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A new species of *Zercon* (Parasitiformes: Mesostigmata) from Norway, with notes on sexual dimorphism in Zerconidae

SŁAWOMIR KACZMAREK[1], TOMASZ MARQUARDT[1] & ANNA SENICZAK[2]

[1]*Department of Evolutionary Biology, Faculty of Biological Sciences, Kazimierz Wielki University, Bydgoszcz, Poland*
[2]*Department of Natural History, University Museum of Bergen, University of Bergen, Bergen, Norway*
Corresponding author: tomasz.marquardt@ukw.edu.pl

Abstract

In this paper we describe and illustrate *Zercon hamaricus* **sp. nov.** based on all postembryonic stages obtained from soil samples and laboratory cultures. The new species belongs to a species group in which dorsal setae *J1*–*J4* in females are short and similar in length, and *J5* are considerably longer. In most species of this group opisthonotal setae *J5* and *Z4* are clearly displaced anteriorly. *Zercon hamaricus* **sp. nov.** is most similar to *Z. forsslundi* Sellnick, 1958 and to a less extent to *Z. polonicus* Błaszak, 1970. The females of *Z. forsslundi*, *Z. polonicus* and *Z. hamaricus* **sp. nov.** can be distinguished based on the range of *J5*, the length and character of the *Z* and *S*-series setae, the distance between setae *Z5* and the location of *gdZ3*. We also include comparative information on other related species of *Zercon*. The new species is one of the six known species that have clearly visible sexual dimorphism in opisthonotal chaetotaxy.

Keywords: zerconid mites, laboratory culture, morphology, immature stages, species distribution

Introduction

The family Zerconidae Canestrini, 1891 currently includes more than 400 described species and 46 genera, and is widely distributed throughout the Northern Hemisphere, including high-altitudes and arctic areas (Sellnick 1958; Halašková 1970, 1977, 1979; Błaszak 1975a, b, 1976, 1978, 1979; Błaszak *et al.* 1997; Mašán & Fenďa 2004; Lindquist *et al.* 2009; Beaulieu *et al.* 2011; Sikora 2014; Faleńczyk-Koziróg *et al.* 2018; Kavianpour *et al.* 2018; Marchenko 2018, 2019, 2021; Karaca 2019, 2021; Urhan & Karaca 2019; Kaczmarek *et al.* 2020). Eight species of Zerconidae have been reported from continental Norway—one of *Parazercon*, two of *Prozercon* and five of *Zercon* (Gwiazdowicz & Gulvik 2005a, 2007; Gwiazdowicz *et al.* 2013). The recently confirmed *Z. lindrothi* Lundqvist & Johnston, 1985 (Bolger *et al.* 2018) was earlier recorded from Norway (Lundqvist & Johnston 1985), but is not mentioned in checklist of Gwiazdowicz & Gulvik (2005a). Other *Zercon* species: *Z. baloghi* Sellnick, 1958; *Z. curiosus* Trägardh, 1910 and *Z. triangularis* C.L. Koch, 1836 have been earlier reported from Norway by Slomian *et al.* (2005) while *Z. zelawaiensis* Sellnick, 1944 [listed by Mehl (1979) as *Zercon* cf. *zelawaiensis*] has been confirmed by Gwiazdowicz & Gulvik (2005b). All above-mentioned records of *Zercon* originate from the southern part of Norway (Vestland county). Most of the *Zercon* species described so far belong to a group in which the opisthonotal chaetotaxy of males and females is very similar (e.g. Halašková 1970, 1977; Błaszak 1974; Sikora 2014; Urhan & Karaca 2019). However, in a few species, the males and females show clear differences in opisthonotal chaetotaxy, a phenomenon that was first described by Sellnick (1958) in *Z. forsslundi*. Since then some other *Zercon* species with clear sexual dimorphism in chaetotaxy have been described, and differences between males and females have also been found in cheliceral morphology, hypostomal and palpal chaetotaxy, and some morphological characters of the venter (Błaszak 1974; Halašková 1977; Błaszak & Skorupski 1992; Călugăr 2004–2006; Ujvári 2011a, b; Sikora 2014; Faleńczyk-Koziróg *et al.* 2018).

We herein describe a new species, *Zercon hamaricus* **sp. nov.**, including a full ontogenetic series, compare its morphology with the most similar congeners, and discuss the phenomenon of sexual dimorphism in Zerconidae.

