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Morphological ontogeny of *Limnozetes schatzi* sp. nov. (Acari: Oribatida: Limnozetidae) from Norway

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Abstract

The morphological ontogeny of *Limnozetes schatzi* **sp. nov.** from Norway is described and illustrated. The adult of this species is the most similar to that of *L. rugosus* (Sellnick, 1925), but differs from it mainly by the body shape (it is stockier in dorsal aspect and less convex in lateral aspect than *L. rugosus*), longer prodorsal seta *in* and notogastral setae, lack of seta c_3, which in some individuals of *L. rugosus* is present, and sculpture of notogaster. Moreover, in *L. schatzi* seta *l′* on femur III is absent, but in *L. rugosus* it is present. Seta *d* on femora I–III and seta *l′* on femora I and II have relatively long barbs, covered often with debris. The juveniles of *L. schatzi* have all gastronotal setae short, whereas the latter species has some setae longer (*lm* and *lp* in larva, *lp* in nymphs).

Key words: oribatid mites, juveniles, leg setation, ecology, stage structure

Introduction

Limnozetes Hull, 1916 is a medium size genus, which comprises 15 species (Subías 2004, unpublished electronic update 2021). Behan-Pelletier (1989) gave the diagnosis of this genus, for which the main diagnostic characters of the adults are: well-developed pteromorph, presence of dorsal expansion of bothridium, well-developed tutorium and genal tooth, weakly developed bothridial seta, lack of lenticulus and one or two setae *a* on leg tarsi, and presence of very long and curved seta *d* on femora I–III. By contrast, the juveniles of *Limnozetes* have long bothridial seta, but the gastronotum can be either rounded, with plicate cuticle and short, thin setae or elongated and boat-shape, with slightly folded cuticle and blade-like marginal setae. In juveniles, seta *d* on femora I–III is short, and not displaced proximally. Based mainly on the morphology of juveniles of nine species of *Limnozetes* from North America and Europe, Seniczak and Seniczak (2009a) divided *Limnozetes* species in '*rugosus* group', with stocky juveniles, plicate cuticle, and short and thin gastronotal setae, and '*ciliatus* group', with boat-shaped juveniles, slightly folded cuticle and blade-like marginal setae on the gastronotum. Seniczak and Seniczak (2020) added to this characteristics setae *d* and *l′* on genu IV of deutonymph, tritonymph and adult, which in '*rugosus* group' are absent, but in '*ciliatus* group' are present.

The morphological ontogeny of *Limnozetes* species is insufficiently known. According to the catalogue of juvenile oribatid mites by Norton and Ermilov (2014) and paper by Seniczak and Seniczak (2020), the full morphological ontogeny of five species of this genus is known, which constitute 33% of all species of *Limnozetes*. The species are: *L. ciliatus* (Schrank, 1803), *L. lustrum* Behan-Pelletier, 1989, *L. foveolatus* Willmann, 1939 (= *L. palmerae* Behan-Pelletier, 1989), *L. rugosus* (Sellnick, 1925) and *L. solhoyorum* A. et S. Seniczak, 2020. The morphological ontogeny

of *L. amnicus* Behan-Pelletier, 1989, *L. borealis* Behan-Pelletier, 1989, *L. feuerborni* Willmann, 1932, *L. guyi* Behan-Pelletier, 1989, *L. latilamellatus* Behan-Pelletier, 1989 and *L. onondaga* Behan-Pelletier, 1989 is only partially known.

While working on the oribatid fauna from bog in Høstedmyra (Trøndelag, Central Norway) we found in a small hollow filled with water and *Sphagnum compactum* Lam. & DC an abundant undescribed *Limnozetes* species from the '*rugosus* group', with stocky juveniles, plicate cuticle, and all developmental stages.

The aim of this paper is to describe and illustrate the morphological ontogeny of this species, as *Limnozetes schatzi* **sp. nov**.

Materials and methods

The juveniles and adults of *L. schatzi* **sp. nov.** were collected by the senior author on 30th June 2020 from a hollow with *Sphagnum compactum* in Høstedmyra (63.405387N, 10.120403E, 107 m a. s. l., Trøndelag, Central Norway). The sample of *Sphagnum* had volume of 500 cm^3 and was extracted with Berlese funnel for 14 days. The illustrations of instars are limited to the body regions of mites that show substantial differences between instars, including the dorsal and lateral aspects of the larva, tritonymph and adult, ventral regions of all instars and some leg segments of the adult and tritonymph. The chelicera and palp of the adult are also illustrated. We measured the total length (from tip of rostrum to posterior edge of notogaster) and width (widest part of notogaster without pteromorphs), and length of setae and some parts of the body of mites in μm. Illustrations were prepared from individuals mounted temporarily on slides in lactic acid. In the text and figures, we used the following abbreviations: rostral (*ro*), lamellar (*le*), interlamellar (*in*) and exobothridial (*ex*) setae, lamella (*La*), bothridium (*bo*), bothridial seta (*bs*), notogastral or gastronotal setae (*c*-, *d*-, *l*-, *h*-, *p*-series), lyrifissures or cupules (*ia*, *im*, *ip*, *ih*, *ips*, *iad*), opisthonotal gland opening (*gla*), subcapitular setae (*a*, *m*, *h*), cheliceral setae (*cha*, *chb*) and Trägårdh organ (*Tg*), palp setae (*sup*, *inf*, *l*, *d*, *cm*, *acm*, *lt*, *vt*, *ul*, *su*) and solenidion ω, pedotectum 1 (*Pd1*), tutorium (*Tut*), genal tooth (*gt*), discidium (*Dis*), epimeral setae (*1a–c*, *2a*, *3a–b*, *4a–b*), adanal and anal setae (*ad*-, *an*-series), aggenital seta (*ag*), leg solenidia (σ, φ, ω), famulus (ε) and setae (*bv*, *ev, d*, *l*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl*, *v*). The terminology used follows that of Grandjean (1951, 1953) and Norton and Behan-Pelletier (2009). The species nomenclature follows Subías (2004, unpublished electronic update 2021).

For scanning electron microscopy (SEM), mites were fixed in 90% ethanol and placed on Al-stubs with a double-sticky carbon tape and coated with Au/Pd in a Polaron SC502 Sputter coater. Observations and micrographs were made with a ZEISS Supra 55VP scanning electron microscope.

Limnozetes schatzi sp. nov.

(Figs. 1–17)

Diagnosis

Adults of medium size (332–377), with characters of '*rugosus* group' of *Limnozetes*. Lamella narrow, with well developed cusp, translamella incomplete. Seta *in* not reaching incomplete translamella, bothridial seta short, setiform, barbed. Notogaster convex (body length to height ratio 1.9:1), with elongated and rounded microtubercles, short and thin setae, length to width ratio of notogaster and length to width ratio of pteromorph 1.2:1 and 1.4:1, respectively. Genal tooth triangular, acuminate, with more sharpened distal part than in *L. solhoyorum*. Seta *d* on femora I–III and seta *l′* on femora I and II with relatively long barbs, covered often with debris. Seta *l′* on femur III absent.

Juveniles with plicate cuticle, and other characters of '*rugosus* group' of *Limnozetes*. Prodorsal setae *le* and *in* and bothridial seta long and thin, gastronotal setae short and thin. In tritonymph, seta *l″* on femora I and II, *l′* on femur III absent.

Adult. Measurements: body length (and range): females 348.4±12.1 (332–377, n= 50) and width 215.5±9.3 (202–234), males absent.

TABLE 1. Measurements of some morphological characters of juvenile and adult stages of *Limnozetes schatzi* **sp. nov.** (mean measurements of 3–10 individuals in μm); Nd: not developed.

