

Differential diagnosis

The new species differs from all known species of *Eustigmaeus* by the presence of callosity located between endopodal plates of legs III and IV (absent in other species).

Type deposition

The holotype is deposited in the collection of the Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia. All paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Eustigmaeus grandis n. sp.

(Figs 14–17)

Zoobank: 37D41070-3037-45B2-9EC7-E703BDE85E54

Description

Female (Figs 14–17) (n=8)

Idiosoma broadly oval. Length of idiosoma 405 (385–435), width 330 (325–345).

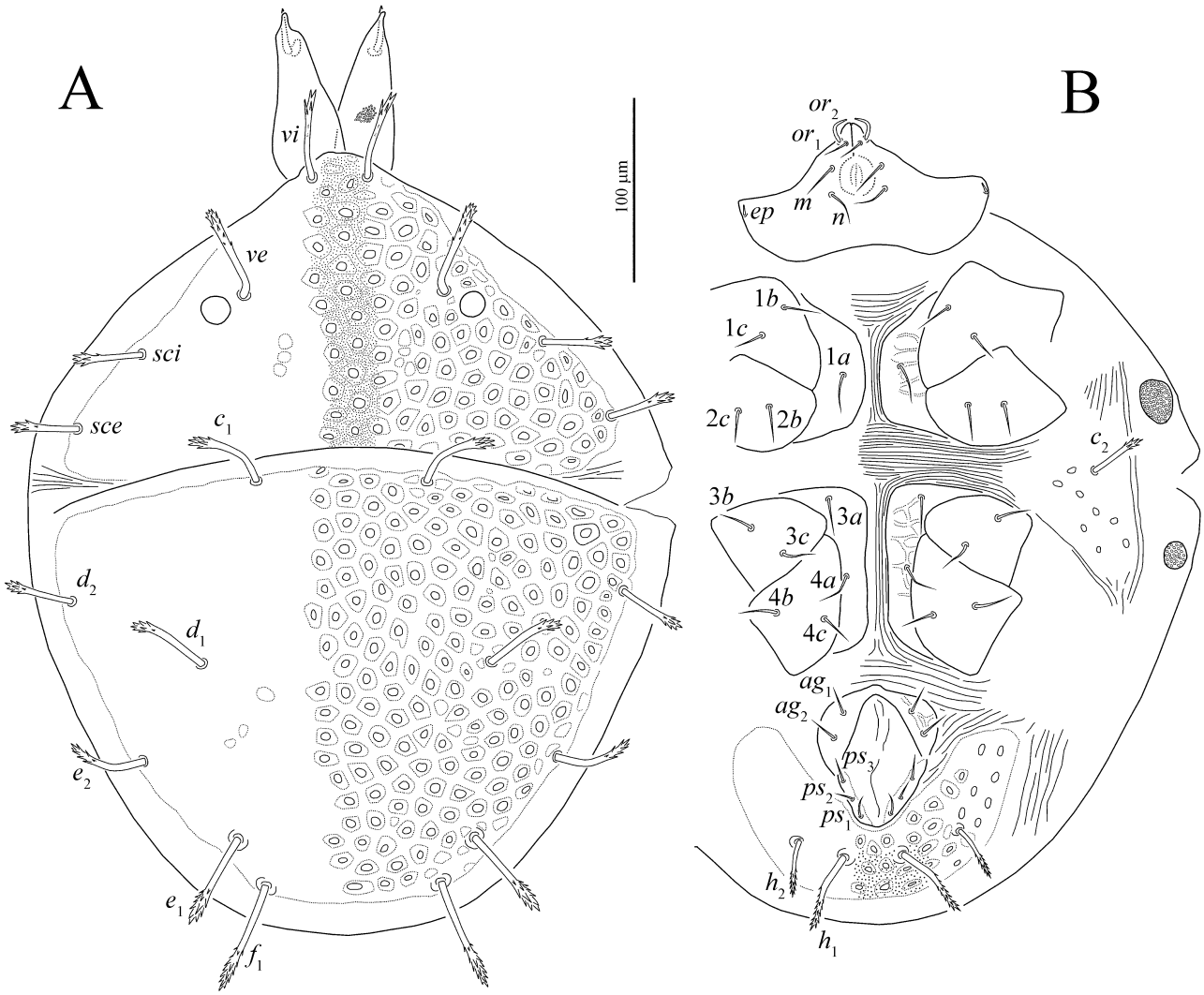

Figure 14 *Eustigmaeus grandis* **n. sp.**, female: A – dorsum of the body, B – venter of the body. Legs omitted.