Material and Methods

Specimens of *Zercon hamaricus* **sp. nov.** were collected on 25 July 2017 by S. Kaczmarek in Hamar, Norway (Innlandet county), from moderately humid moss on rocks. Mites were extracted using Tullgren funnels for 7 days and mounted in PVA mounting medium (Lactic Acid, Poly Vinyl Acetate, and Phenol Solution, BioQuip Products, Inc., CA, USA). The drawings were made using a Nikon Eclipse E200 microscope equipped with a Nikon Y-IDT drawing tube, and then edited with Corel Draw 2017. Measurements and transmitted-light photomicrographs were made using a Leica DM3000 equipped with a Leica DFC420 camera and Leica Application Suite 3.8. For scanning electron microscopy (SEM), the mites were air-dried and coated with Au/Pd in a Polaron SC502, sputter coated and placed on Al-stubs with double-sided adhesive tape. Observations and micrographs were made with a ZEISS Supra 55VP scanning electron microscope at the Department of Natural History, University Museum of Bergen, Norway. Due to lack of measurements in some previous work, some measurements were taken from the original drawings with the use of imageJ 1.50d software (Schneider *et al.* 2012) as clearly explained in the text. All measurements are given in micrometres (μm). The setal terminology used in the description of *Z. hamaricus* **sp. nov.** follows Lindquist & Evans (1965) and Lindquist & Moraza (1998) for idiosomal setation and Johnston & Moraza (1991) for the notation of dermal glands and lyrifissures. The setal terminology and notation of dermal glands and lyrifissures used in descriptions of other Zerconidae species discussed in this paper have been converted to the above-mentioned systems if necessary.

Taxonomy

Zercon hamaricus sp. nov.
(Figures 1–27)

Material examined

Holotype female, collected from moderately humid moss on rocks on a slope near the bank of Mjøsa Lake, in a mixed forest stand with pine (*Pinus sylvestris* L.), birch (*Betula pendula* Roth), rowan (*Sorbus aucuparia* L.) and ash (*Fraxinus excelsior* L.), in the surroundings of Domkirkeodden Museum of Medieval Culture and History in Hamar, Norway (N 60°47′33.7″, E 11°2′9.2″, 150 m. a.s.l.). Field collected paratypes—2 females, 1 male, 3 deutonymphs and 2 protonymphs—collection data as for holotype. Paratypes from laboratory culture—6 females, 7 males, 5 deutonymphs, 1 protonymph and 6 larvae—collected from culture founded by three females, on Plaster of Paris and charcoal substrate, fed with nematodes.

The holotype (1 female) and paratypes (5 females, 5 males, 6 deutonymphs, 2 protonymphs, 4 larvae) of *Zercon hamaricus* **sp. nov.** are deposited in the Department of Evolutionary Biology, Kazimierz Wielki University (Bydgoszcz, Poland). Other paratypes (3 females, 3 males, 2 deutonymphs, 1 protonymph, 2 larvae) are deposited in the collection of the University Museum of Bergen (Norway).

Diagnosis (adult female)

