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Authors: Seniczak, Stanisław, Seniczak, Anna, Kaczmarek, Sławomir, Marquardt, Tomasz, and Jangazieva, Bibigul

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Morphological ontogeny of *Cosmochthonius oralensis* sp. nov. (Acari: Oribatida: Cosmochthonidae) from Kazakhstan, and comments on *Cosmochthonius* Berlese

STANISŁAW SENICZAK[a*], ANNA SENICZAK[b], SŁAWOMIR KACZMAREK[a], TOMASZ MARQUARDT[a] & BIBIGUL JANGAZIEVA[c]

[a] *Department of Evolutionary Biology, Faculty of Biological Sciences, Kazimierz Wielki University, Bydgoszcz, Poland*
[b] *University of Bergen, University Museum of Bergen, Bergen, Norway*
[c] *Department of Biology and Ecology, M. Utemisov West Kazakhstan State University, Uralsk, Kazakhstan*
[*] *Corresponding author: stseni@ukw.edu.pl*

Abstract

The morphological ontogeny of *Cosmochthonius oralensis* **sp. nov.** from West Kazakhstan is described and illustrated. The adult of this species has thin cerotegument and microfoveae on the pygidium, as has *C. minifoveolatus* Gil *et al*., 1991, but the latter species is smaller than *C. oralensis* and its basal cilia on erected setae of *f*-series are distinctly longer than on setae of *e*-series; in *C. oralensis* these cilia are of similar length. The juveniles of both species are similar to adults, except for smaller body size and more delicate cuticle of juveniles. These species also differ from each other by the number of cilia on erected setae, both in the juveniles and adults. The morphology of *C. oralensis* is compared with congeners.

Keywords: oribatid mites, juveniles, leg setation, stage structure

Introduction

Cosmochthonius Berlese, 1910 comprises medium sized mites (250–360 μm) as adults. These mites are elongated, with many heavily barbed or bushy setae on the main body and legs. *Cosmochthonius* belongs to the lower Oribatida and has four plates on the notogaster (Weigmann 2006), which are connected with thin cuticle, making the body elastic while squeezing through soil pores. This genus has four pairs of long, strong, barbed and erected setae, which are inserted on transverse intercalar sclerites on the notogaster (Grandjean 1931). After erection, these setae enlarge the body size of mites, protecting them to a certain degree against small predators. Most species of *Cosmochthonius* are covered with a thick layer of cerotegument (Gordeeva 1980; Ayyildiz & Luxton 1990; Gil *et al*. 1991; Penttinen & Gordeeva 2010), which probably limits intensive water evaporation from the body, but there are also species with thin cerotegument, like *Cosmochthonius oralensis* **sp. nov.** from West Kazakhstan studied herein. This species has irregular microfoveae on the pygidium, which are rare in *Cosmochthonius*. Pygidial microfoveae also occur on *C. minifoveolatus* Gil *et al*., 1991, but this species is smaller than *C. oralensis* and has basal cilia on erected setae of *f*-series distinctly longer than on setae of *e*-series; in *C. oralensis*, these cilia are of similar length. In most species of *Cosmochthonius*, the pygidium is reticulate or with foveae. The *Cosmochthonius* species also differ from one another by the number of cilia on erected setae. The juveniles of *Cosmochthonius* are similar to adults, except for smaller body size and more delicate cuticle of juveniles (Seniczak & Seniczak 2010; Seniczak *et al*. 2011). *Cosmochthonius* comprises 32 species and two subspecies (Subías 2019).

In the catalogue of juvenile oribatid mites, Norton and Ermilov (2014) listed four species of *Cosmochthonius* with full ontogeny, which constitute 12% of all species of this genus. These species are: *C. foliatus* Subías, 1982, *C. ponticus* Gordeeva, 1980, *C. reticulatus* Grandjean, 1947 and *C. ugamaensis* Gordeeva, 1980. A nymph of *C. lanatus* (Michael 1885) is also known.

The aim of this paper is to describe and illustrate the morphological ontogeny *C. oralensis* **sp. nov.** and compare the morphology of this species with congeners.

Material, methods and terminology

The juveniles and adults of *C. oralensis* **sp. nov.** used in this study were collected on 21 November 2018 by S. Kaczmarek from the litter of Scots pine (*Pinus sylvestris* L.), about 50–60 years old, which was planted in lines 30–50 m wide, in a steppe of West Kazakhstan (Uralsk surroundings, 51.2753ºN, 52.1322ºE, 40 m a. s. l.). Illustrations were prepared from individuals mounted temporarily on slides in lactic acid, using the open-mount technique (Grandjean 1949). We measured total length (from tip of rostrum to posterior edge of notogaster) and width (widest part of notogaster) of mites, and length of setae and some parts of the body of mites in μm. The illustrations of instars of *C. oralensis* are limited to the body regions of mites that show substantial differences between instars, including the dorsal and lateral aspects and some leg segments of the larva, tritonymph and adult, ventral regions of all instars, and chelicera and palp of the adult. We also investigated leg setae and solenidia, chelicera and palp of *C. foliatus*, which were omitted by Seniczak *et al*. (2011). The latter species originated from cypress litter in Santa Susana (Costa Brava, North-East Spain, 41.3726°N, 2.4324°E, 4 m a. s. l.). In the text and figures, we used the following abbreviations: rostral (*ro*), lamellar (*le*), interlamellar (*in*) and exobothridial (*exs*, *exi*) setae, bothridium (*bo*), bothridial seta (*bs*), notogastral or gastronotal setae (*c*-, *d*-, *e*-, *f*-, *h*-, *p*-series), notogastral or gastronotal plates (*Na*, Nm_1, Nm_2, *Py*), genital (*G*) aggenital (*Ag*), adanal (*Ad*) and anal (*An*) plates, cupules (*ia*, *im*, *ip*, *ih*, *ips*, *iad*), epimeral setae (*1a–c*, *2a*, *2b*, *3a–c*, *4a–d*), adanal and anal setae (*ad-*, *an*-series), subcapitular setae (*a*, m_1, m_2, *h*), cheliceral setae (*cha*, *chb*), palp setae (*sup*, *inf*, *l*, *d*, *cm*, *acm*, *lt*, *vt*, *ul*, *su*) and solenidion ω, leg solenidia (φ, ω), famulus (ε) and setae (*bv*, *ev, d*, *l*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl*, *v*). Terminology used follows that of Grandjean (1931, 1947, 1949, 1953) and Norton and Behan-Pelletier (2009). The species nomenclature follows Subías (2004, 2019).

For scanning electron microscopy (SEM), the mites were air-dried and coated with Au/Pd in a Polaron SC502, sputter coater and placed on Al-stubs with double-sticky carbontape. Observations and micrographs were made with a ZEISS Supra 55VP scanning electron microscope.

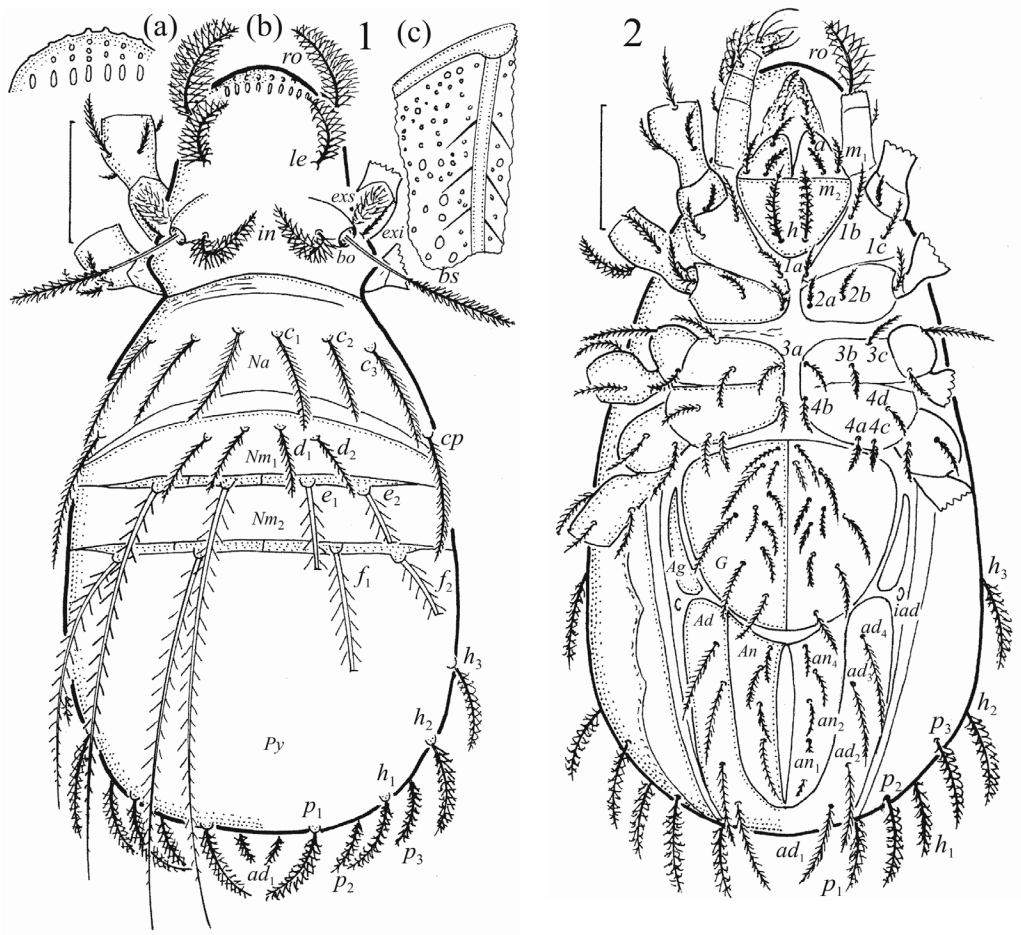
Cosmochthonius oralensis sp.nov.

(Figs. 1–6, 7a, 8–15)

Diagnosis

Adults of medium size (287–323), yellowish-brown, with characters of *Cosmochthonius*. Pygidium with thin cerotegument and microfoveae of irregular size. Setae of *c*-series longer than those of *d*-series. Seta c_1 longer than d_1, erected setae of *e*- and *f*-series with 18–20 pairs and 16–18 pairs of cilia, respectively, setae and basal cilia of both series of similar length. Legs II–IV tridactylous.