Morphological character	Larva	Protonymph	Deutonymph	Tritonymph	Adult
Body length	191	241	277	330	353
Body width	117	131	158	231	240
Length of prodorsum	55	67	71	82	63
Length of: seta *ro*	19	21	23	25	31
seta *le*	28	41	44	47	46
seta *in*	25	27	28	30	48
seta *bs*	36	31	33	36	11
seta c_1	3	3	3	3	Lost
seta c_2	3	3	4	5	14
seta c_3	3	3	4	5	Lost
seta *da*	3	3	4	5	Lost
seta *dp*	3	3	4	5	Lost
seta *la*	3	3	4	5	16
seta *lm*	3	3	4	5	18
seta *lp*	3	3	4	5	17
seta h_1	4	3	4	5	16
seta h_3	1	3	4	5	17
seta p_1	Nd	3	4	5	15
genital opening	Nd	19	32	44	50
anal opening	57	65	78	90	82

Prodorsum. Rostrum dorsally rounded, but with two indentations in frontal aspect, lamella long, translamella incomplete, lamellar cusp of medium size (16), rounded, with lamellar seta of medium size (Figs. 1a, 2, 3a, 4, 5, Table 1). Setae *le* and *in* longer (45–48) than *ro* (30–32), and *in* thinner than *le* and *ro*, seta *ex* short; *in* with short barbs, other setae smooth. Seta *ro* inserted on lateral part of rostrum, seta *in* inserted close to inner border of lamella and anterior border of notogaster. Bothridium rounded, with well developed dorsal expansion (Figs. 1a, 3a, 6a, 6b), bothridial seta short (11–12), setiform, barbed. Medial and posterior parts of prodorsum irregularly tuberculate (Figs. 5b, 5c).

Notogaster. Convex (body length to height ratio 1.9:1), length to width of notogaster (Figs. 1a, 4a) and length to width of pteromorph (Figs. 3a, 4c) is 1.2:1 and 1.4:1, respectively. Ten pairs of notogastral setae present, including c_2, all thin and short (Figs. 1a, 3a, 4, 5b, 5c, 6c, Table 1), seta h_3 inserted closer to h_2 than to *lp*. Notogaster with elongated and rounded microtubercles (Figs. 1a, 5b, 5c, 6c). Lyrifissures *ia* and *im* posterolateral to seta c_2 and posterior to seta *la*, respectively, *ip* anterolateral to seta h_1, *ips* and *ih* anterolateral and medial to seta p_3, respectively, and *iad* anteromedial to seta ad_3 (Figs. 1a, 2, 3a).

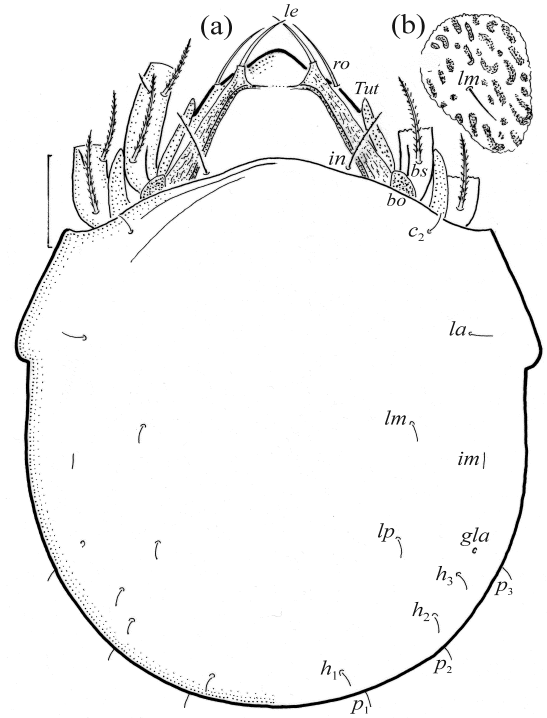

FIGURE 1. *Limnozetes schatzi* **sp. nov.**, female. (a) Dorsal aspect, legs partially drawn, scale bar 50 μm, (b) region of setae *lm* (enlarged).

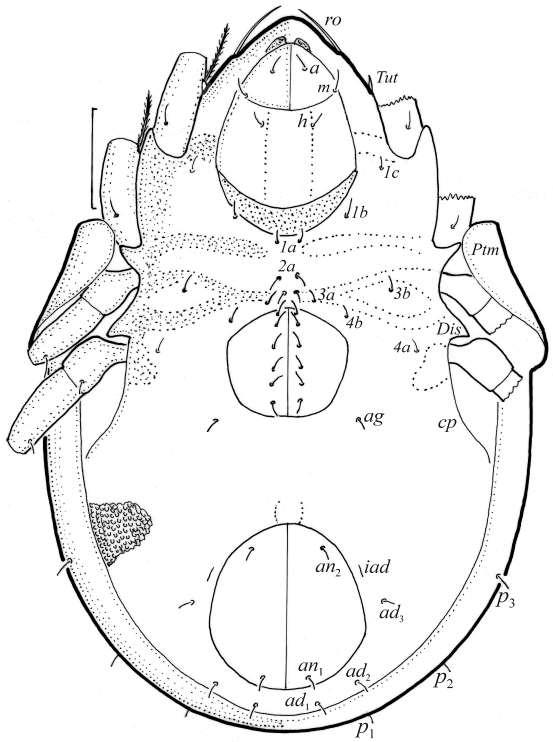

FIGURE 2. *Limnozetes schatzi* **sp. nov.**, female, ventral aspect, legs partially drawn, scale bar 50 μm.

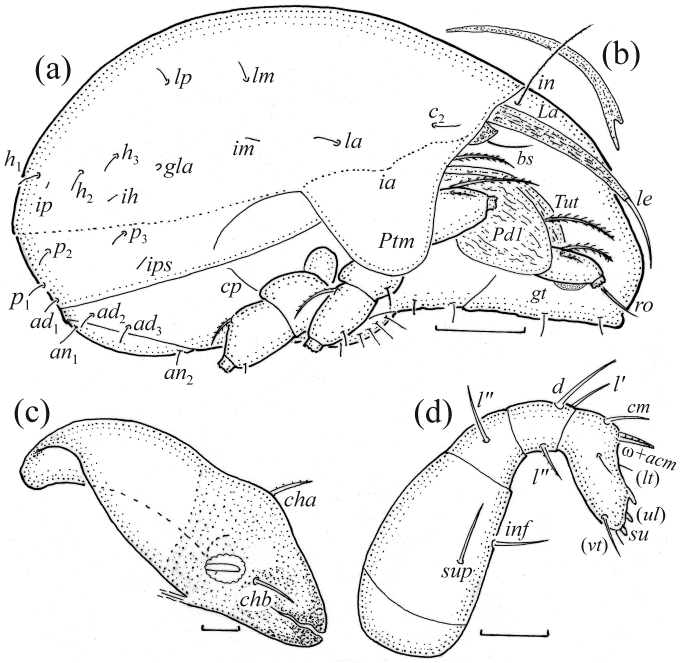

FIGURE 3. *Limnozetes schatzi* **sp. nov.**, female. (a) Lateral aspect, legs partially drawn, scale bar 50 µm, (b) tutorium (enlarged); mouthparts, right side, antiaxial aspect, scale bars 10 µm, (c) chelicera (Trägårdh organ indicated in 'transparent' area), (d) palp.