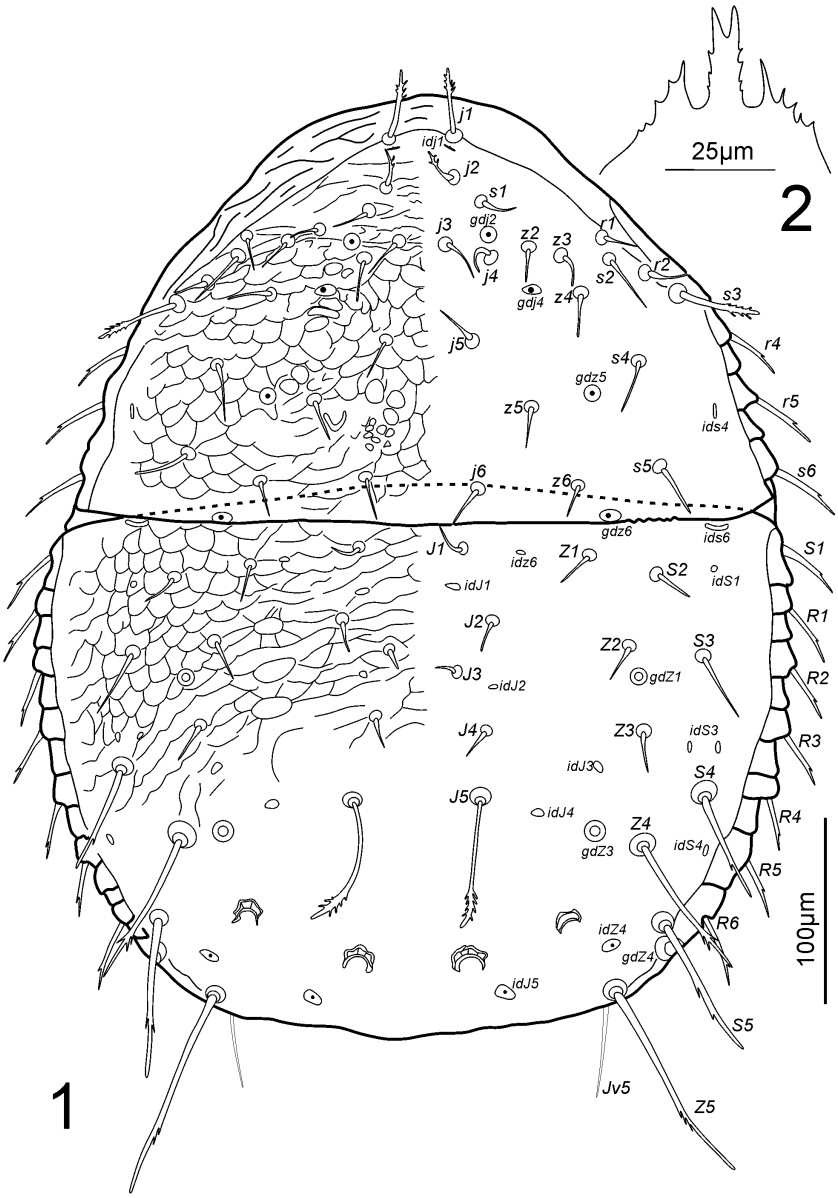
Anterior margin of ventrianal shield with two pairs of setae (*Zv1* present). Pores *gv3* located posteriorly to line connecting para-anal setae close to line connecting setae *Jv4*. Podonotal shield with 21 pairs of setae, covered entirely with irregular tile-like sculpture. Setae *j1*, *j2*, *s3* and *r4–r5* and *s6* barbed. Seta *r3* barbed, located on ventral side of idiosoma. Opisthonotal shield with 21 pairs of setae (*Z2* present). All opisthonotal setae without apical hyaline endings. Setae *J1–J4* and *Z1–Z3* and *S2* short, smooth and pointed. Seta *S3* clearly longer than *S2*, smooth and pointed. Setae *S2* and *S3* never reach the insertions of next setae in series and never reach beyond the edge of opisthonotum. Other opisthonotal setae long and barbed. Seta *J5* never reach beyond posterior edge of opisthonotum and almost reach the posterodorsal cavities. Pores *gdZ1* (*Po2*) close and posterior to line connecting insertions of setae *Z2* and *S3*, closer to insertion of *Z2*. Pores *gdZ3* (*Po3*) on the line connecting the insertions of setae *J5* and *Z4*, closer to insertion of *Z4*. Pores *gdZ3* and insertions of setae *J5* and *Z4* located distinctly anterior to posterodorsal cavities.

Description

Female (n=9)