Juveniles uncoloured, cuticle more delicate than in adult. Setae of *c*- and *d*-series as in adult, erected setae (*e*- and *f*-series) with 11–15 pairs, and 9–12 pairs of cilia in larva, and 15–18 and 11–14 pairs in tritonymph, respectively. In larva, basal cilia on erected setae of similar length, in tritonymph, basal cilia on setae of *f*-series slightly longer than on setae of *e*-series.



FIGURES 1–2. *Cosmochthonius oralensis*, female, legs partially drawn, scale bars 50 μm. 1. (a) Anterior part of prodorsum, (b) dorsal aspect, (c) anterior part of pygidium; a, c, enlarged. 2. Ventral aspect.

Morphology of adult

Measurements. Body length and width of holotype (305, 155, respectively), length and width (and range) of other females—306.9 (287–323, n= 17), 156.8 (142–172), respectively.

Prodorsum. Rostrum rounded and wide in dorsal and ventral aspects (Figs. 1b, 2), rostral fenestration comprises rounded alveoli in anterior 1–3 rows and elongated alveoli in posterior row (Figs. 1a, 1b). Rostral setae bushy or barbed (Figs. 1b, 2, 3a, 4a–c, 5b, 5c). Five pairs of setae present, including two pairs of exobothridial setae (*exs*, *exi*, Figs. 1b, 3a); all bushy, except for barbed *exi*. Seta *ro* slightly longer than *le*, both curved inwards, seta *in* curved anterior. Mutual distance between insertions of setae *ro* slightly longer than between setae *le* and *in*. Bothridium rounded, protruding above surface, bothridial seta long, with barbed apical half (Figs. 1b, 3a, 4a–c, 5c). Prodorsum yellowish-brown, covered with thin granular cerotegument, some parts with thicker cerotegument (Fig. 6d).

Notogaster. Elongated, egg-shaped, with 16 pairs of setae and three transverse scissures, dividing notogaster into four plates (Figs. 1b, 3a, 4), *Py* longest, Nm_2 shortest. Plate *Na* with four pairs of setae, c_1–c_3 in anterior row and *cp* in posterior row; all of medium size (Table 1) and pinnate; *cp* longest, c_2 shortest. Plate Nm_1 with two pairs of setae (d_1, d_2), shorter than *c*-series and with shorter barbs. Transverse intercalar sclerites present between plates Nm_1 and Nm_2, and Nm_2 and *Py,* each with two pairs of long, hypertrophied and erected setae (*e*- and *f*-series, respectively). Setae of *e*- and

f-series with 18–20 and 16–18 pairs of cilia, respectively, all pinnate, basal cilia of each series of similar length. When not erected, all erectile setae protrude behind anterior part of pygidium. Pygidium with six pairs of bushy setae (*h*-, *p*-series) and irregular microfoveae (Figs. 1c, 4d, 5a). Lyrifissures *ia* and *im* posterolateral to setae c_3 and *cp*, respectively, lyrifissure *ip* posterior to seta p_3, and lyrifissure *iad* lateral to anterior part of adanal plate (Figs. 2, 3a). Other lyrifissures not observed. Notogaster yellowish-brown, covered with thin granular cerotegument. Lateral sides of hysterosoma with denser microfoveae than on pygidium, also observed as small net (Figs. 3b, 5a, 6a, 6b).

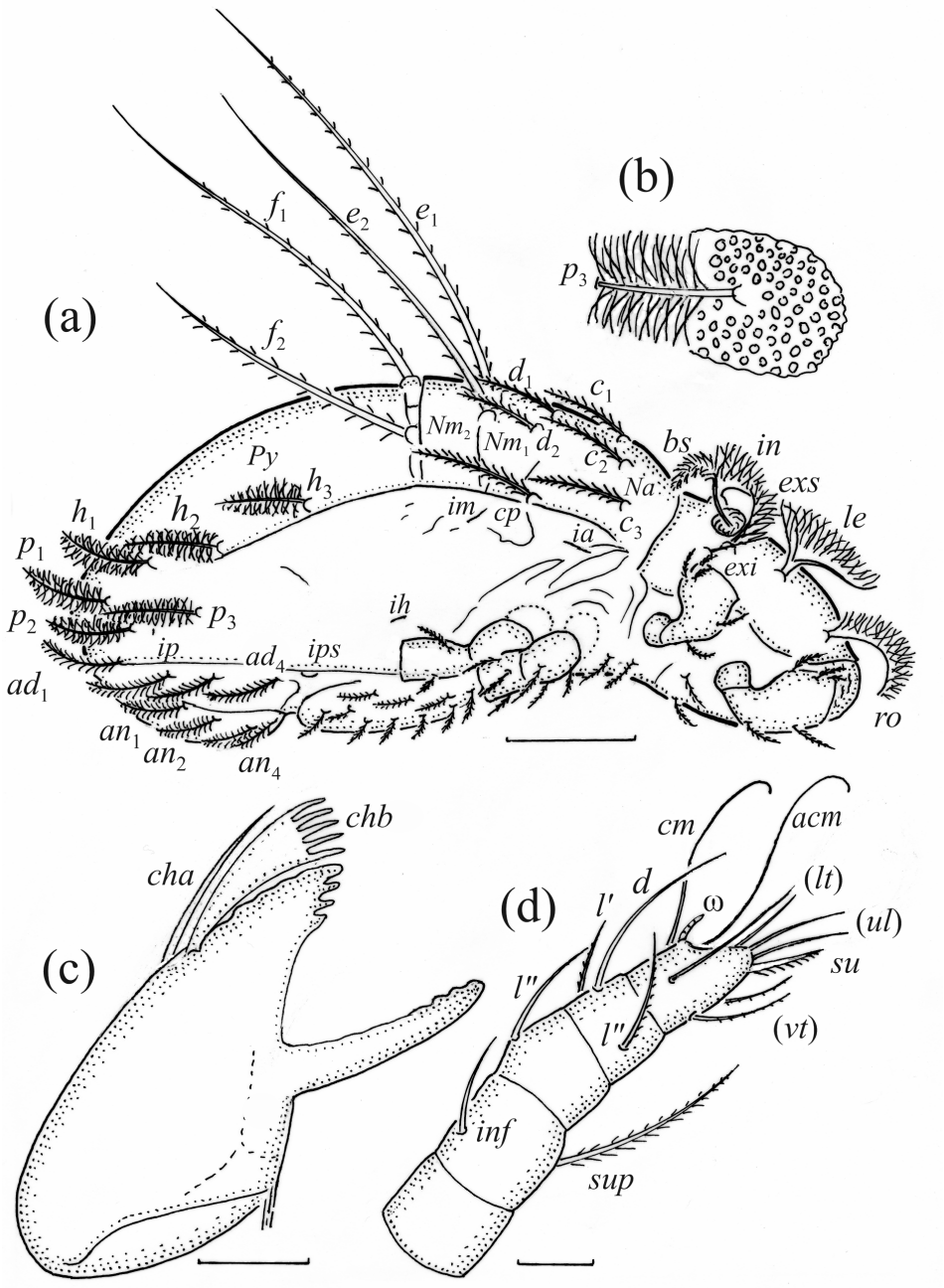


FIGURE 3. *Cosmochthonius oralensis*, female. (a) Lateral aspect, legs partially drawn, scale bar 50 μm; (b) region of seta p_3; mouthparts, right side, scale bars 10 μm; (c) chelicera, (d) palp.

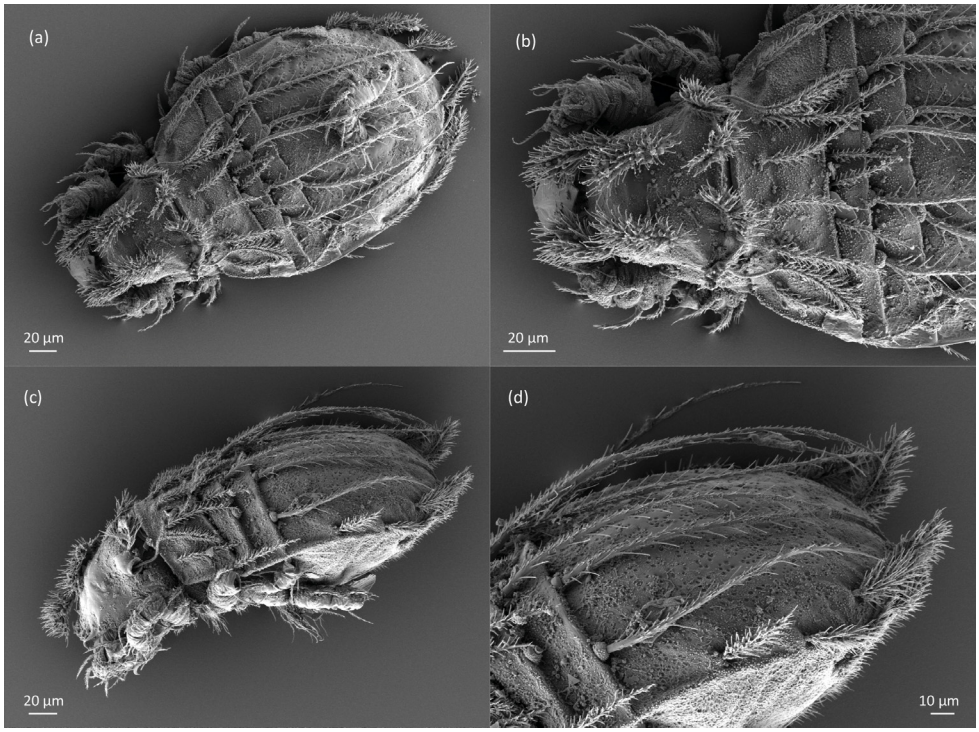


FIGURE 4. *Cosmochthonius oralensis*, adult, SEM micrographs. (a) Dorsal aspect, (b) anterior and medial parts of body, dorsal aspect, (c) dorsolateral aspect, (d) posterior part of body, dorsolateral aspect.