Idiosomal dorsum (Figs 14A, 17A, D, E) — Eyes present. Idiosoma almost completely covered by 2 large and well sclerotized plates. Plates punctate, with large round dimples (Figs 17D, E) and distinct subcuticular reticulation. Dorsal setae subequal, brush-like distally. Setae *h*1 and *h*2 situated ventrally. Lengths of dorsal setae: *vi* 47 (44–48), *ve* 50 (47–53), *sci* 42 (38–43), *sce* 37 (34–3)9, *c*1 41 (34–43), *c*2 30 (29–31), *d*1 43 (41–44), *d*2 37 (36–37), *e*1 47 (46–47), *e*2 44 (41–45), *f*1 52 (51–53), *h*1 45 (42–46), *h*2 32 (27–33).

Idiosomal venter (Figs 14B, 17F) — With 2 oval callosities located anterolaterally and posterolaterally to humeral plate; anterior callosity distinctly larger than posterior. Suranal plate situated ventrally, with distinct large dimples, subcuticular reticulation and punctate in central part. Endopodal plates separated medially. Humeral plate weakly sclerotized, subtriangular, with distinct large dimples. Ventral setae smooth and pointed; with 2 pairs of simple subequal aggenital, and 3 pairs of pseudanal setae. Aggenital plate smooth, with weak subcuticular reticulation posteriorly to setae *ag*1. All coxal plates distinctly punctate. Coxal and endopodal plates of legs I-IV with weak subcuticular reticulation. Lengths of ventral setae: 24 (20–26), 1*b* 23 (21–25), 1*c* 17 (16–18), 2*b* 18 (16–18), 2*c* 18 (16–19), 3*a* 25 (24–26), 3*b* 19 (17–19), 3*c*

16 (15–17), 4*a* 20 (18–20), 4*b* 19 (18–20), 4*c* 20 (19–21), *ag*1 17 (16–18), *ag*2 17 (15–18), *ps*1 16 (15–17), *ps*2 16 (14–17), *ps*3 15 (14–17).

Gnathosoma (Figs 15, 17B, C) — Tibial claw well-developed. Setae *l'* on palpal tibia short, spine-like, with slightly angulate margin. All palpal setae of femur, genu and tibia (except *l'Ti*) pointed and barbed; setae of palptarsus smooth, except weakly barbed *va*. Number of setae on palpal segments as in *E. bochkovi* **n. sp.** Palpal supracoxal setae (*ep*) needle-like, slightly curved, located ventrolaterally. Rostrum of subcapitulum short. All subcapitular setae smooth. Setae *or*2 distinctly blunt-ended and curved, other subcapitular setae pointed. Basal part of subcapitulum distinctly punctate and with indistinct subcuticular reticulation posterolaterally to setae *n* (Fig. 17C). Length of subcapitular setae: *m* 18 (17–19), *n* 17 (16–18), *or*1 15 (13–15), *or*2 17 (16–18). Chelicerae dorsally distinctly punctate (Fig. 17B) with short stylets.

Legs (Fig. 16) — Empodial raylets not capitate. Leg setation as in *E. bochkovi* **n. sp.** Leg I (Fig. 16A). Coxae I posterodorsally with needle-like leg supracoxal setae (*el*). Setae (*p*), (*tc*) and (*ft*) of tarsus are eupathidia. Setae *d*, *l''* of femur, *d*, (*l*) of genu, and *d*, *l'* of tibia brush-like distally, located on small protuberances; other setae (except eupathidia) pointed; setae (*u*) of tarsus smooth, other setae (except eupathidia) sparsely barbed. Seta *k* 10–11 smooth, blunt-ended, more than twice shorter than seta *d* of genu. Solenidion *ω* long 25 (23–27), narrow, finger-shaped; solenidion *φ* 8 (8) baculiform, solenidion *φp* 16 (15–17) attenuate. Leg II (Fig. 16B). Setae *p'* and *tc'* of tarsus represented by eupathidia. Setae *d*, *l''* of femur, *d*, (*l*) of genu, and *d*, *l'* of tibia brush-like distally, usually located on small protuberances; other setae (except eupathidia) pointed; setae (*u*) of tarsus smooth, other setae (except eupathidia) sparsely barbed. Seta *k* 7 (6–7) of genu short, rod-like. Solenidion *ω* 17 (14–18) finger-shaped; solenidion *φp* 14 (12–15) attenuate. Leg III (Fig. 16C). Solenidion *ω* 6 (5–6) short, baculiform; solenidion *φp* 10 (9–10) attenuate. Setae *d*, *l'* of femur, *d* of genu and tibia brush-like distally, seta *l'* of tibia weakly blunt-ended and strongly barbed; other setae pointed. Setae (*u*) of tarsus smooth, other tarsal setae barbed. Leg IV (Fig. 16D). Solenidion *ω* 5 (4–5) short, baculiform; solenidion *φp* 9 (8–9) rod-like. Setae *d* of femur, *d* of genu and tibia, and (*l*) of tibia brush-like distally, other