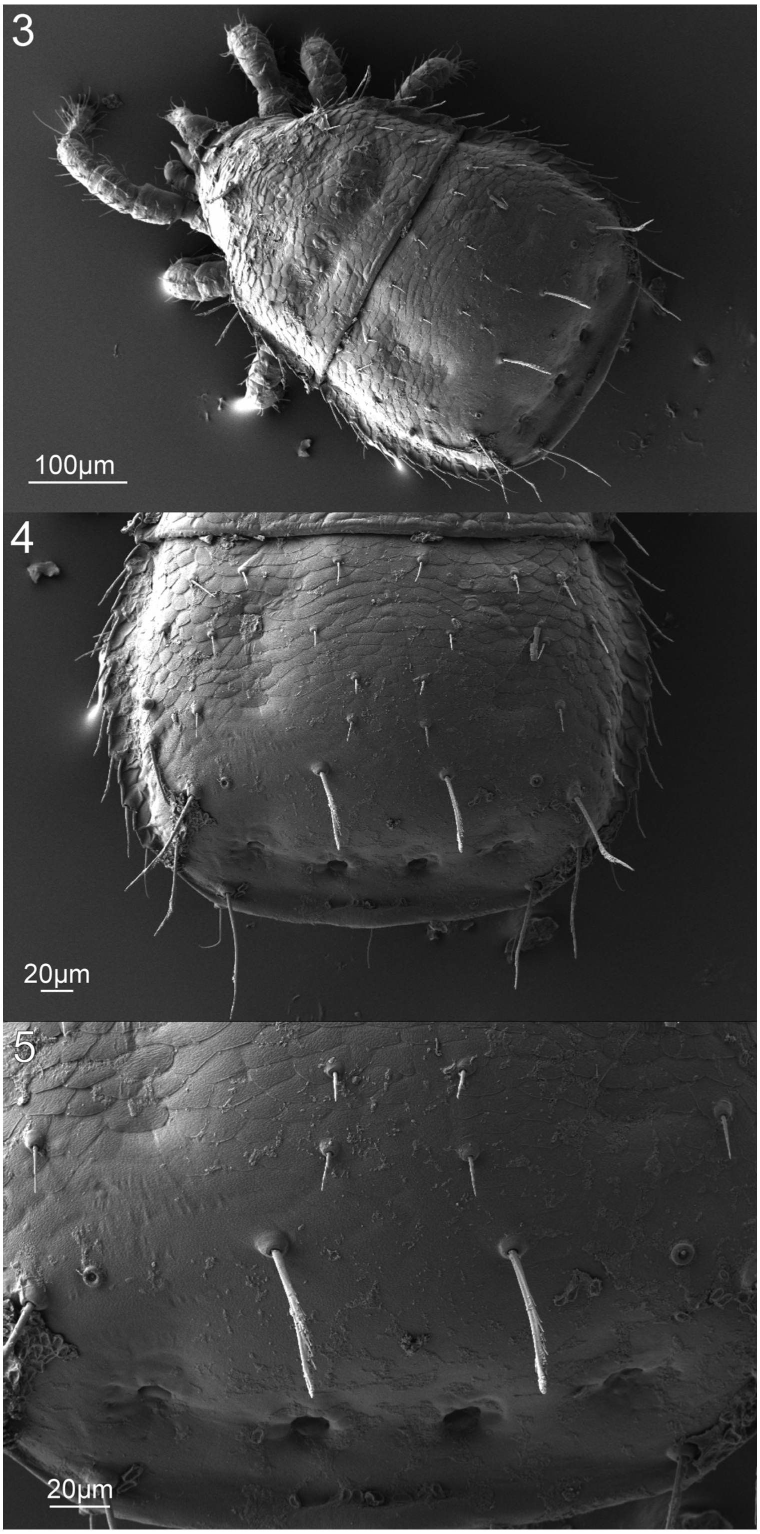
Idiosoma length 505–529, width (at level of anterior edge of ventrianal shield) 403–410.