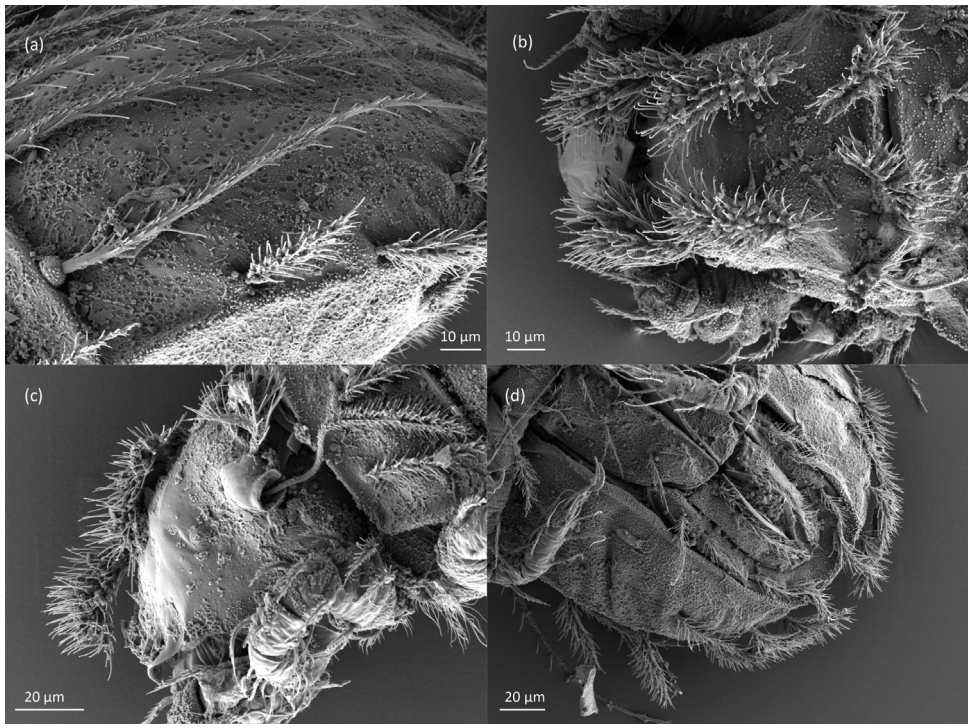


FIGURE 5. *Cosmochthonius oralensis*, adult, SEM micrographs. (a) Part of pygidium, dorsolateral aspect, (b) shape of prodorsal setae, dorsal aspect, (c) shape of bothridium and bothridial seta, dorsolateral aspect, (d) posterior part of body, ventral aspect.

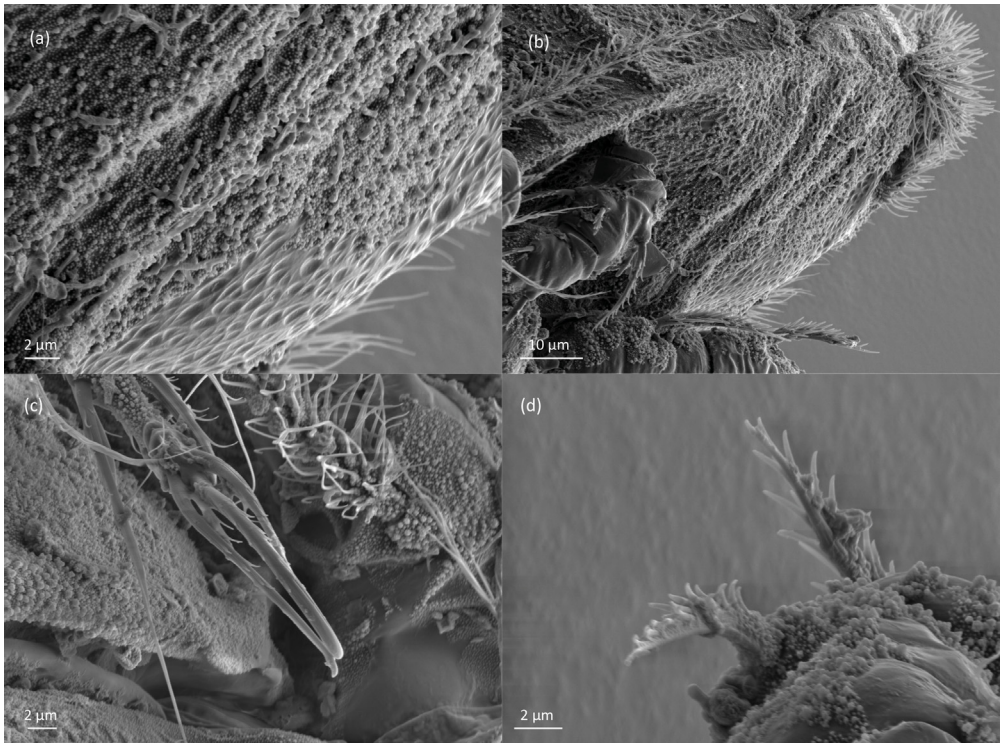


FIGURE 6. *Cosmochthonius oralensis*, adult, SEM micrographs. (a) Posterior part of hysterosoma, dorsolateral aspect, (b) posterior part of hysterosoma, dorsolateral aspect, (c) shape of leg claws, leg II, (d) thick cerotegument in anterior part of body.

Gnathosoma. Subcapitular seta *h* longer (23) than m_1, m_2 and *a* (11), all barbed (Fig. 2). Chelicera (length 47–49, width 21) with two setae of similar length (13), *cha* setiform, *chb* with comb-form distal part (Fig. 3c). Palp (length 60–62) with smooth setae (Fig. 3d), except for barbed *sup*, palpal *eupathidium acm* separated from solenidion ω, eupathidia ul_1 and ul_2 setiform and relative long, *su* shorter and barbed. Formula of palp setae (trochanter to tarsus + solenidion ω): 0-2-1-3-9(1).

Ventral and lateral aspects. All epimeral setae barbed (Fig. 2), formula of epimeral setae 3-2-3-4. Ten pairs of genital setae present of different lengths. Based on appearance of setae in ontogeny, g_1, g_3, g_5 and g_7 longer than other setae (Figs. 2, 7a). Elongated aggenital plate lateral to genital plate, but aggenital seta absent. Anadal and anal plates with four pairs of setae each, all barbed, but setae of *ad*-series longer than of *an*-series; setae of *ad*-series of similar length, but an_1 longer than $an_{2–4}$. Anal plate with short longitudinal lines. Ventral and lateral parts of hysterosoma yellowish-brown and covered with thin granular cerotegument.

Legs. Most leg setae barbed, but dorsal and lateral setae of femora, genua and tibiae with longer barbs than other setae (Fig. 8). Solenidion φ on tibia I long, on large apophysis, directed anterior and pliable, solenidion ω on tarsi I and II shorter and curved anterior, other leg solenidia short; famulus ε on tarsus I relatively long. Solenidion σ on all genua absent, but seta *d* present on all femora, genua and tibiae. Formula of leg setae and solenidia: I—1-5-5-5(1)-20(1); II—1-6-5-5(1)-17(1); III—2-3-4-4(1)-15; IV—2-3-4-4(1)-13. Leg I heterobidactylous, legs II–IV heterotridactylous.

Description of juvenile stages

Larva oval, unpigmented, usually distended in lactic acid. Prodorsum relatively long (Table 1), subtriangular, with rounded, wide rostrum, and with small, fenestrate areas (Fig. 9). Prodorsal setae

ro, *le*, *in* and *exs* with long basal barbs, curved, uniramous, cilia on setae single, except for bifurcate basal cilia of setae *le* and *exs*; seta *exi* distinctly shorter and barbed. Bothridium rounded, bothridial seta long, with narrow, and barbed apical half.

TABLE 1. Measurements of some morphological characters of juvenile stages of *Cosmochthonius oralensis* (mean measurements of 1–10 individuals per instar in μm); Nd—not developed.

Morphological characters	Larva	Protonymph	Deutonymph	Tritonymph	Adult
Body length	163	191	231	284	307
Body width	102	108	118	142	160
Length of prodorsum	54	64	72	79	80
Length of: seta *bs*	46	55	58	61	78
seta *ro*	21	24	26	28	32
seta *le*	20	22	23	26	30
seta *in*	12	15	20	24	29
seta *c*1	19	28	32	38	42
seta *c*2	27	31	33	46	47
seta *c*3	25	27	28	45	47
seta *cp*	23	32	36	47	48
seta *d*1	18	18	20	30	32
seta *d*2	18	18	19	33	40
seta *e*1	65	74	108	121	163
seta *e*2	59	66	84	115	141
seta *f*1	53	72	95	117	144
seta *f*2	38	57	71	83	106
seta *h*1	28	30	33	34	43
seta *h*2	28	31	33	35	42
seta *h*3	19	24	26	34	44
seta *p*1	6	24	26	35	36
seta *p*2	6	24	25	34	36
seta *p*3	6	22	23	34	35
genital opening	Nd	21	32	48	85
anal opening	35	38	40	48	66

Gastronotum of larva with 14 pairs of setae (Figs. 9, 10a, 11a), including inguinal h_4 positioned anterior to paraproctal valves (segment PS). Pygidial plate weakly developed, with three pairs of barbed setae of *h*-series, h_3 shorter than h_1 and h_2. Seta h_1 pinate (with about 7 cilia), other setae of *h*-series barbed. Gastronotum with three transverse scissures, which divide it into four plates. Plate *Na* with four pairs of setae; c_1–c_3 in anterior row, *cp* in posterior row; all long and barbed, c_1 and c_2 reaching anterior board of plate Nm_1, *cp* hardly reaching anterior board of plate Nm_2. Plate Nm_1 with two pairs of setae (d_1, d_2), shorter than of *c*-series and barbed, not reaching anterior intercalary sclerites. Setae of *e*- and of *f*-series hypertrophied, erectile, pinnate, inserted on intercalary sclerites, located between plates Nm_1 and Nm_2, and Nm_2 and pygidium (*Py*), respectively. Setae of *e*- and *f*-series with 13–15 and 9–12 pairs of cilia, respectively, basal cilia of each series of similar length. Paraproctal valves with four pairs of barbed setae, slightly shorter than h_4. Cupule *ia* posterior to seta c_3, cupule *im* posteroventral to seta *cp*, cupule *ip* anterior to seta h_3, cupule *ih* lateral to seta p_4 (Figs.