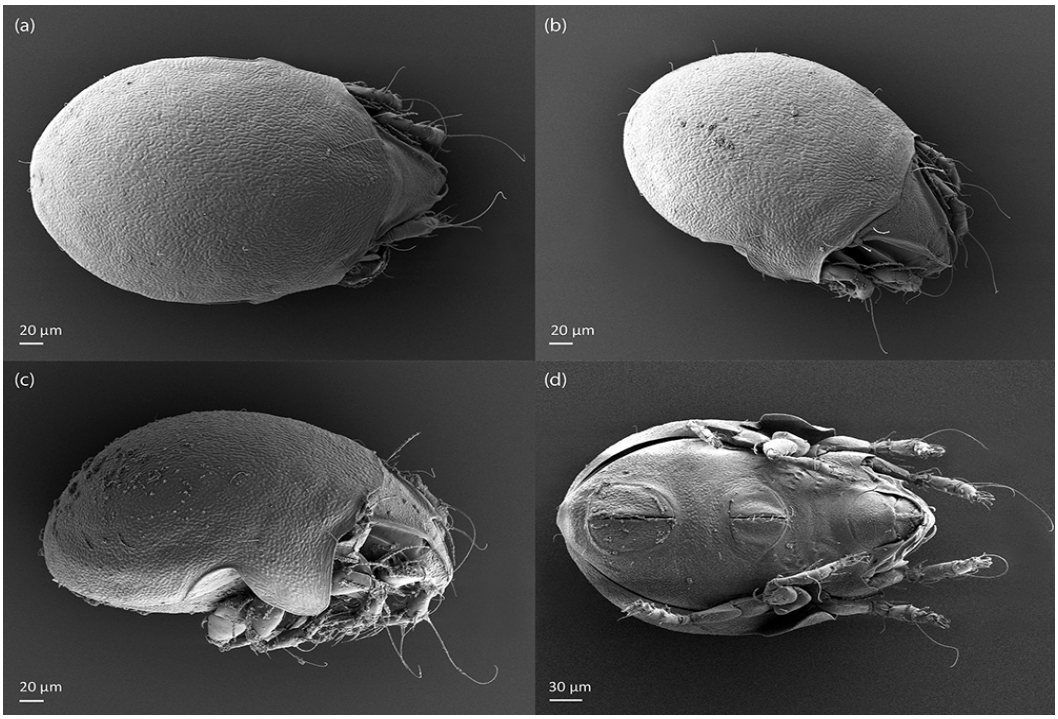

FIGURE 4. *Limnozetes schatzi* **sp. nov.**, adult, SEM micrographs. (a) Dorsal aspect, (b) fronto-lateral aspect, (c) lateral aspect, (d) ventral aspect.

Gnathosoma. Subcapitular seta *h, m* and *a* short (8–10) and smooth (Fig. 2). Chelicera (length 97–99, width 37) with short setae (12), *cha* thicker than *chb* and barbed, *chb* smooth (Fig. 3c). Palp short (length 66–68) with short and smooth setae (Fig. 3d), except for slightly barbed seta *l″* on tibia, palpal eupathidium *acm* fused with solenidion ω, eupathidia ul_1, ul_2 and *su* short. Formula of palp setae (trochanter to tarsus + solenidion ω): 0-2-1-3-9(1).

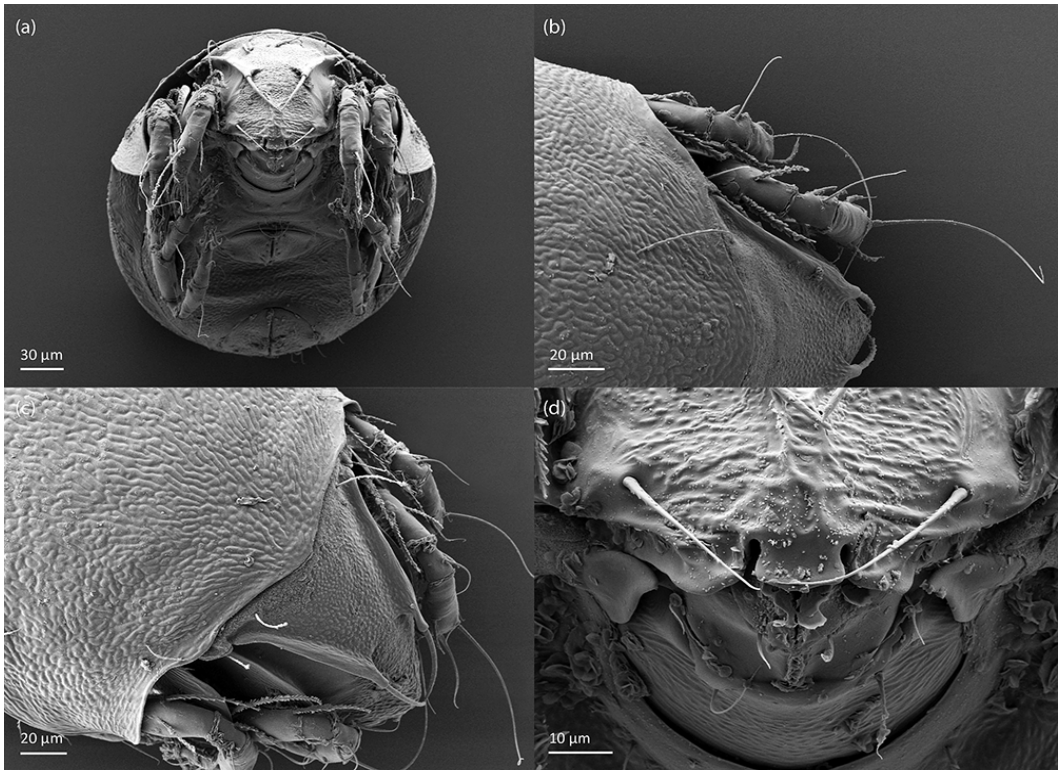

FIGURE 5. *Limnozetes schatzi* **sp. nov.**, adult, SEM micrographs. (a) Frontal aspect; (b) legs I and II, dorsal aspect; (c) anterior part, dorsal aspect; (d) anterior part, frontal aspect.

Lateral aspect. Pedotectum I large, oval, covering basal part of leg I, pedotectum II small, circumpedal carina incomplete, porose area *Ah* elongated, difficult to observe.

Ventral aspect. All epimeral setae short and smooth (Figs. 2, 4d), formula of epimeral setae 3-1-2-2. Genital setae (6 pairs) smooth and inserted on inner part of genital plates (Figs. 2, 6d). One pair of aggenital setae, three pairs of adanal and two pairs of anal setae; all short. Ventral and anal plate with small microtubercles (Figs. 4d, 6d).

Legs. Seta *d* on femora I–III and seta *l′* on femora I and II with relatively long barbs (Figs. 1a, 3a, 5b, 5c, 6b, 7), and some parts of them often with debris. Seta *l″* on genua I and II thicker than other leg setae, famulus ε on tarsus I close to solenidia ω_1 and ω_2, but hardly visible in light microscope, solenidia ω_1 and ω_2 on tarsi I and II glued at some distance from insertions, seta *l′* absent from femur III, distal setae on all tarsi short, thick and barbed, setae *d* and *l′* on genu IV absent. Formulae of leg setae [trochanter to tarsus (+ solenidia)]: I—1-4-3(1)-4(2)-15(2); II—1-4-3(1)-4(1)-14(2); III—2-2-1(1)-3(1)-13; IV—1-2-0-3(1)-10. Tarsi heterotridactylous.