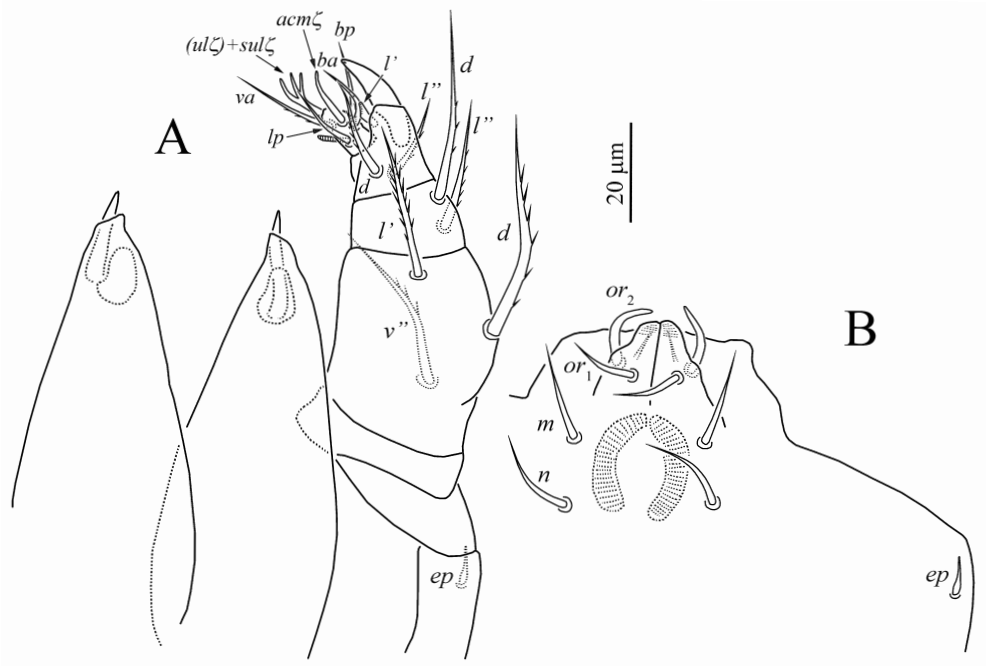

Figure 15 *Eustigmaeus grandis* **n. sp.**, female: A – gnathosoma in dorsal view, B – gnathosoma in ventral view.