10a, 11a). Ventral parts of gastronotum weakly striated. Leg setae of larva barbed (Fig. 12). Solenidion φ on tibia I long, solenidion ω on tarsi I and II of medium size, other leg solenidia short, famulus ε on tarsus I relatively long.

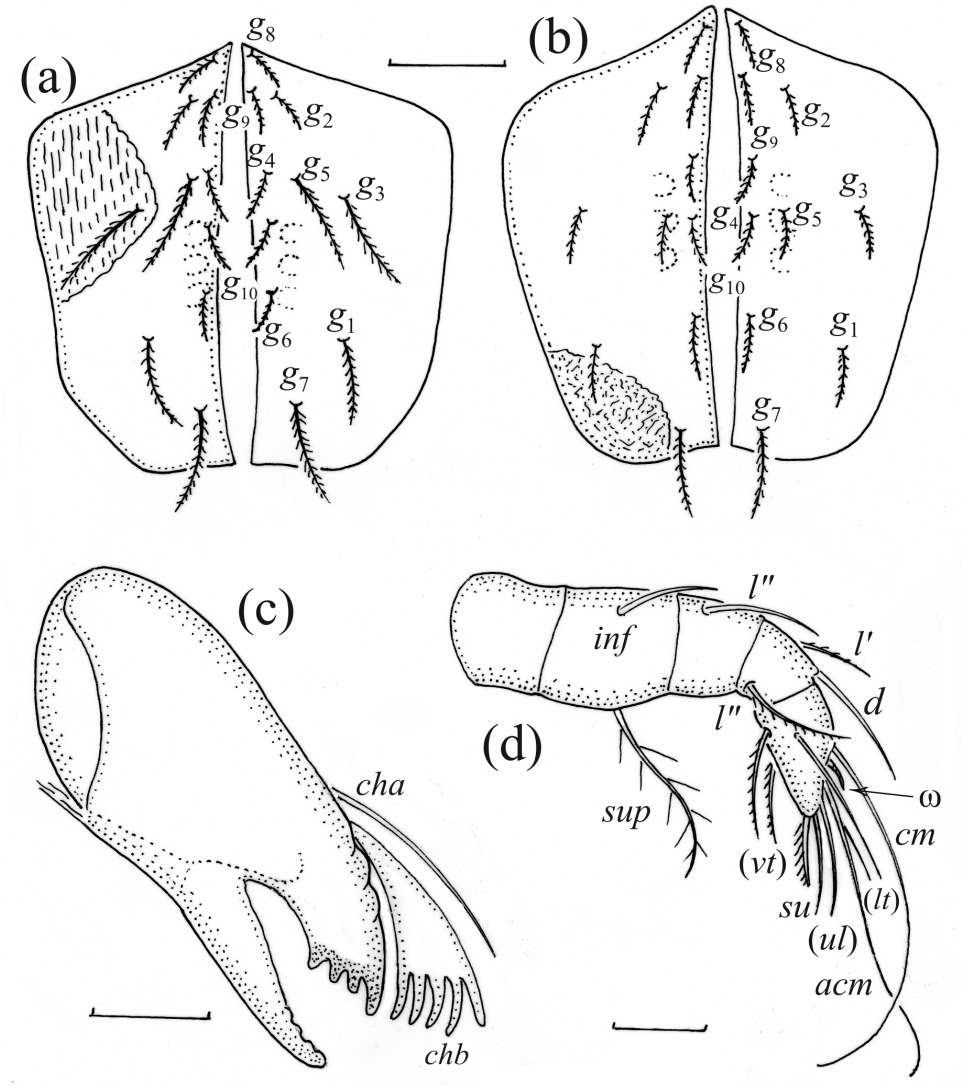


FIGURE 7. Parts of adults. Genital plates, scale bar 20 μm, (a) *Cosmochthonius oralensis*, (b) *C. foliatus*. Mouthparts of *C. foliatus*, right side, scale bars 10 μm, (c) chelicera, (d) palp.

Nymphs more slender than larva, most prodorsal setae bushy, except for barbed *exi*. Bothridium relatively smaller than in larva, but bothridial seta as in larva. Gastronotum of protonymph with 16 pairs of setae due to lost inguinal seta h_4 and p_4, and transfer of three pairs of *p*-series setae from paraproctal valves to gastronotum (Fig. 10b), retained in deutonymph and tritonymph (Figs. 13a, 13b), all of medium size (Table 1), curved and barbed; in protonymph and deutonymph, p_1 and p_2 longer than p_3, in tritonymph all setae of similar length. In all nymphs, three transverse scissures present, which divide gastronotum in four parts. Number and distribution of setae on plates *Na*, Nm_1 and Nm_2 as in larva, but pygidium with six pairs of setae (*h*- and *p*-series); all of medium size and barbed (Table 1). Setae of *c*-series longer than of *d*-series, and barbed, erectile setae of *e*- and *f*-series pinnate. In tritonymph, setae of *e*- and *f*-series with 15–18 and 11–14 pairs of cilia, respectively,

basal cilia on setae of *f*-series slightly longer than on setae of *e*-series (Figs. 11b, 14). Protonymph with one pair of medium sized genital setae, and two pairs of similar setae added in deutonymph, and four pairs in tritonymph (one pair medium sized and three pairs of short setae, Figs. 13a, 13b), all barbed. In deutonymph four pairs of adanal setae present on segment AD, which remain in tritonymph. Paraproctal valves of protonymph (segment AD), deutonymph and tritonymph (segment AN) with four pairs of setae; anal barbed and shorter than adanal setae. Aggenital plate and setae absent. Anogenital region of nymphs with gentle striae. Dorsal and lateral setae on femora and genua I and II with longer barbs than in larva (Fig. 15), but shape of leg solenidia as in adult.

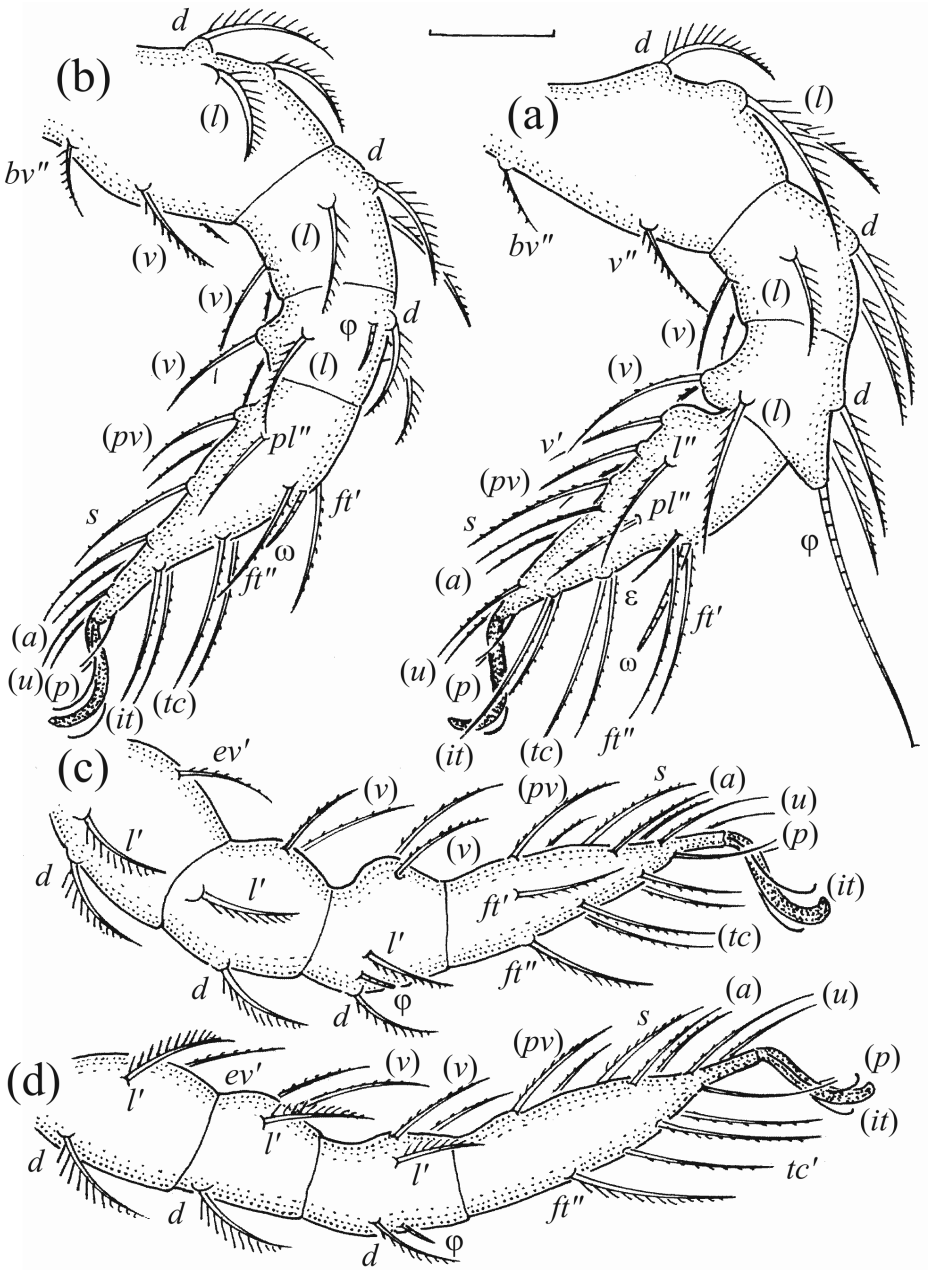
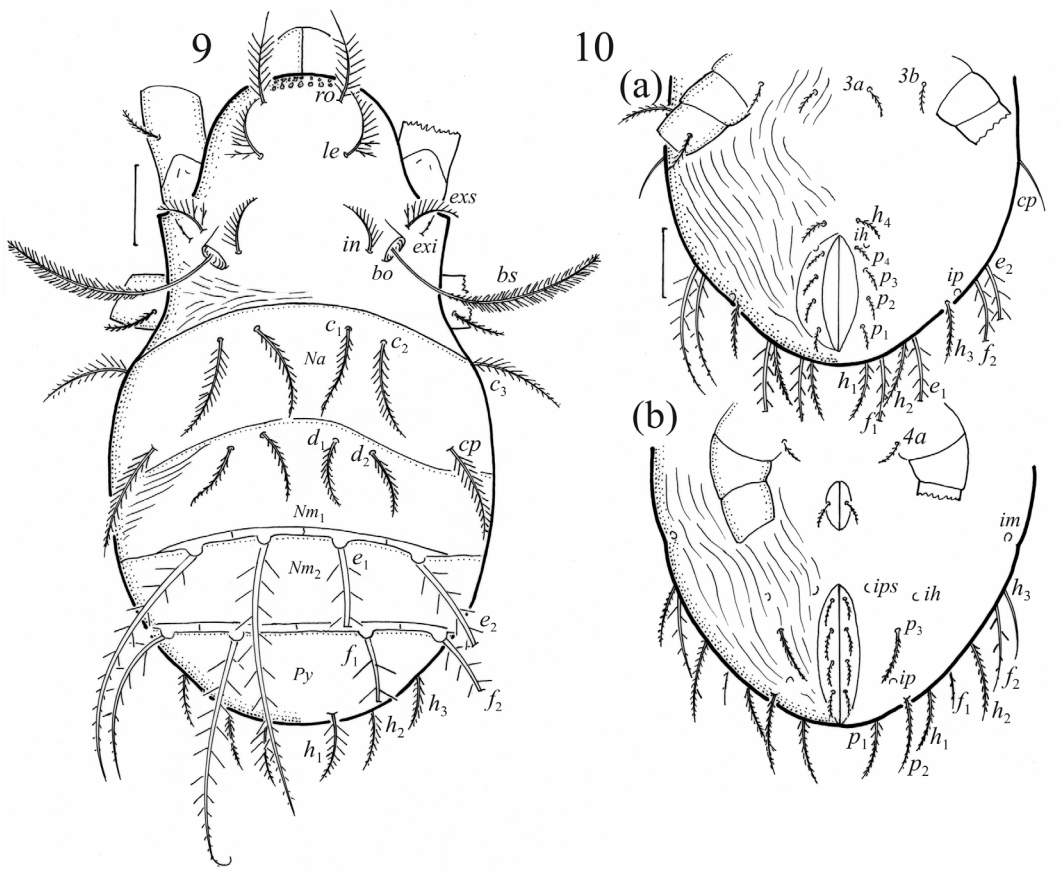