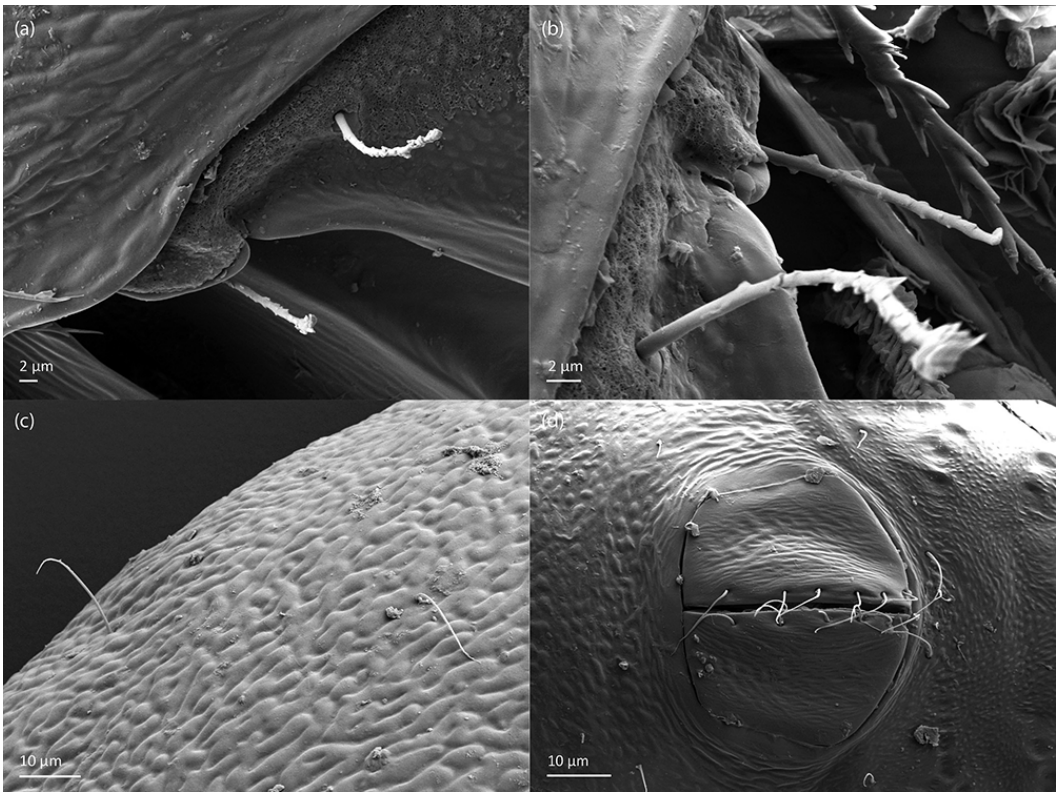

FIGURE 6. *Limnozetes schatzi* **sp. nov.**, adult, SEM micrographs. (a) Bothridium and bothridial seta, dorsal aspect; (b) seta *d, in* and bothridial seta on femur I, dorsal aspect; (c) notogastral setae, lateral aspect; (d) genital plate, ventral aspect.

Juvenile stages

Larva oval in dorsal aspect, light brown, cuticle plicate (Figs. 8, 9, 11a). Prodorsum subtriangular, setae *le* and *in* long and with short barbs, seta *ro* of medium size and seta *ex* short, both smooth (Table 1). Mutual distance between setal pair *le* about two times longer that between setal pair *ro*, and mutual distance between setal pair *in* about six times longer that between pair *ro*. Pair *le* inserted closer to pair *ro* than to pair *in*. Opening of bothridium small, oval, bothridial seta setiform and smooth, and about twice longer than seta *in*. Area between bothridia with transverse folds, lateral parts with longitudinal folds.

Gastronotum of larva with 12 pairs of setae, including minute h_3 inserted laterally to medial part of anal valves (Figs. 10a, 11a). All gastronotal setae short and smooth (8, 9, 10a, 11a, Table 1). Cupules not observed in plicate cuticle. Opisthonotal gland opening posterolateral to seta *lm* (Fig. 11a). Paraproctal valves (segment PS) glabrous. Most leg setae short, conical and smooth, distal setae on all tarsi short, thick and barbed (Fig. 12).

Prodorsum of protonymph porose, prodorsal setae and bothridial seta as in larva. Gastronotum of protonymph with 15 pairs of setae because setae of *p*-series appearing (Fig. 10b), and present in subsequent nymphs (Figs. 13a, 13b); all short and smooth. In protonymph, one pair of genital setae present on genital valves, and two pairs added in deutonymph and two pairs in tritonymph, all short and smooth. In deutonymph, one pair of aggenital setae and three pairs of adanal setae added, and retained in tritonymph (Figs. 13a, 13b), all short and smooth. In protonymph and deutonymph, anal valves glabrous, in tritonymph two pairs of short and smooth anal setae present. In all nymphs, cupules

not observed in plicate cuticle, opisthonotal gland opening anterolateral to seta *lp* (Fig. 11b). Some gastronotal setae hardly visible in plicate cuticle in light microsopy, but better observed in SEM micrographs (Figs. 15, 16a). Leg segments of tritonymph stocky, most leg setae short and conical (Figs. 16c, 16d, 17), famulus ε on tarsus I hardly visible in light microsopy, solenidia ω_1 and ω_2 on tarsi I and II glued together at some distance from insertions; seta *l″* on femora I and II, *l′* on femur III absent.

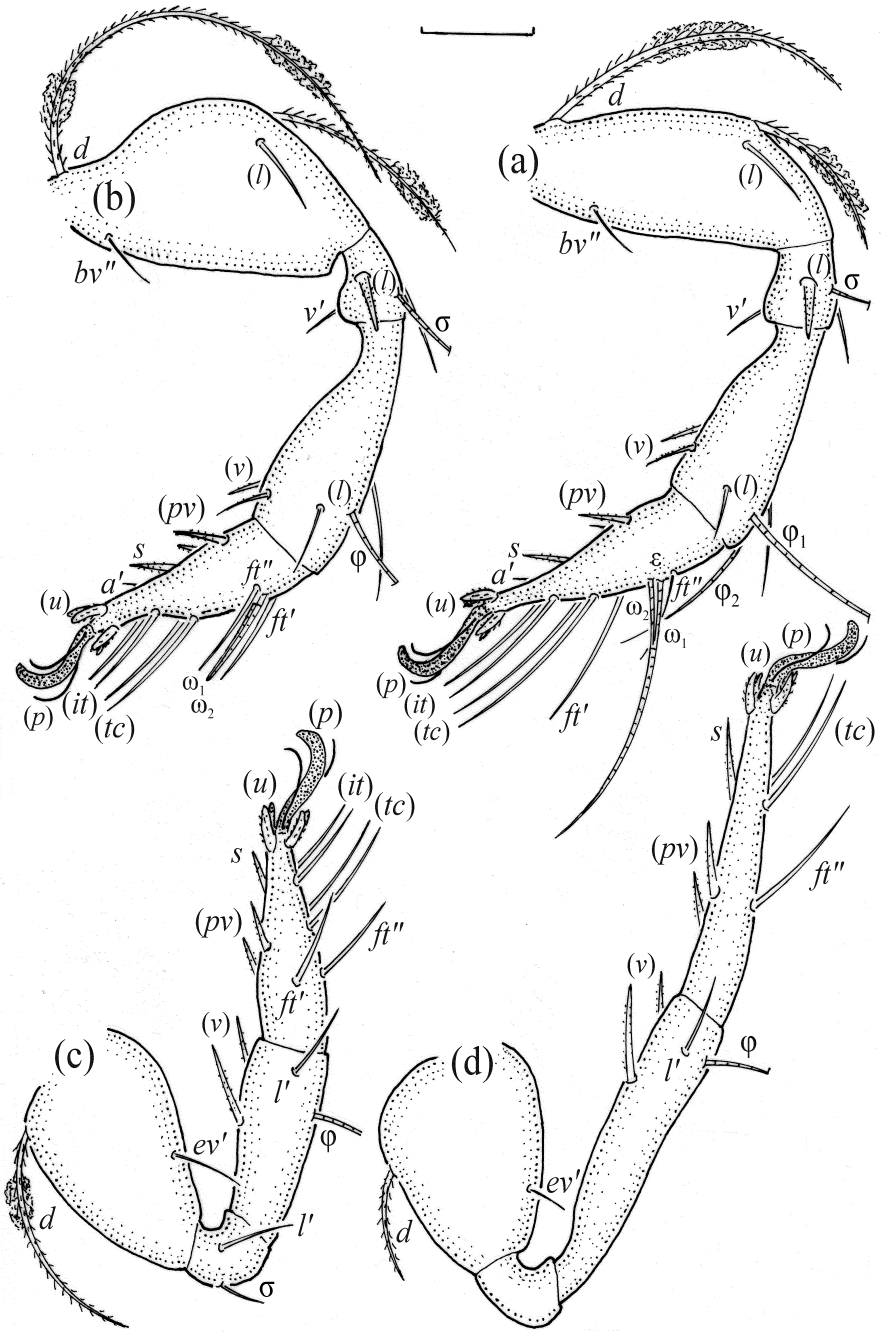

FIGURE 7. *Limnozetes schatzi* **sp. nov.**, leg segments of adult (part of femur to tarsus), right side, antiaxial aspect, scale bar 20 μm. (a) Leg I, (b) leg II, (c) leg III, (d) leg IV.