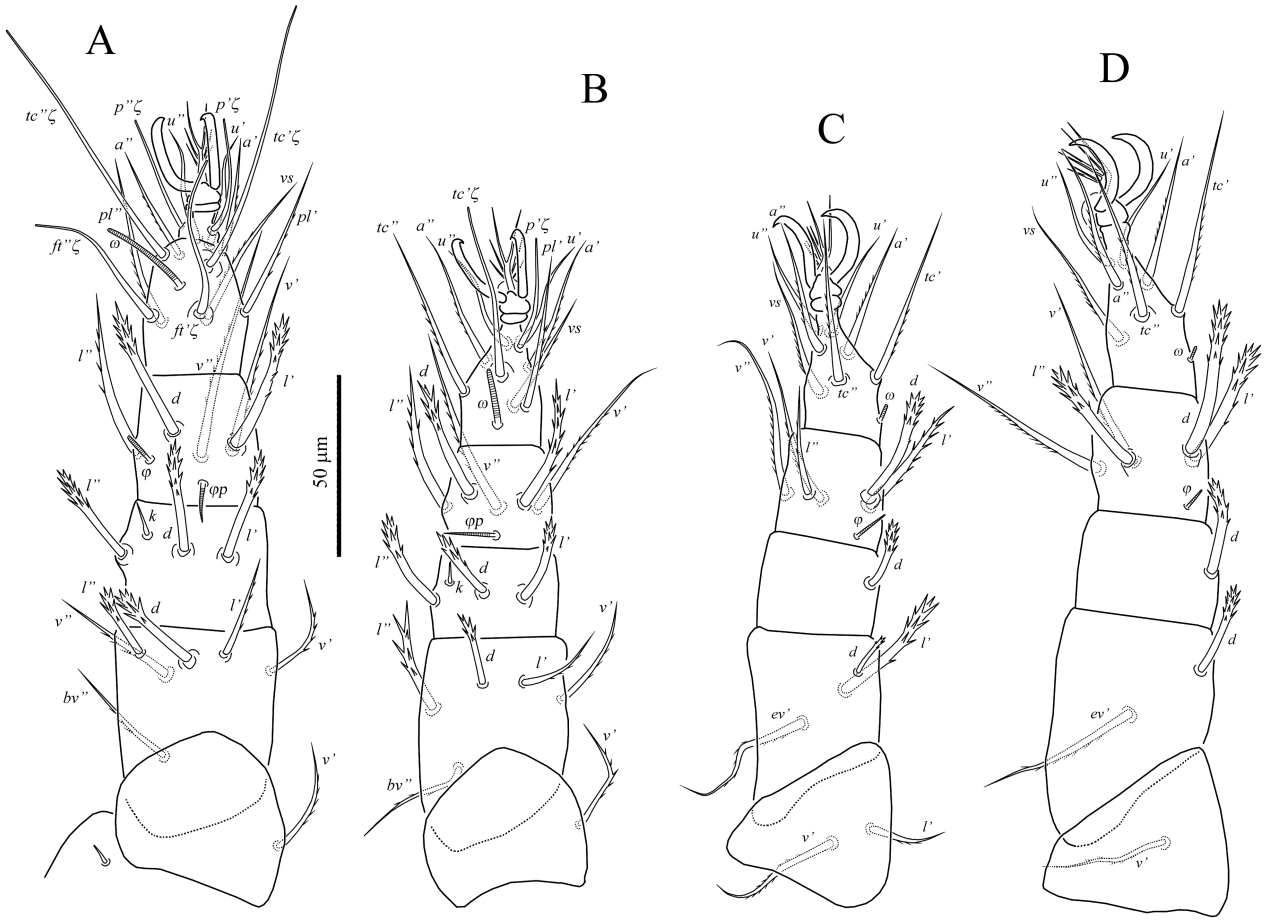

Figure 16 *Eustigmaeus grandis* **n. sp.**, female: A – left leg I in dorsal view, B – left leg II in dorsal view, C – left leg III in dorsal view, D – left leg IV in dorsal view.

setae pointed. Setae (*u*) of tarsus smooth, other tarsal setae barbed.

Type material

Female holotype slide N° ZISP T-St-003, and 7 female paratypes, Russia: Primorsky kray, Vladivostok, Botanical Garden-Institute, Far Eastern Branch of the Russian Academy of Sciences, 43°13'N, 131°59'E, from soil, 10 September 2015, coll. A.V. Tolstikov.

Etymology

The name of the new species is derived from Latin "*grandis*" meaning "*large*" and refers to very large body size.

Differential diagnosis

By the distinctly reticulate dorsal shields, similar shape of dorsal idiosomal setae and presence of two pairs of aggenital setae, the new species is most similar to *E. changbaiensis* (Bei and Yin), described from China by Bei & Yin (1995). The new species can be distinguished from *E, changbaiensis* by the presence of two pairs of callosities (only one pair in *E. changbaiensis*) and by much larger idiosomal length (385-435 vs. 285 in *E. changbaiensis*).