FIGURE 8. *Cosmochthonius oralensis*, leg segments of adult (femur to tarsus), right side, setae on the opposite side are not illustrated, but indicated in the legend, scale bar 20 μm. (a) Leg I, tarsus (*pl′*); (b) leg II, tarsus (*pl′*); (c) leg III; (d) leg IV.



FIGURES 9–10. *Cosmochthonius oralensis*, legs partially drawn, scale bar 50 μm. 9. Larva, dorsal aspect. 10. Ventral part of hysterosoma, (a) Larva, (b) protonymph.

Summary of ontogenetic transformations

The number of prodorsal setae is constant during the ontogeny of *C. oralensis* (5 pairs, including bothridial setae), and the shape of these setae remains similar, but the number of gastronotal setae increases from 14 pairs in the larva to 16 pairs in the nymphs and adult (inguinal h_4 and p_4 lost, p_1–p_3 present). All instars have three transverse scissures on the dorsal part of hysterosoma, and hypertrophied, erectile and pinnate setae of *e*- and *f*-series, which are inserted on transverse intercalary sclerites. Aggenital setae are absent. The formula gastronotal setae is 14-16-16-16-16, whereas the formulae of epimeral, genital, and segments PS–AN are as in *C. ponticus* (Seniczak & Seniczak 2010). The ontogeny of leg setae is given in Table 2.

Distribution, ecology and biology

Cosmochthonius oralensis was found in a dry Scots pine litter in a steppe of West Kazakhstan. In this sample, the density of this species was 46 individuals per 500 cm^3, and the juveniles constituted 67% of the total population. The stage structure of *C. oralensis* was the following: one larva, two protonymphs, 16 deutonymphs, 10 tritonymphs and 17 adults. No gravid female was observed in a sample population.

TABLE 2. Ontogeny of leg setae (Roman letters) and solenidia (Greek letters) in *Cosmochthonius oralensis*.

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	*d*, *bv″*	(*l*), *d*	(*l*), *v′*, *d*, φ	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, (*pv*), (*pl*), ε, ω
Protonymph	*v′*	–	*v′*	*v″*	–
Deutonymph	–	(*l*), *v″*	–	–	–
Tritonymph	–	–	*v″*	–	(*it*)
Adult	–	–	–	–	*l″*, *v′*
Leg II					
Larva	–	*d*, *bv′*	(*l*), *d*	(*l*), *v′*, *d*, φ	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, (*pv*), (*pl*), ω
Protonymph	*v′*	–	*v′*	*v″*	–
Deutonymph	–	(*l*), *v″*	–	–	–
Tritonymph	–	*v′*	*v″*	–	(*it*)
Adult	–	–	–	–	–
Leg III					
Larva	–	*d*, *ev′*	*l′*, *d*	*l′*, *v′*, *d*, φ	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, (*pv*)
Protonymph	*v′*	–	*v′*	–	–
Deutonymph	*l′*	*l′*	*v″*	*v″*	–
Tritonymph	–	–	–	–	(*it*)
Adult	–	–	–	–	–
Leg IV					
Protonymph	–	–	–	*v′*	*ft″*, (*p*), (*u*), (*pv*)
Deutonymph	*v′*	*d*, *ev′*	*d*, *l′*, *v′*	*l′*, *v″*, *d*, φ	*tc′*, (*a*), *s*
Tritonymph	*l′*	*l′*	*v″*	–	(*it*)
Adult	–	–	–	–	–

Note: structures are indicated where they are first added and are present through the rest of ontogeny; pairs of setae in parentheses, dash indicates no additions.

Type material deposition

Holotype female and three paratypes (females) are deposited in the University Museum of Bergen, University of Bergen, Bergen, Norway.

Etymology

The species name follows the Kazakhstanis name Oral (Uralsk), in which surroundings this species was found.

Comparison of morphology of *Cosmochthonius oralensis* with congeners and remarks

Among *Cosmochthonius* species, the largest is *C. foveolatus* Beck, 1962, and smallest is *C. maroccanus* Gil *et al*., 1992, and the body length of most species overlaps (Table 3). In *C. asiaticus* Gordeeva, 1980 and *C. desaussurei* Mahunka, 1982, the pygidium has no distinct pattern, in *C. minifoveolatus* Gil *et al*., 1991, and *C. oralensis* **sp. nov.** it has microfoveae, whereas in other species the pygidium is either foveolate or reticulate. *Cosmochthonius* species also differ one from another by the number and shape of cilia on erected setae, shape of setae of *c*-and *d*-series, and number of genital setae and claws on legs II–IV (Table 3). From this comparison it is evident that *C. oralensis* is similar to *C. minifoveolatus*, but the latter species is smaller than *C. oralensis* and its basal cilia on setae of *f*-series are distinctly longer than those of *e*-series, whereas in *C. oralensis* these cilia are of similar length.

TABLE 3. Selected morphological characters of adults of *Cosmochthonius* species.

Species	Body length	Pattern of pygidium	Pairs of cilia on setae:		Size of erected setae	Basal cilia on erected setae	Length of seta c_1	Pairs of inner genital setae	Claws on legs II–IV
			e-series	*f*-series					
C. agartalensis Sarkar, 1983	310–314	Reticulate	0	0	Similar	No cilia	Longer than d_1	5	3
C. asiaticus Gordeeva, 1980	319	No pattern	8–9	8–9	Similar	Similar	Longer than d_1	?	3
C. assamensis Talukdar & Chakrabarti, 1985	273–281	Reticulate	20–24	6–15	*e*-series	*e*-series	As long as d_1	5	3
C. australicus Womersley, 1945	256	Foveolate	16–17	16–17	Similar	Similar	Longer than d_1	?	3
C. bengalensis Chakrabarti *et al*., 1972	288–290	Reticulate	30–32	25–27	Similar	Similar	Longer than d_1	8	2
C. bhutanensis Chakrabarti & Wilson, 1981	281–283	Foveolate	32–33	24–28	Similar	Similar	Longer than d_1	8	2
C. concavus Aoki, 1994	270	Reticulate	21–26	6–7	Diffrent[4]	Diffrent[5]	Longer than d_1	?	?
C. desaussurei Mahunka, 1982	287	No pattern	21–22	13–23	Similar	Diffrent[6]	As long as d_1	5	?
C. foliatus Subías, 1982[1]	279–325	Reticulate	23–25	22–24	Similar	Similar	Longer than d_1	6	3
C. foveolatus Beck, 1962	320–360	Foveolate	32–33	24–26	Similar	Similar	As long as d_1	6	3
C. imperfectus Aoki, 2000	305–320	Foveolate	11–12	10–11	Similar	Similar	Longer than d_1	6	?
C. lanatus (Michael, 1885)[2]	290–330	Foveolate	19–23	16–18	Similar	Similar	Longer than d_1	6	3
C. lusitanicus Subías & Shtanchaeva, 2012	250–260	Foveolate	24–26	19–20	Similar	Diffrent[7]	Longer than d_1	?	3
C. macrosetosus Ayyildiz & Luxton, 1990	300–310	Foveolate	14–15	11–13	Similar	Similar	Longer than d_1	6	3
C. margaritatus Mahunka & Mahunka-Papp, 2011	297	Reticulate	15–16	14–16	Similar	Similar	As long as d_1	?	3
C. maroccanus Gil *et al*., 1992	255	Punctate	16–19	16–18	Similar	Similar	Longer than d_1	?	3
C. minifoveolatus Gil *et al*., 1991	275	Microfoveolate	16–17	15–18	Similar	Diffrent[7]	Longer than d_1	6	3
C. monegrensis Pérez-Íñigo jr., 1991	284	Foveolate	42	40	Similar	Similar	Longer than d_1	6	3
C. nayoroensis Fujikawa, 1980	294	Foveolate	20–22	12–18	Diffrent[4]	Similar	Longer than d_1	6	3
C. oralensis **sp. nov.**	287-323	Microfovoelate	18–25	16–18	Similar	Similar	Longer than d_1	6	3
C. perezinigoi Morell, 1988	288-312	Foveolate	24–25	20–21	Similar	Diffrent[7]	Longer than d_1	5	3
C. plumatus Berlese, 1910[3]	300	Foveolate	11–12	10–11	Similar	Similar	Longer than d_1	?	3
C. ponticus Gordeeva, 1980	290–300	Foveolate	13–14	10–11	Similar	Similar	Longer than d_1	?	3
C. reticulatus Grandjean, 1947	290–300	Reticulate	12–13	10–11	Similar	Similar	Longer than d_1	6	3
C. semiareolatus Hammer, 1966	285	Foveolate	Many[4]	Many[4]	Similar	Similar	Longer than d_1	?	?
C. semifoveolatus Subías, 1982	260–305	Foveolate	0–24	0–14	Similar	Similar	Longer than d_1	?	?
C. signatus Pérez-Íñigo jr., 1989	264–280	Foveolate	20–21	14–15	Similar	Similar	Longer than d_1	5	3
C. spinosus Gil *et al*., 1991	252–299	Foveolate	22–26	18–22	Similar	Similar	As long as d_1	6	3
C. sublanatus Mahunka, 1977	273–294	Reticulate	26–27	11–12	Diffrent[4]	Diffrent[5]	Longer than d_1	6	3
C. taurus Niemi *et al*, 2002	351	Reticulate	26–28	16–18	Similar	Diffrent[5]	Longer than d_1	5	3
C. tenuisetus Gordeeva, 1980	245	Foveolate	6–7	5–6	Similar	Similar	Shorter than d_1	?	3
C. ugamaensis Gordeeva, 1980	290–304	Alveolate	16–18	13–14	Similar	Diffrent[5]	Longer than d_1	6	3
C. zanini Penttinen & Gordeeva, 2003	277–293	Reticulate	15–17	9–10	Similar	Similar	Longer than d_1	6	3