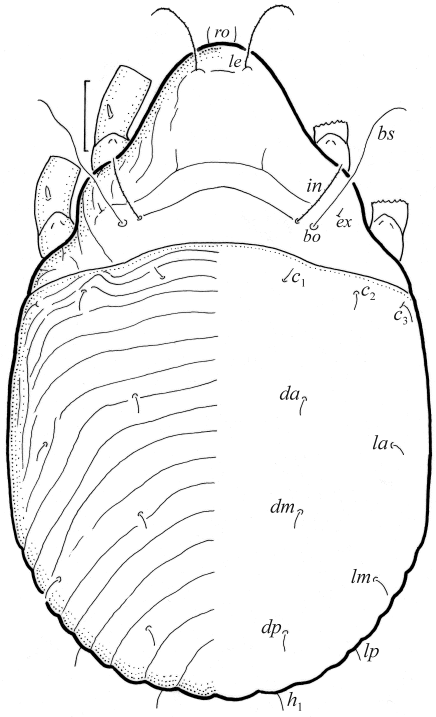

FIGURE 8. *Limnozetes schatzi* **sp. nov.**, larva, dorsal aspect, legs partially drawn, scale bar 20 µm.

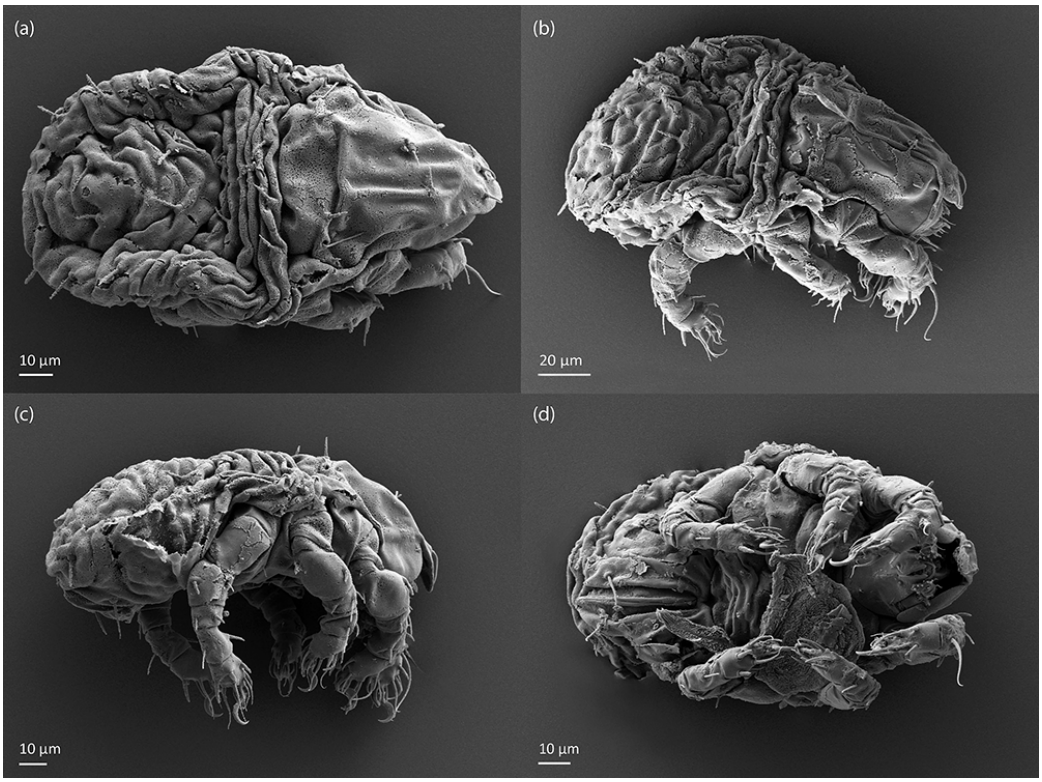

FIGURE 9. *Limnozetes schatzi* **sp. nov.**, larva, SEM micrographs. (a) Dorsal aspect, (b) dorsolateral aspect, (c) lateral aspect, (d) ventral aspect.

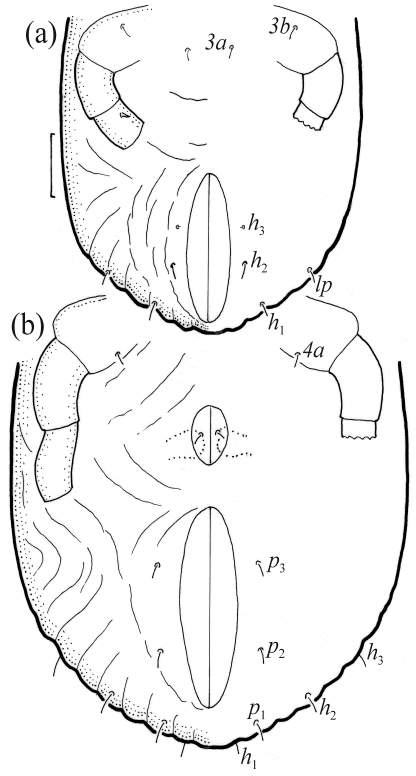

FIGURE 10. *Limnozetes schatzi* **sp. nov.**, legs partially drawn, ventral aspect of hysterosoma, scale bar 20 μm. (a) Larva, (b) protonymph.

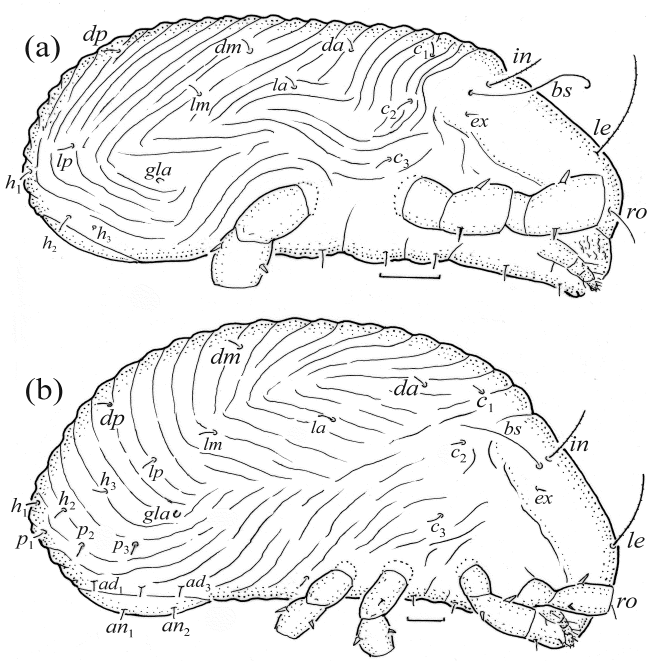

FIGURE 11. *Limnozetes schatzi* **sp. nov.**, lateral aspect, legs partially drawn, scale bars 20 μm. (a) Larva, (b) tritonymph.

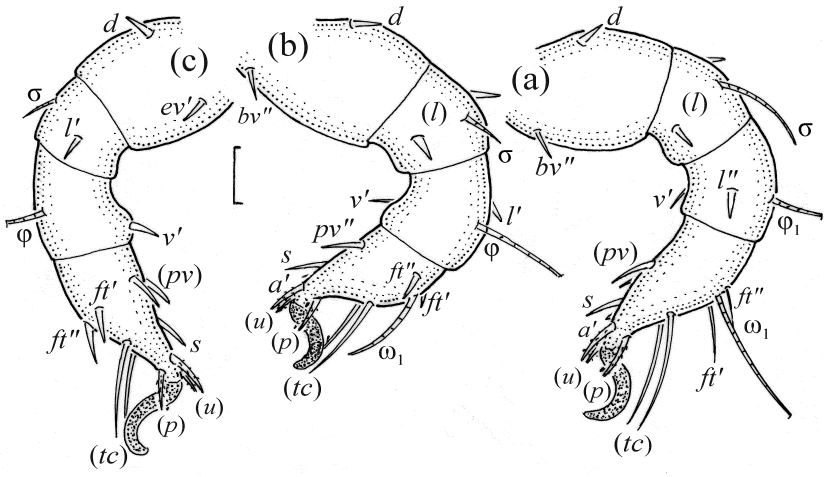

FIGURE 12. *Limnozetes schatzi* **sp. nov.**, leg segments of larva (part of femur to tarsus), right side, antiaxial aspect, setae on the opposite side not illustrated are indicated in the legend, scale bar 10 µm. (a) Leg I, tibia (*l′*); (b) leg II, tarsus (*pv′*); (c) leg III.