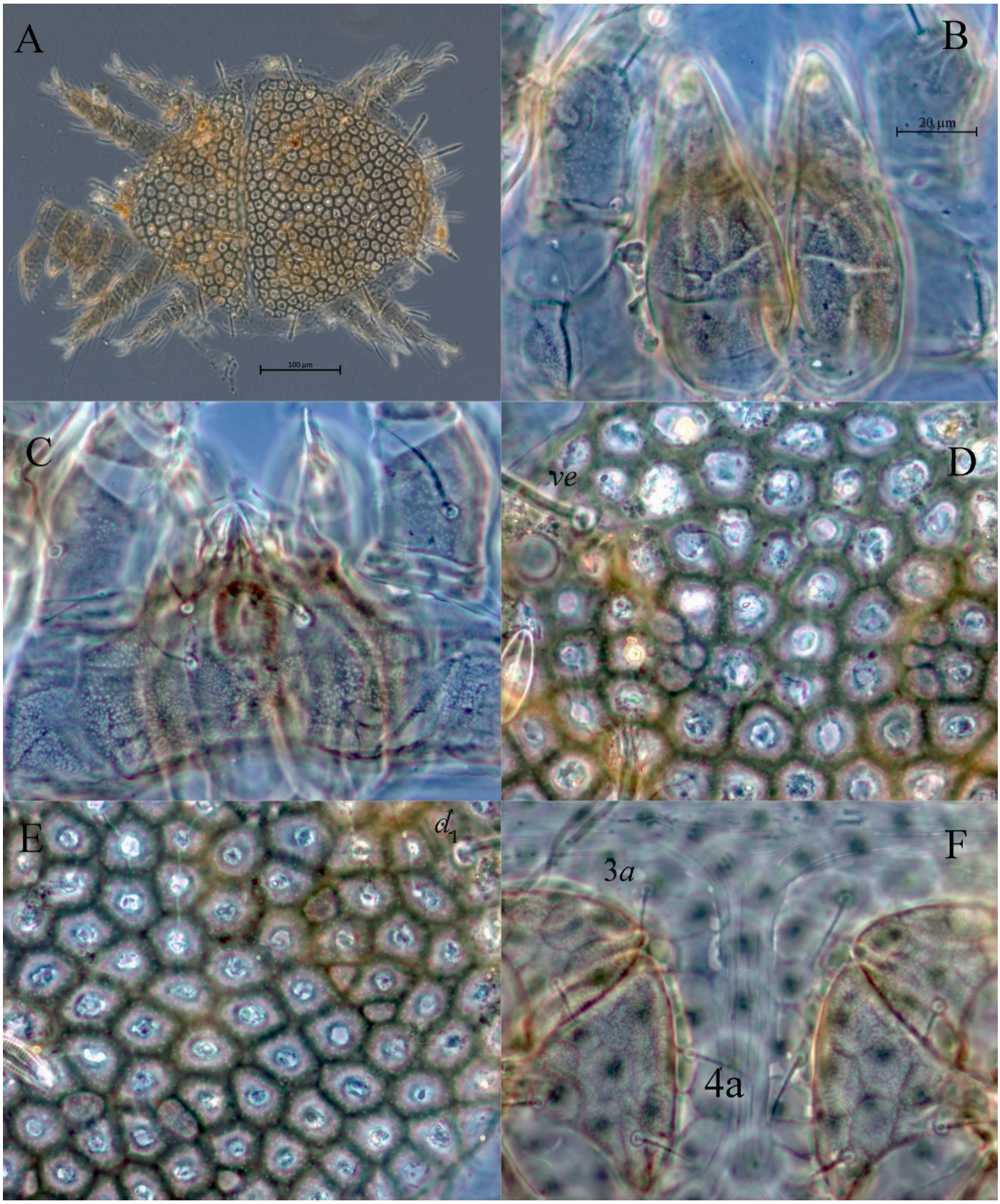

Figure 17 Phase-contrast micrographs of *Eustigmaeus grandis* **n. sp.**, female: A – dorsal view, B – chelicerae in dorsal view, C – subcapitulum, D – central part of prodorsum, E – central part of hysterosomal shield, F – coxal plates III, IV.

Type deposition

The holotype and 2 paratypes are deposited in the collection of the Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia. Other paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Synonymy of the genera *Paravillersia* and *Eustigmaeus*

Kuznetsov (1978) created monotypic genus *Paravillersia* with type species *P. grata* Kuznetsov, 1978. He noted that the genus *Paravillersia* has intermediate position between the genera *Eustigmaeus* Berlese, 1910 and *Villersia* Oudemans, 1927. According to Kuznetsov (1978) the genus *Paravillersia* differs from *Eustigmaeus* by the location of setae *sce* on separate plate (on prodorsal shield in *Eustigmaeus*), and from *Villersia* by the location of setae *d*2 on hysterosomal shield (on separate plate in *Villersia*). Khaustov (2014) examined the holotype of *P. grata* and provided supplementary description of legs, gnathosoma and some idiosomal setae.