[1]supplemented with Gil-Martín *et al*. (1992), [2]supplemented with Ayyildiz and Luxton (1990), [3]supplemented with Weigmann (2006), [4]difficult to count, [4]longer *e*-series, [5]longer *e*-series, [6]longer f_1, [7]longer *f*-series.

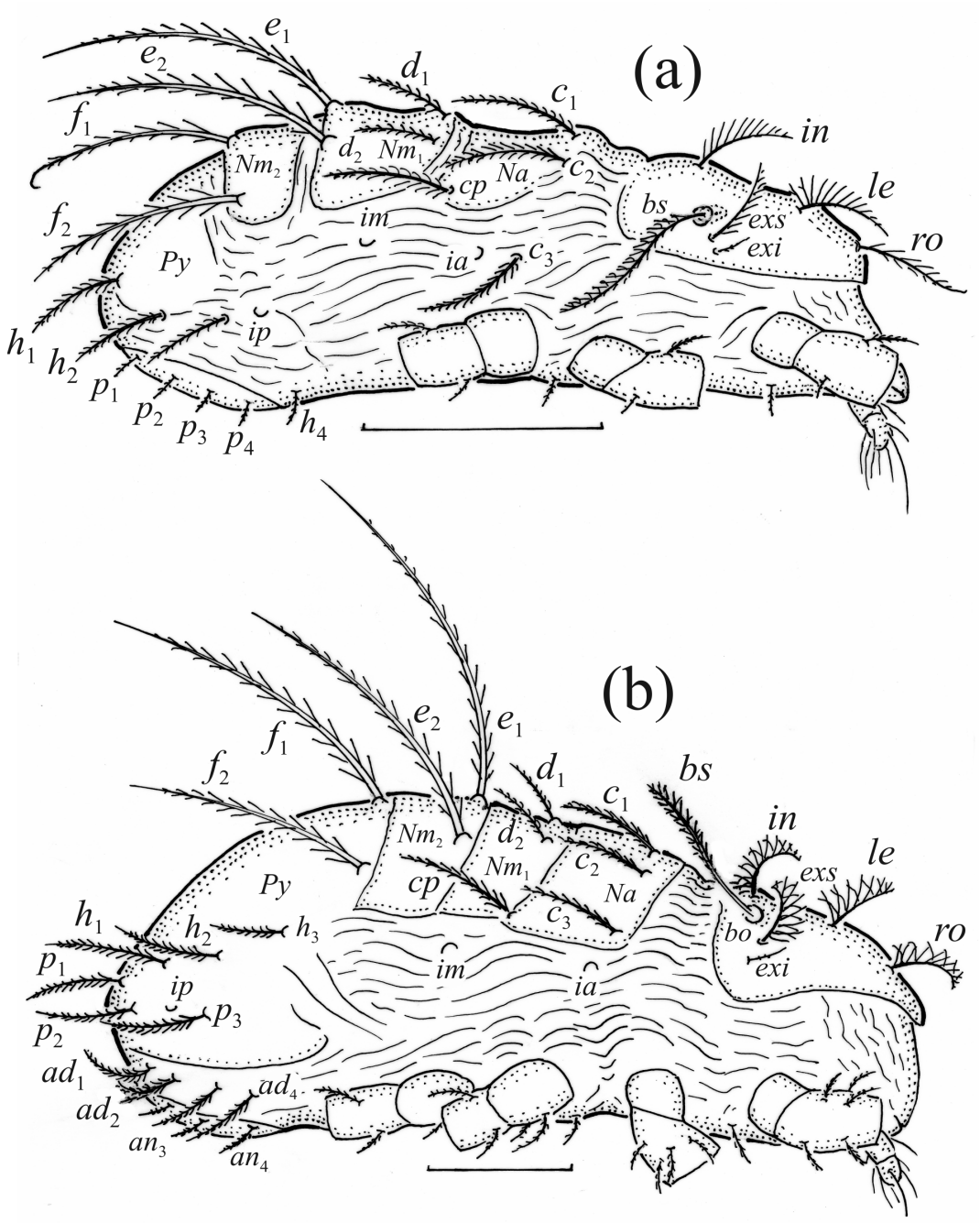


FIGURE 11. *Cosmochthonius oralensis*, lateral aspect, legs partially drawn, scale bars 50 μm. (a) Larva, (b) tritonymph.

Seniczak *et al*. (2011) compared the juveniles of *C. foliatus*, *C. reticulatus*, *C. ponticus* and *C. ugamaensis*, and it is possible to find some differences between these species and *C. oralensis*. In the larva of *C. oralensis*, the number of pairs of cilia on erected setae of *e*- and *f*-series is similar to that of *C. foliatus*, whereas *C. reticulatus* has fewer cilia and *C. ponticus* and *C. ugamaensis* have more cilia than *C. oralensis*. In *C. oralensis*, the basal cilia on setae f_1 and e_1 are of similar length, as in *C.*

foliatus, whereas in *C. reticulatus*, *C. ponticus* and *C. ugamaensis* the basal cilia on seta e_1 are longer than on seta f_1. In *C. oralensis*, seta h_1 is pinnate, as in *C. foliatus*, *C. reticulatus* and *C. ugamaensis*, whereas in *C. ponticus* has this seta is bushy. In *C. oralensis*, the number of cilia on seta h_1 is similar to that of *C. foliatus* and *C. ugamaensis*, whereas *C. reticulatus* has fewer cilia and *C. ugamaensis* has more cilia than *C. oralensis*. *Cosmochthonius oralensis* also differs from other species by the shape of setae of *d*- and *h*-series and p_1.