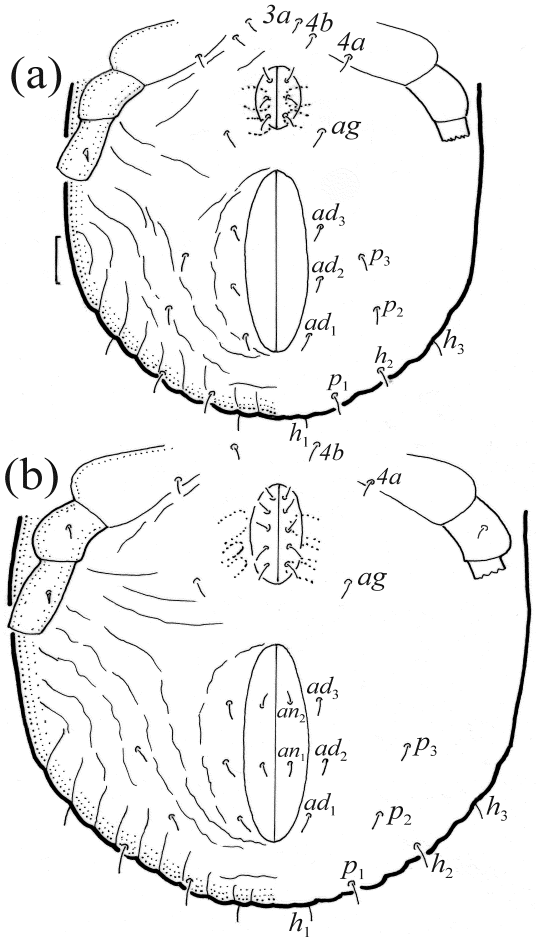

FIGURE 13. *Limnozetes schatzi* **sp. nov.**, ventral aspect of hysterosoma, legs partially drawn, scale bar 20 µm. (a) Deutonymph, (b) tritonymph.

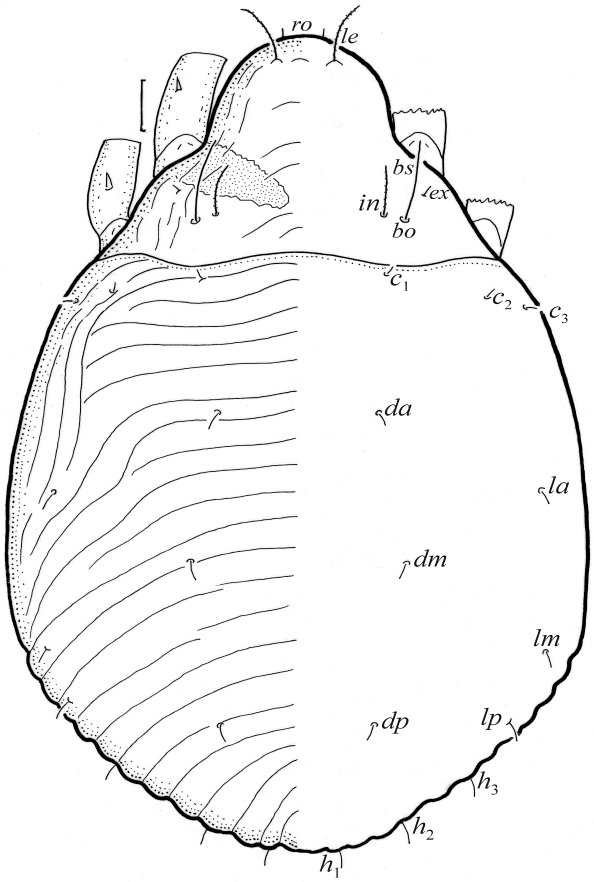

FIGURE 14. *Limnozetes schatzi* **sp. nov.**, tritonymph, dorsal aspect, legs partially drawn, scale bar 20 μm.

Summary of ontogenetic transformations

In all juveniles of *L. schatzi*, setae *le* and *in* are long, *ro* is of medium size and *ex* is short, whereas in the adult *in* remains long, *ro* and *le* are of medium size, and *ex* is short. The bothridium is small and rounded in all juveniles, but in the adult, it is larger, and develops a dorsal scale. In all juveniles, the bothridial seta is long, setiform, whereas in adults it is short and setiform, barbed. In all instars, the gastronotal setae are short. The larva has 12 pairs of gastronotal setae, including minute h_3, the nymphs have 15 pairs (*p*-series is added). The notogaster of adult loses setae c_1, c_3 and of *d*-series, such that 10 pairs of setae remain. The formula of gastronotal setae of *L. schatzi* is 12-15-15-15-10 (from larva to adult), formulae of epimeral setae is 2-1-2 (larva), 3-1-2-1 (protonymph), 3-1-2-2 (deutonymph, tritonymph and adult), formula of genital setae is 1-3-5-6 (protonymph to adult) and formula of aggenital setae is 1-1-1 (deutonymph to adult). Fomula of segments PS–AN is 03333-0333-022. The ontogeny of leg setae and solenidia of *L. schatzi* is given in Table 2.

Distribution, ecology, and biology

We found quite a large population of *L. schatzi* in Høstedmyra (Trøndelag, Central Norway), in a hollow filled with water and overgrown by *Sphagnum compactum*. In one sample of this peat moss 14 oribatid species were found and the total density of Oribatida was 1722 specimens per 500 cm^3. The most abundant oribatid species was *L. ciliatus* which comprised 43.0% of all specimens collected. The second abundant species was *Trhypochthoniellus longisetus* (Berlese, 1904, in

Berlese 1905) which comprised 12.2% of Oribatida, followed by *L. foveolatus* (12.0%) and *L. schatzi* (11.4%). The density of *L. schatzi* was 197 specimens per 500 cm^3 of peat moss. In the sample population, the adults dominated (71% of all individuals), and the stage structure was: 3 larvae, 16 protonymphs, 34 deutonymphs, 4 tritonymphs and 140 adults. Only females were noted, and 70% of them were gravid, carrying one or two large eggs. The eggs were relatively large (175 x 80), comprising 50% of total body length of females.

Type material

The holotype (female) and five paratypes (females) with above collection data are deposited in University Museum of Bergen, University of Bergen, Bergen, Norway.

Etymology

This species is named in honour of Dr. Heinrich Schatz (c/o Institute of Zoology, University of Innsbruck, Austria), who is an outstanding oribatologist and very helpful and appreciated Colleague.