During this study, I examined 6 female paratypes of *P. grata* deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All type specimens of *P. grata* are squeezed and strongly flattened. Thus, some ventral and dorsal structures are visible almost in the same plane, especially in phase-contrast objective. In some type specimens of *P. grata* it seems that seta *sce* is located on separate plate (Fig. 18A). However, in DIC objective it is clearly visible that seta *sce* is located on prodorsal shield and only thin striated incision of the prodorsal plate visible anteriorly to seta *sce* (Fig. 18B). Numerous specimens of this species, collected from Western Siberia are also confirmed that seta *sce* is

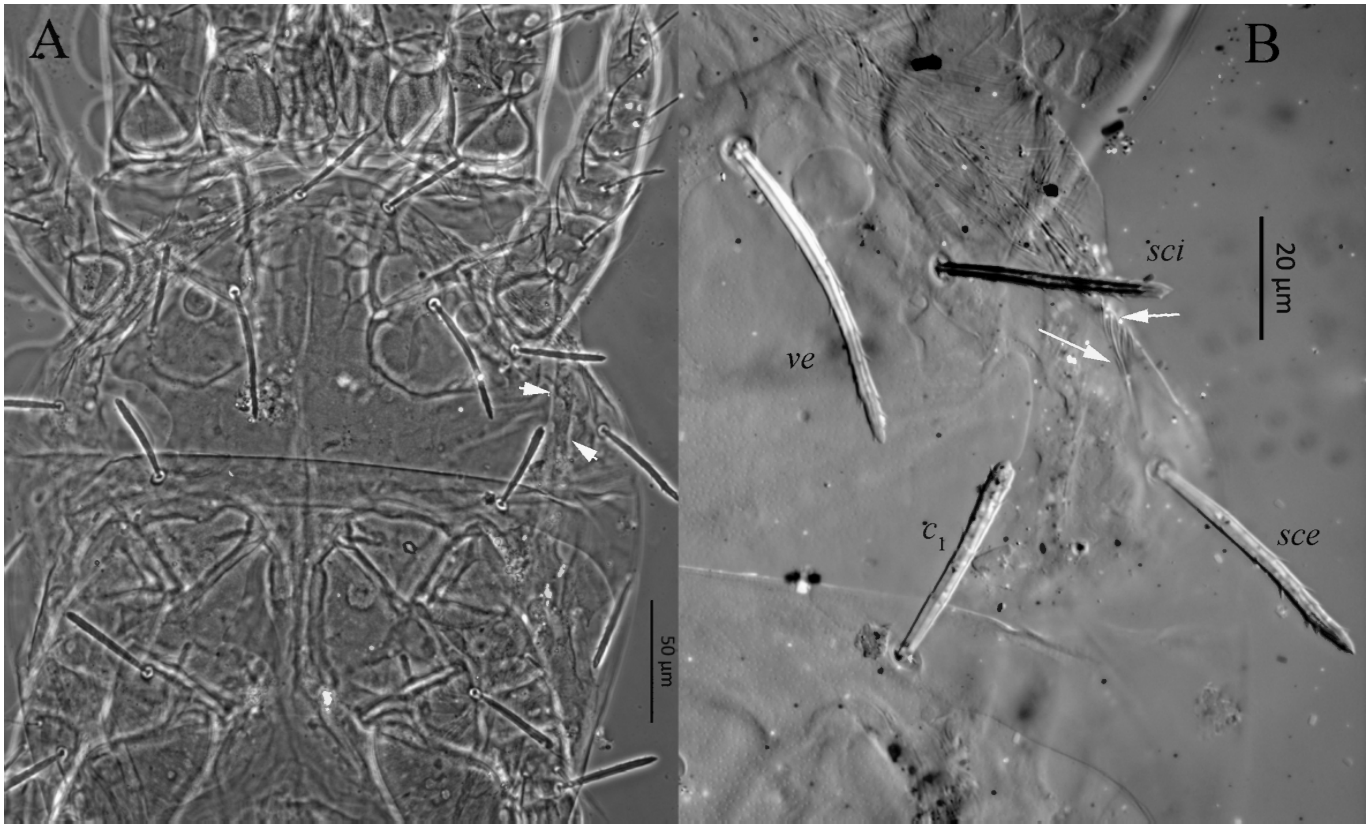

Figure 18 Phase-contrast (A) and DIC (B) micrographs of *Paravillersia grata* Kuznetsov, 1978, female (paratype): A – anterior half of the body in dorsal view (arrows point to imaginary boundary between prodorsal plate and plate with seta *sce*), B – right half of prodorsum and anterior part of hysterosomal shield (arrows point to narrow incision anteriorly to seta *sce*).

located on prodorsal shield. Based on the absence of morphological differences between the genera *Paravillersia* and *Eustigmaeus*, I consider the genus *Paravillersia* as a junior synonym of *Eustigmaeus*. The specific epithet of *Eustigmaeus gratus* (Kuznetsov, 1978) comb. nov. is modified according to masculine gender of the generic epithet. The second described species in the genus *Paravillersia*, *P. jamaliensis* Khaustov, 2014 moved to the genus *Villersia* Oudemans, 1927, because seta *sce* of this species is located on separate plate as in the genus *Villersia*. However, in *Villersia jamaliensis* (Khaustov, 2014) comb. nov. seta *d*2 located on hysterosomal shield (on separate plate in *Villersia*), but other characters are typical for *Villersia*.