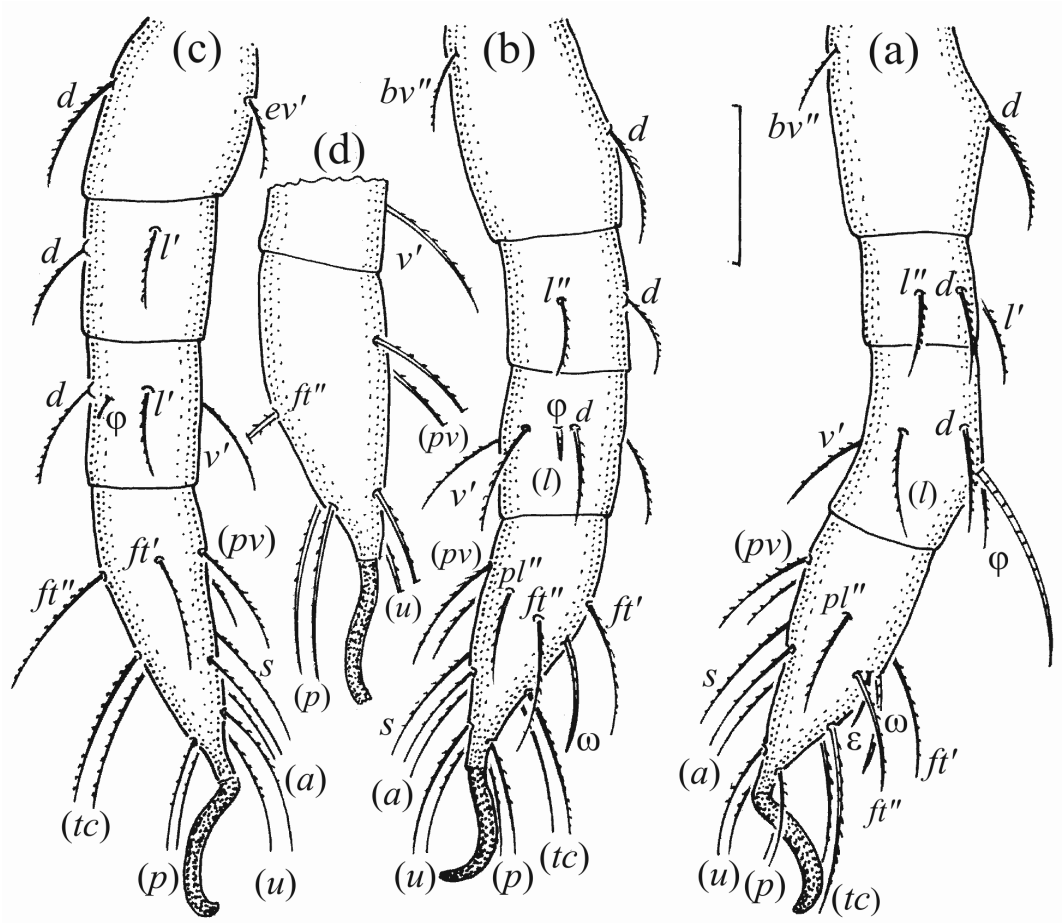


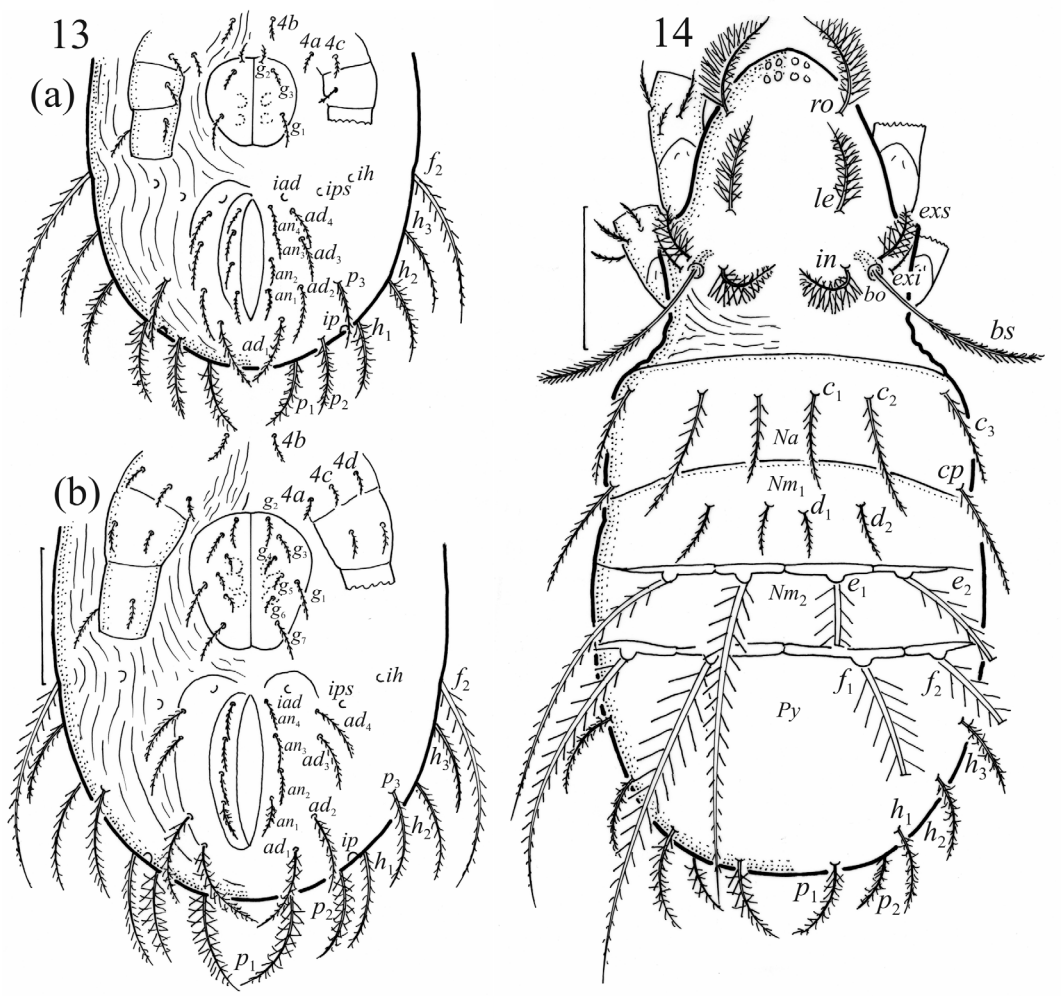
FIGURE 12. *Cosmochthonius oralensis*, leg segments. Larva (femur to tarsus), right side, setae on the opposite side are not illustrated, but indicated in the legend, scale bar 20 μm. (a) Leg I, tarsus (*pl′*); (b) leg II, genu (*l′*), tarsus (*pl′*); (c) leg III, (d) part of tibia and tarsus of protonymph.

In the nymphs of *C. oralensis*, the number of pairs of cilia on erected setae of *e*- and *f*-series is similar to that of *C. ugamaensis*, whereas *C. foliatus* and *C. ugamaensis* have more cilia, and *C. ponticus* has fewer cilia than *C. oralensis.* In *C. oralensis*, the basal cilia on setae of *e*- and *f*-series are of similar length, as in *C. foliatus*, whereas in other species the basal cilia on seta e_1 are longer than on seta f_1. From these comparisons it is evident that the juveniles of *C. oralensis* differ from other species mainly by the number and shape of cilia on erected setae. In the nymphs, the shape of setae of *d*- and *h*-series and p_1 is also important.

The chelicerae of *C. oralensis* and *C. foliatus* are typical of *Cosmochthonius*, by having two setae of different shape, *cha* setiform and *chb* with comb-form distal part (Grandjean 1947; Beck 1962; Lee 1982). In both species, seta *cha* is smooth, but in *C. foliatus* the combs of seta *chb* are

slightly longer (Fig. 7c) than in *C. oralensis* (Fig. 3c). In *C. australicus* Womersley, 1945, seta *cha* (Lee 1982) is smooth as in *C. oralensis* and *C. foliatus*, whereas in *C. reticulatus* and *C. domesticus* Grandjean, 1947 [= *C. lanatus* (Michael 1885)], *C. foveolatus* Beck, 1962 and *C. nayoroensis* Fujikawa, 1980 this seta is barbed. Grandjean (1947) used the shape of chelicera to separate *C. reticulatus* from *C. domesticus.*

The number and location of palp setae of *C. oralensis* are similar as in *C. foliatus*, but the shape of some setae differs, especially *sup*. In the former species, this seta is barbed (Fig. 3d), whereas in the later species it has rare and long cilia (Fig. 7d). In both species, two long setae are observed on the palpal tarsus, probably *cm* and *acm*, as in *C. foveolatus* (see Beck 1962) and *C. australicus* (see Lee 1982), but the former author noted 10 palpal setae, whereas the latter author illustrated nine setae, as in *C. oralensis* and *C. foliatus*. However, it is difficult to discuss the differences in the number and shape of palp setae because the notation of these setae by Beck (1962) and Lee (1982) differs from that of *C. oralensis* and *C. foliatus.*



FIGURES 13–14. *Cosmochthonius oralensis*, legs partially drawn, scale bars 50 μm. 13. Ventral part of hysterosoma, (a) deutonymph, (b) tritonymph. 14. Tritonymph, dorsal aspect.

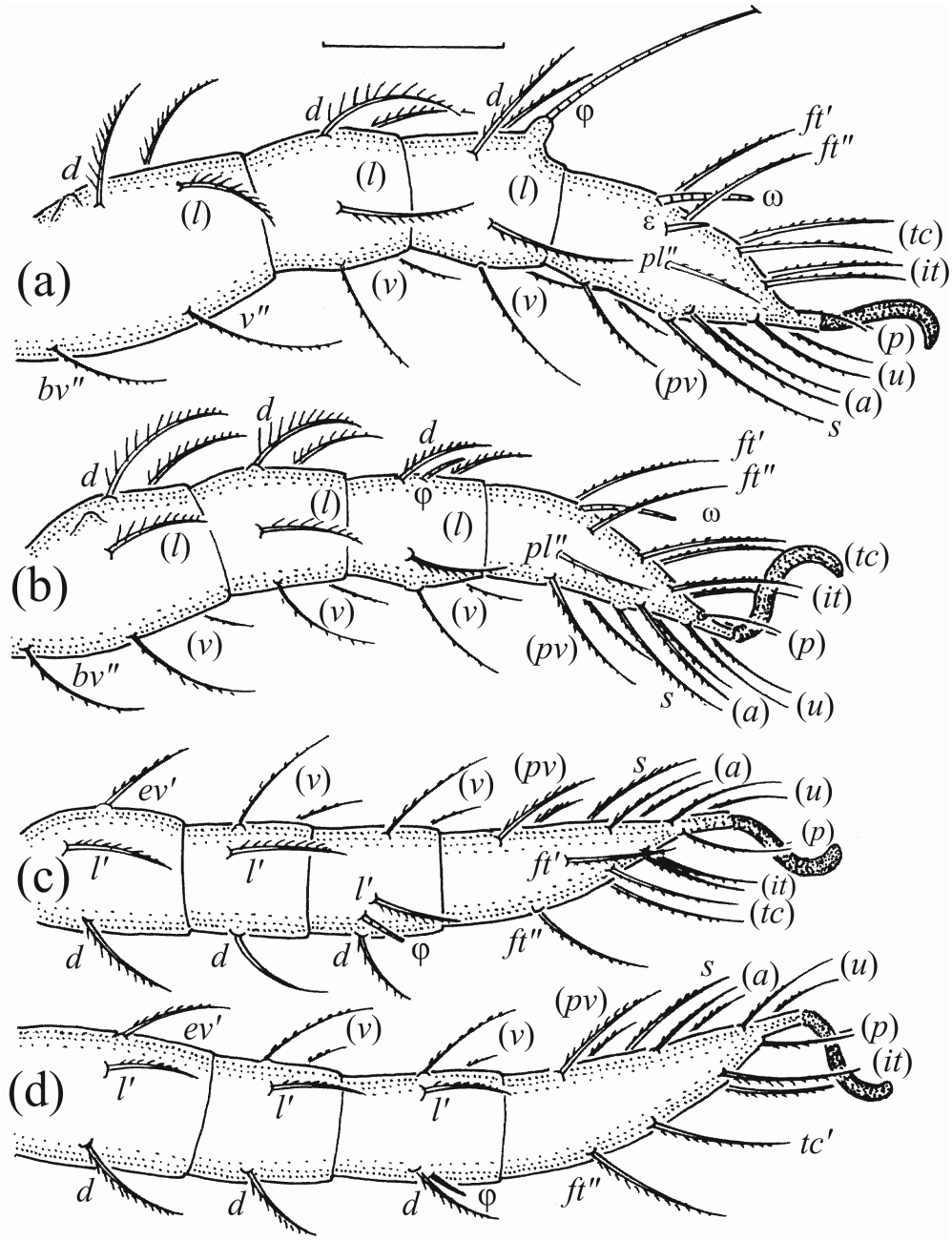


FIGURE 15. *Cosmochthonius oralensis*, leg segments of tritonymph (femur to tarsus), right side, setae on the opposite side are not illustrated, but indicated in the legend, scale bar 20 μm. (a) Leg I, tarsus (*pl′*); (b) leg II, tarsus (*pl′*); (c) leg III; (d) leg IV.