TABLE 2. Ontogeny of leg setae (Roman letters) and solenidia (Greek letters) in *Limnozetes schatzi* **sp. nov.**

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	*d*, *bv″*	(*l*), σ	(*l*), *v′*, φ_1	(*ft*), (*tc*), (*p*), (*u*), *a′*, *s*, (*pv*), ε, ω_1
Protonymph	–	–	–	–	ω_2
Deutonymph	–	*l′*	–	φ_2	–
Tritonymph	*v′*	–	–	–	(*it*)
Adult	–	*l″*	*v′*	*v″*	–
Leg II					
Larva	–	*d*, *bv″*	(*l*), σ	*l′*, *v′*, φ	(*ft*), (*tc*), (*p*), (*u*), *a′*, *s*, (*pv*), ω_1
Protonymph	–	–	–	–	–
Deutonymph	–	*l′*	–	–	ω_2
Tritonymph	*v′*	–	–	*l″*	(*it*)
Adult	–	*l″*	*v′*	*v″*	–
Leg III					
Larva	–	*d*, *ev′*	*l′*, σ	*v′*, φ	(*ft*), (*tc*), (*p*), (*u*), *s*, (*pv*)
Protonymph	–	–	–	–	–
Deutonymph	–	–	–	–	–
Tritonymph	*v′*, *l′*	–	–	*l′*	(*it*)
Adult	–	–	–	*v″*	–
Leg IV					
Protonymph	–	–	–	–	*ft″*, (*p*), (*u*), (*pv*)
Deutonymph	–	*d*, *ev′*	–	*v′*, φ	(*tc*), *s*
Tritonymph	*v′*	–	–	*l′*	–
Adult	–	–	–	*v″*	–

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.

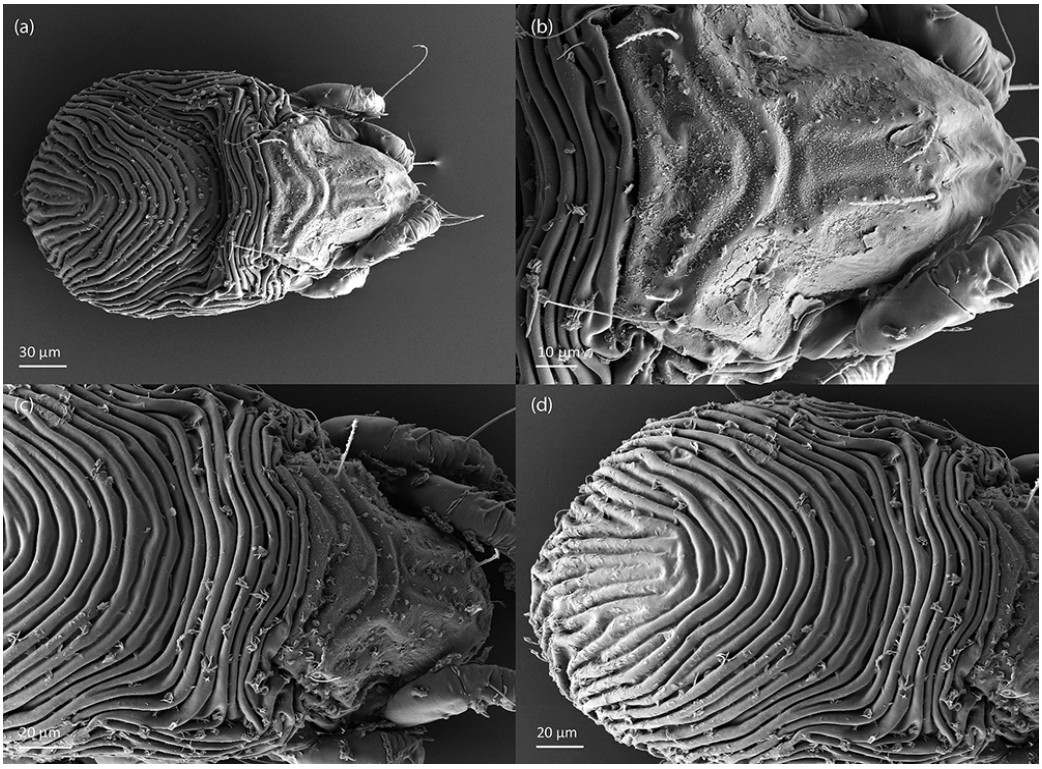

FIGURE 15. *Limnozetes schatzi* **sp. nov.**, tritonymph, dorsal aspect SEM micrographs. (a) Habitus, (b) anterior part, (c) anterior and medial part, (d) medial and posterior part.

Comparison of the morphology of Limnozetes schatzi *with congeners and remarks*

The adult of *L. schatzi* **sp. nov.** is the largest species of '*rugosus* group' of *Limnozetes*, while the smallest are *L. guyi* and *L. latilamellatus*, but the body length of all species overlaps (324–377, Table 3). None of species has a complete translamella, but in some species, including *L. schatzi*, the translamella is incomplete. The stockiest species is *L. latilamellatus*, and the slimmest is *L. rugosus*. In in all species the bothridial seta is setiform, but in *L. schatzi* and *L. borealis* it is barbed, while in other species it is smooth. In most species, setae *ad*-series are short, but in *L. borealis* and *L. latilamellatus* they are of medium size. In both species, anal and aggenital setae are also medium sized, as are epimeral setae in *L. borealis*. These species differ also from one another by the location of seta h_3 on the notogaster, length of some setae on the main body and length and presence of some setae on legs (Table 3). Seniczak and Seniczak (2020) compared the morphology of all species of *Limnozetes*, and the adults of '*rugosus* group' differ from'*ciliatus* group' mainly by more convex notogaster and lack of setae *d* and *l′* on genu IV, which are present in the '*ciliatus* group'.

The adult of *L. schatzi* is the most similar to that of *L. rugosus*, including rostral structure, but differs from it mainly by the shape of body (stockier in dorsal aspect, and less convex in lateral aspect than *L. rugosus*), longer prodorsal seta *in* and notogastral setae, lack of seta c_3, which in some individuals of *L. rugosus* is present, and sculpture of notogaster (Seniczak & Seniczak 2020). For example, in SEM micrographs, the anterior part of notogaster of both species has elongated elevations, but in *L. schatzi* these elevations are longer than in *L. rugosus*. Moreover, *L. schatzi* has seta *d* on femora I–III and seta *l′* on femora I and II with longer barbs than *L. rugosus* (best observed in dorsal aspect), lacks seta *l′* on femur III, which in *L. rugosus* is present, and has seta *ev* on femur IV shorter than on femur III, whereas in *L. rugosus* this seta is of similar length (Seniczak & Seniczak

2020). In the juveniles of *L. schatzi*, the gastronotal setae are short, whereas in those of *L. rugosus* *lm* and *lp* in larva, *lp* in nymphs are longer. Moreover, in *L. schatzi* seta *l′* on femur III is absent, but in *L. rugosus* is present (Table 4).

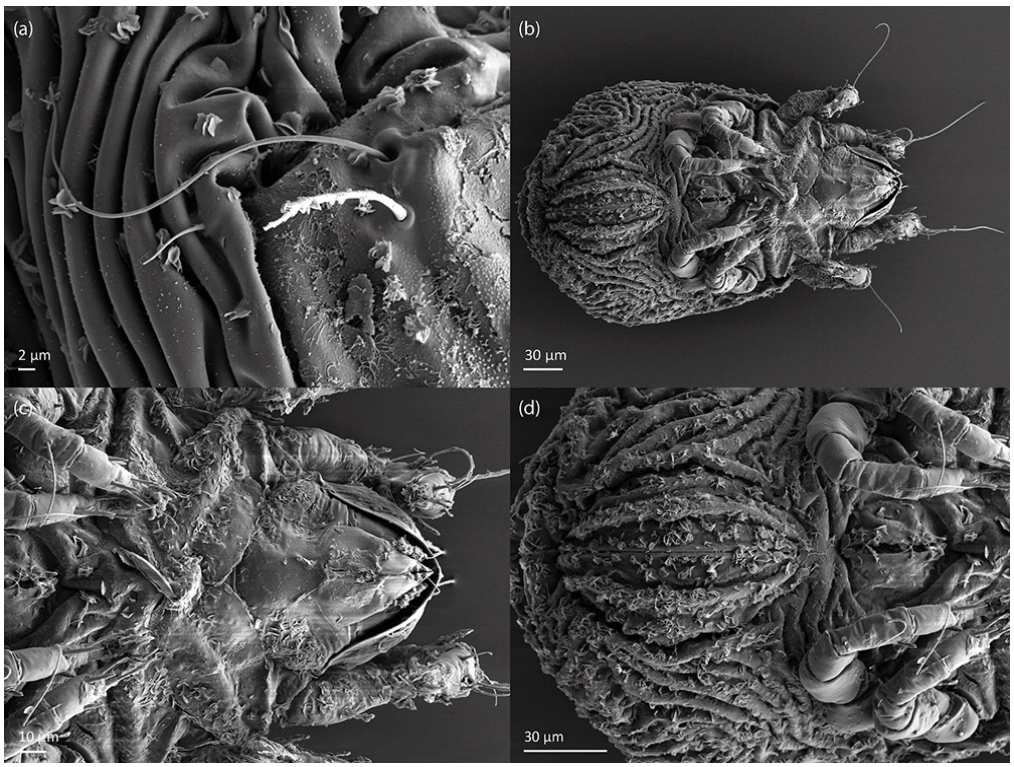

FIGURE 16. *Limnozetes schatzi* **sp. nov.**, tritonymph, SEM micrographs. (a) Bothridial seta, dorsal aspect; ventral aspect, (b) habitus, (c) anterior and medial part, (d) medial and posterior part.