Synonymy of *Eustigmaeus gratus* (Kuznetsov, 1978) comb. nov. and *E. ottavii* (Berlese, 1910)

Eustigmaeus gratus (Kuznetsov, 1978) comb. nov. is characterized by the unique shape and location of callosities (see Fig. 7A in Khaustov 2014), baculiform and sparsely barbed dorsal idiosomal setae, presence of 3 pairs of aggenital setae and almost smooth dorsal idiosomal shields. Such combination (especially shape and location of callosities) of characters is known only in *Eustigmaeus ottavii* (Berlese, 1910) redescribed by Stathakis *et al*. (2016) and in *E. isfahanensis* Khanjani *et al*., 2014. Comparison of specimens of *E. gratus* from Russia with description of *E. ottavii* from Greece do not revealed any sufficient differences between these species. Therefore, I consider *Eustigmaeus gratus* (Kuznetsov, 1978) comb. nov. as a junior synonym of *E. ottavii* (Berlese, 1910). Potentially *E. isfahanensis* also could be a junior synonym of *E. ottavii*, but examination of the type material of this species is necessary.

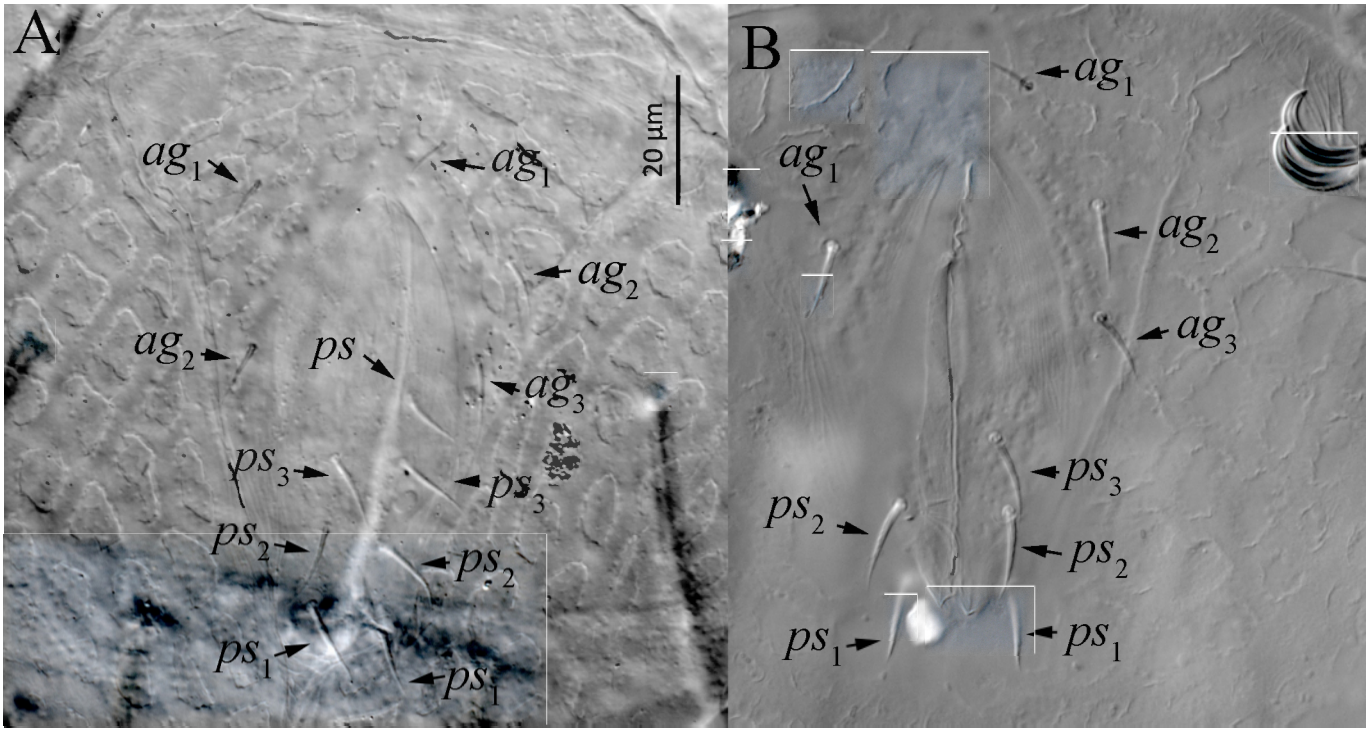

Figure 19 DIC micrographs of ano-genital area of females: A – *Eustigmaeus pinnatus* (Kuznetsov, 1977), holotype, B – *Eustigmaeus ioanninensis*, specimen from Western Siberia.