The ontogeny of leg setae and solenidia of *C. oralensis* is similar to that of *C. foliatus*. In both species, most leg setae are added in the protonymph and deutonymph, and solenidion σ is absent from genua I–III. The distribution of leg setae and solenidia in the adult of *C. foliatus* (Fig. 16) is similar to that of *C. oralensis* (Fig. 8), but the shape of some setae differs. In *C. foliatus*, the dorsal and lateral setae on femora and genua I–IV are bushy or have longer barbs than in *C. oralensis*, and a thick layer of cerotegument is present between some setae, which is absent in *C. oralensis*. In the tritonymph of *C. foliatus* (Fig. 17), the dorsal and lateral setae on femora and genua I–IV are slightly

shorter than in the adult, and a thick layer of cerotegument is absent. In the adults of most other species of *Cosmochthonius*, only the number of leg claws is known, whereas the formulae of setae and solenidia is known in *C. nayoroensis*, *C. taurus* and *C. zanini* (Fujikawa 1980; Niemi *et al*. 2002; Penttinen & Gordeeva 2003), and formulae of legs I–III in *C. australicus* (Lee 1982). In all species, the number of leg setae is similar to that of *C. oralensis* and *C. foliatus*, except for tarsus IV (two latter species has one seta less than other species), and tarsus I of *C. nayoroensis* (it has one seta less than *C. oralensis* and *C. foliatus*). All these data indicate that hat the shape of chelicera, palp and leg setae of *Cosmochthonius* can be diagnostic and needs more investigation.

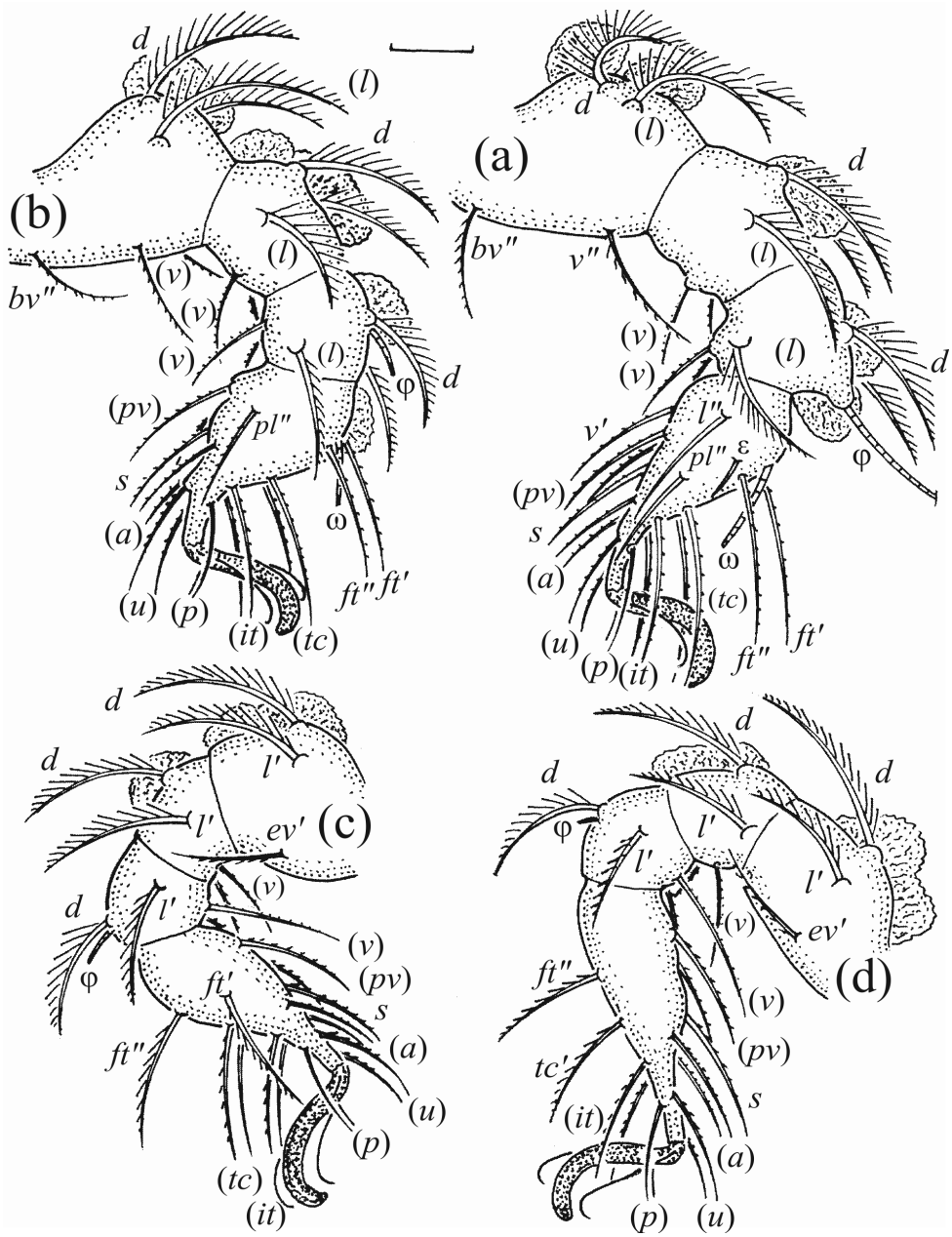


FIGURE 16. *Cosmochthonius foliatus*, leg segments of adult (femur to tarsus), right side, setae on the opposite side are not illustrated, but indicated in the legend, scale bar 20 μm. (a) Leg I, tarsus (*pl′*); (b) leg II, tarsus (*pl′*); (c) leg III; (d) leg IV.

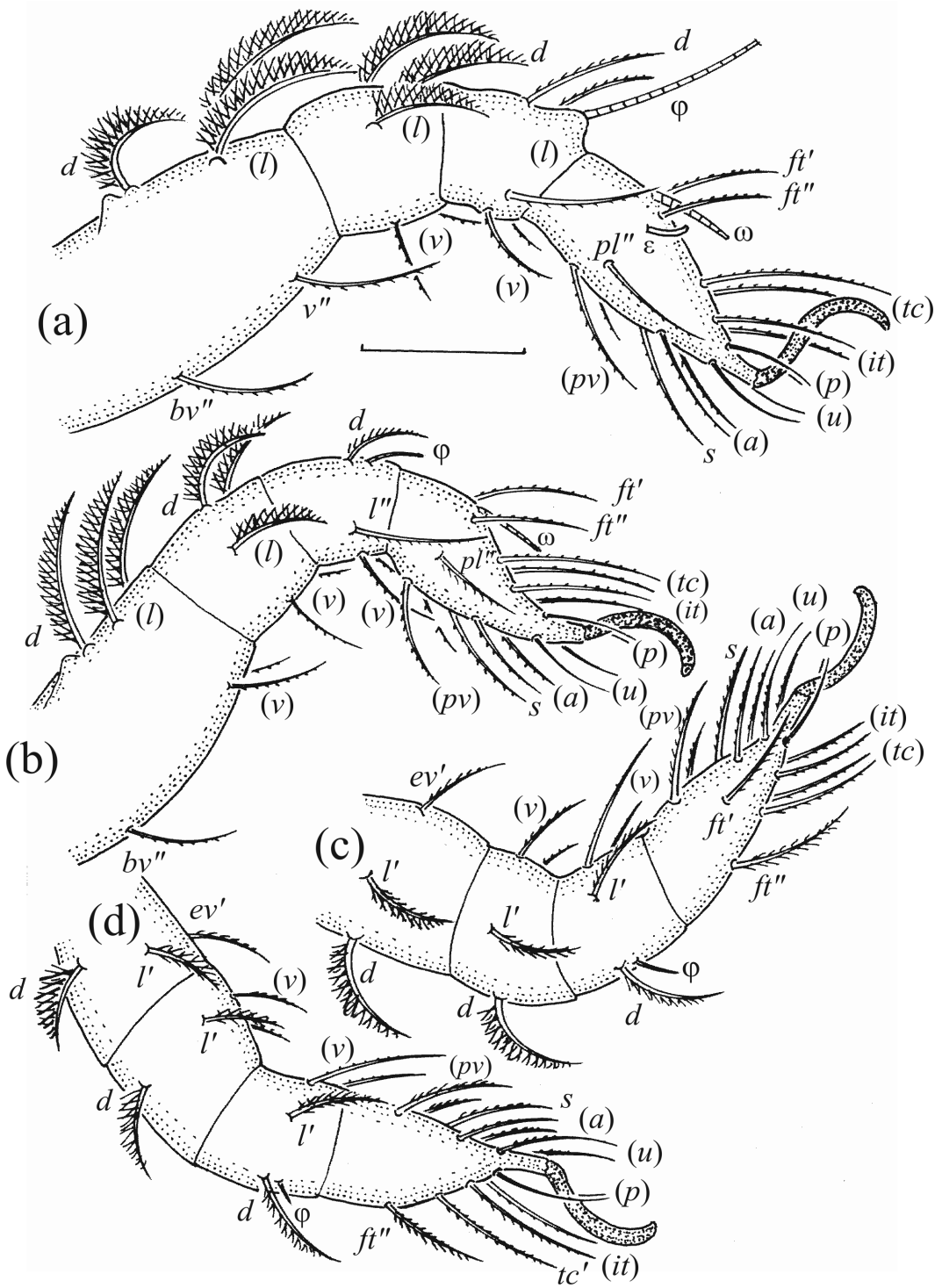


FIGURE 17. *Cosmochthonius foliatus*, leg segments of tritonymph (femur to tarsus), right side, setae on the opposite side are not illustrated, but indicated in the legend, scale bar 20 μm. (a) Leg I, tarsus (*pl′*); (b) leg II (tibia *l′*), tarsus (*pl′*); (c) leg III; (d) leg IV.

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