TABLE 3. Selected morphological characters of adults of '*rugosus* group' of *Limnozetes*.

Species	Body length in µm	Body length/ high	Shape of translamella	Appearance of *bs*	Length/width of:		Location of seta h_3[a]	Length of setae:			Leg setal characters	
					Ng	Ptm		in	lp	*ad*-series	*l′*/Fe III	*ev*/Fe IV
L. borealis Behan-Pelletier, 1989	343–376	1.7:1	incomplete	barbed	1.2:1	1.4:1	in similar distances	long	short	medium sized[b]	present	?
L. guyi Behan-Pelletier, 1989	324–343	1.7:1	absent	smooth	1.2:1	0.9:1	closer to *lp* than h_2	long	medium sized[c]	short	present	shorter than *ev*/Fe III
L. latilamellatus Behan-Pelletier, 1989	324–343	1.7:1	absent[d]	smooth	1.1:1	1.9:1	in similar distances	medium sized[c]	medium sized[c]	medium sized[b]	absent	?
L. rugosus (Sellnick, 1925)	350	1.8:1	incomplete	smooth	1.3:1	1.0:1	in similar distances	medium sized[c]	short	short	present	as long as *ev*/Fe III
L. schatzi **sp. nov.**	332–377	1.9:1	incomplete	barbed	1.2:1	1.4:1	closer to h_2 than *lp*	long	short	short	absent	shorter than *ev*/Fe III
L. solhoyorum A. et S. Seniczak, 2020	344–364	1.6:1	absent	smooth	1.2:1	1.2:1	closer to *lp* than h_2	medium sized[c]	short	short	present	longer than *ev*/Fe III

[a]In dorsal aspect, [b]as long or longer than a half of distance between setae ad_2 and ad_3; [c]reaches insertion of seta h_3, [d]lamella is wide, without lamellar cusp (unique in *Limnozetes*), [e]does not reach a half length of lamella.

Grandjean (1951), Behan-Pelletier (1989) and Seniczak and Seniczak (2020) compared several morphological characters of *Limnozetes* and *Hydrozetes* Berlese, 1902 and stated that these genera are closely related, that was also supported by the molecular phylogeny (Krause *et al*. 2016). The ontogeny of leg setae of *Limnozetes* species differs from that of *Hydrozete*s species, but in both genera the tarsal setae *u* and *p* are short, thick, and barbed (Seniczak & Seniczak 2008, 2009a, 2009b, 2010; Seniczak *et al*. 2007, 2009, 2017), reflecting their ecological importance. They cooperate with claws and help the mites to stick to water plants, which can be easily observed while manipulating mites with the needle.

Our study on *L. schatzi* shows the importance of SEM micrographs for better understanding the morphology of this species. For example, the sculpture of some parts of body of the adult of *L. schatzi* illustrated from light microscopy does not fully reflect the SEM micrographs, which better characterize the difference between species. The famulus ε on tarsus I is difficult to observe in a light microscopy and is well observed in SEM micrographs, similarly as the shape of palp setae and solenidion (Seniczak & Seniczak 2020).

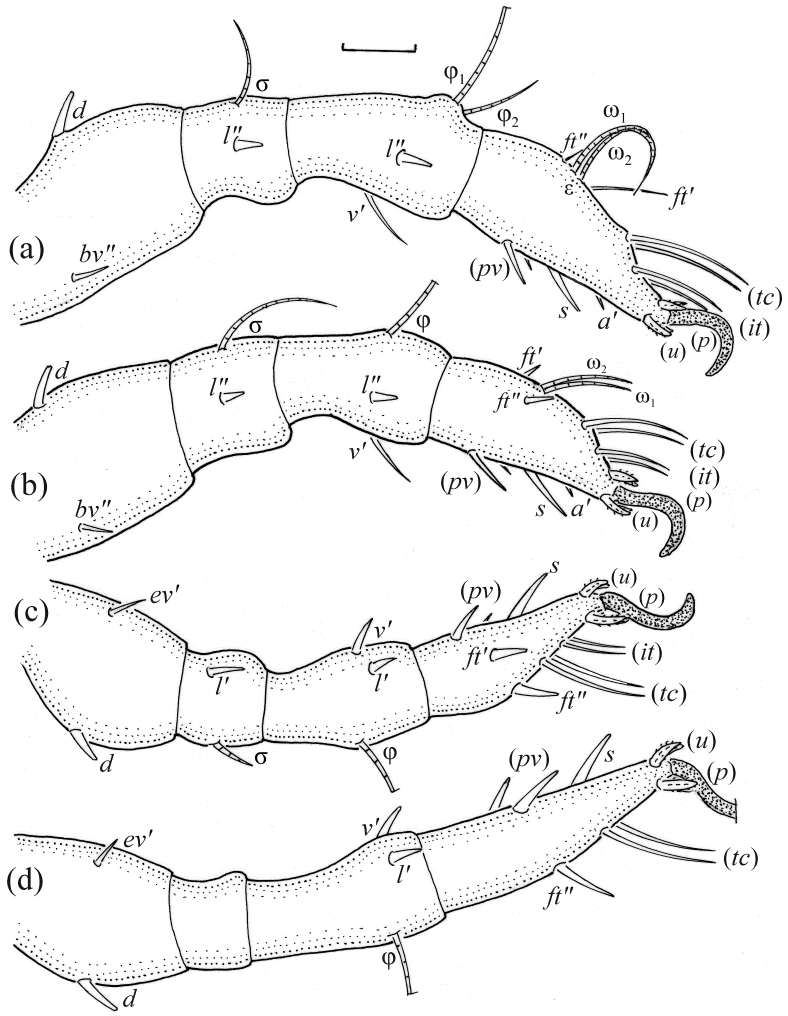

FIGURE 17. *Limnozetes schatzi* **sp. nov.**, leg segments of tritonymph (part of femur to tarsus), right side, antiaxial aspect, seta on the opposite side not illustrated are indicated in the legend, scale bar 20 μm. (a) Leg I, femur (*l′*), genu (*l′*), tibia (*l′*); (b) leg II, femur (*l′*), genu (*l′*), tibia (*l′*); (c) leg III; (d) leg IV.

TABLE 4. Selected morphological characters of juveniles of *Limnozetes schatzi* **sp. nov.,** *L. rugosus* and *L. solhoyorum*.

Morphological characters	*L. schatzi*	*L. rugosus*[a]	*L. solhoyorum*[b]
Juveniles			
Length of *c*-series setae	short	short	minute
Tritonymph			
Longer gastronotal setae	none	*lp*	*h*-series, p_1
Seta *l′* on femur III	absent	present	present/absent
Larva			
Appearance of seta *in*	smooth	barbed	smooth
Longer gastronotal setae	none	*lm*, *lp*	*dp*, *lp*
Length of seta h_3	minute	short	minute

[a]According to Seniczak and Seniczak (2010), [b]according to Seniczak and Seniczak (2020).

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