Synonymy of *Eustigmaeus ioanninensis* Kapaxidi and Papadoulis, 1999 and *E. pinnatus* (Kuznetsov, 1977a)

Eustigmaeus pinnatus (Kuznetsov, 1977a) was described from European Russia based on two females (Kuznetsov 1977a). This species is unique in having 4 pairs of pseudanal setae. I examined the female holotype of this species. It has abnormal number of aggenital and pseudanal setae. Left side of ano-genital area with 2 aggenital and 3 pseudanal setae, while right side with 3 aggenital and 4 pseudanal setae (Fig. 19A). Undoubtedly, the presence of unpaired additional pseudanal seta (*ps* on Fig. 19A) is abnormal. The normal number of pseudanal setae in *Eustigmaeus* is 3 pairs (Fan & Zhang 2005). The most similar species to *E. pinnatus* with normal 3 pairs of pseudanal setae is *E. ioanninemsis* Kapaxidi and Papadoulis, 1999. I compared female holotype of *E. pinnatus* with description of *E. ioanninensis* and specimens reported from Western Siberia (Khaustov & Tolstikov 2014) and did not find any sufficient differences. One female from Western Siberia identified as *E. ioanninensis* also has abnormal number of aggenital and pseudanal seta. Left side of aggenital area with 1 aggenital and 2 pseudanals, while right side with normal 3 aggenital and 3 pseudanal setae (Fig. 19B). Variability in number of setae in ano-genital area was also observed in Turkish specimens of *E. ioanninensis* (Bingül *et al*. 2017b). Based on the variability in number of setae in ano-genital area, I consider *E. ioanninensis* as a junior synonym of *E. pinnatus*.

Discussion

Eustigmaeus bochkovi **n. sp.** is remarkable because the presence of callosity located between endopodal plates of legs III and IV. The external surface of the callosity has numerous tiny pores (Fig. 4E) and looks like a ”sponge”. Among approximately 125 described species of *Eustigmaeus* (Khaustov & Tsurikov 2018), at least 13 species (*E. acidophilus* (Wood, 1972), *E. baguioensis* Rimando and Corpuz-Raros, 1997, *E. bali* Doğan and Ayyildiz, 2003, *E. changbaiensis* (Bei and Yin, 1995), *E. erciyesiensis* Doğan *et al*., 2003, *E. erzincanensis* Doğan, 2005, *E. etruscus* (Berlese, 1910), *E. granulosus* (Wood, 1966), *E. kauaiensis* Swift, Gerson, Goff, 1985, *E. parakauaiensis* Kapaxidi *et al*., 2013, *E. parvisetus* (Chaudhri, 1965), *E. schusteri* (Summers and Price, 1961), *E. zhengyii* Hu and Zhu, 1994) have one pair of callosities usually located laterally to prodorsal shield, and at least 12 species (*E. absens* Dogan, 2005, *E. extremiorientalis* Khaustov, 2016a, *E. frigidus* (Habeeb, 1958), *E. gersoni* (Wood, 1972), *E. isfahanensis* Khanjani *et al*., 2014, *E. grandis* **n. sp.**, *E. lacuna* (Summers, 1961), *E. najeba* (Habeeb, 1973), *E. ottavii* (Berlese, 1910), *E. rhodomela* (Koch, 1841), *E. rotundus* (Wood, 1072), *E. tjumeniensis* Khaustov and Tolstikov, 2014) have 2 pairs of callosities usually located laterally to humeral plate. Also all species of the genus *Villersia* have 2 pairs of callosities. The function of callosities is unknown. In light microscope numerous dimple-like round structures visible on callosities (see Fig.5C in Khaustov 2016a). The shape and location of callosities is good highly specific taxonomic character. It is not clear is the callosity found in *E. bochkovi* **n. sp.** homologous to callosities in other *Eustigmaeus* species because its location is very unusual. However, callosities found in the genus *Villersia* undoubtedly homologous to those found in *Eustigmaeus* species with 2 pairs of callosities. Potentially the genus *Villersia* could be synonymized to *Eustigmaeus* because it is differs only by the location of seta *sce* on separate plate.

Acknowledgements

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