Dorsal idiosoma (Figures 1, 3–5). Podonotal shield with 21 pairs of setae. All podonotal setae without hyaline endings. Lengths of podonotal setae of females summarized in Table 1. Seta *j1* longest in *j*-series, other *j*-series setae of comparable length. Setae *j1* and *j2* with subapical barbs. Setae *j3–j6* smooth and pointed. All *z*-series setae of comparable length, smooth and pointed. Seta *s1* shortest of the *s*-series. Setae *s3* and *s6* of comparable length and longest of *s*-series. Seta *s3* with subapical barbs, seta *s6* with one subapical barb, other *s*-series setae smooth and pointed. Setae *r1* and *r2* smooth and pointed, setae *r4–r5* with one subapical barb. Seta *r1* shortest and *r5* longest of *r*-series on podonotal shield. Podonotal shield covered entirely with irregular tile-like sculpture. Location of podonotal glands: *gdj2* (*po1*) posterior to insertion of seta *s1*, close and anterior to line connecting setae *j3* and *z2*; *gdj4* (*po2*) close and posterior to line connecting insertions of setae *j4* and *z4*; *gdz5* (*po3*) close and posterior to line connecting insertions of setae *z5* and *s4*. Location of podonotal poroids: *idj1* posterior to insertion of seta *j1*; *ids4* close to lateral margin of podonotum, at the level of seta *r5*; *idj3*, *idj6* and *idz4* not visible. Opisthonotal shield with 21 pairs of setae. All opisthonotal setae without hyaline endings. Lengths of opisthonotal setae and longitudinal distances between insertions of setae in specific series of females summarized in Table 2. Setae *J1–J4* short, smooth and pointed. Seta *J5* clearly longer, with subapical barbs. Seta *J5* never reach beyond posterior edge of opisthonotum, almost reach posterodorsal cavities. Setae *Z1–Z3* of comparable length, short, smooth and pointed. Setae *Z4* and *Z5* clearly longer, with barbs located at about one third or one fourth from seta termination. Seta *Z4* clearly reach beyond lateral edge of opisthonotum, and reach the insertion of *Z5*. Seta *Z5* longer (1.2–1.3 times) than *Z4*. Distance between setae *Z5* 214–225. Seta *S2* shortest of *S*-series. Setae *S1* and *S4* with one subapical barb. Setae *S2* and *S3* smooth and pointed, *S3* clearly longer (1.4–1.7 times) than *S2*. Setae *S2* and *S3* never reach the insertion of next seta in series. Seta *S4* clearly longer (1.6–2.1 times) than *S3*. Seta *S5* with subapical barbs, longer (1.1–1.4 times) than *S4*. Setae *R1–R6* of similar length (30–40), pointed, with one subapical barb. Opisthonotal shield covered with tile-like structure in anterior corners from the anterior edge to *Z1–Z2–S4* line. The axial part of opisthonotal shield with irregular horizontal lines to *J4–J4* line. Similar lines visible also in the lateral parts of opisthonotal shield to *J4–Z4* line. Remaining posterior surface of opisthonotum without sculpture, finely dotted. Posterodorsal cavities crescent-like with undulating anterior margins. Location of opisthonotal glands: *gdz6* (*Po1*) anterolateral to *Z1*; *gdZ1* (*Po2*) close and posterior to line connecting insertions of setae *Z2* and *S3*, closer to insertion of *Z2*; *gdZ3* (*Po3*) on the line connecting insertions of setae *J5* and *Z4*, closer to insertion of *Z4*; *gdZ4* (*Po4*) behind the insertion of seta *S5*; *gdJ3* not visible. Location of opisthonotal poroids: *idz6* on line connecting insertions of setae *J1* and *Z1*; *idJ1* close and adaxial to line connecting insertions of setae *J1* and *J2*; *idJ2* on line connecting insertions of setae *J2* and *J4*; *idJ3* posterior to line connecting insertions of setae *J4* and *Z3*, closer to *Z3*; *idJ4* on line connecting insertions of setae *J5* and *Z4*, closer to *J5*; *idJ5* posterior and adjacent to line connecting posterior edges of inner posterodorsal cavities; *idZ4* close to line connecting setae *Z4* and *Z5*, closer to *Z5*; *ids6* close to antero-abaxial edge of opisthonotum; *idS1* posterior to *ids6* at the level of seta *S2*; *idS3* doubled, close to line connecting setae *S3* and *S4*, closer to *S4*; *idS4* posterior to seta *S4*, at the level of seta *Z4*; *idR3* not visible.



FIGURES 1–2. *Zercon hamaricus* **sp. nov.**, female. 1. Dorsal aspect; 2. Epistome.

Gnathosoma. Epistome (Figure 2) typically shaped for genus, with medial process bifurcated. One female with medial process tripartite.



FIGURES 3–5. *Zercon hamaricus* **sp. nov.**, female, SEM micrographs. 3. Dorsal aspect; 4. Opisthonotum; 5. *J*-series setae and dorsal cavities.

TABLE 1. Length (mean ± SD / range in µm) and smoothness of podonotal setae in female and male of *Zercon hamaricus* **sp. nov.** with comparison to *Z. polonicus* Błaszak, 1970.

	♀♀				♂♂			
	Z. hamaricus		*Z. polonicus*		*Z. hamaricus*		*Z. polonicus*	
	length	type	length	type	length	type	length	type
j1	36 ± 2 / 32–39	B	35	B	33 ± 3 / 30–37	B	n/a	B
j2	24 ± 1 / 23–27	B	n/a	S	20 ± 1 / 19–22	B	n/a	S
j3	24 ± 1 / 23–25	S	n/a	S	20 ± 1 / 18–23	S	n/a	S
j4	23 ± 2 / 20–25	S	n/a	S	21 ± 1 / 19–22	S	n/a	S
j5	22 ± 1 / 21–24	S	n/a	S	19 ± 1 / 17–20	S	n/a	S
j6	24 ± 1 / 23–26	S	n/a	S	19 ± 1 / 17–20	S	n/a	S
z1	not developed in *Zercon*							
z2	19 ± 1 / 18–21	S	n/a	S	19 ± 1 / 18–22	S	n/a	S
z3	20 ± 1 / 19–21	S	n/a	S	22 ± 1 / 21–23	S	n/a	S
z4	26 ± 2 / 23–29	S	n/a	S	23 ± 1 / 21–25	S	n/a	S
z5	24 ± 2 / 22–26	S	n/a	S	21 ± 1 / 19–23	S	n/a	S
z6	18 ± 2 / 15–21	S	n/a	S	14 ± 1 / 13–17	S	n/a	S
s1	19 ± 2 / 17–22	S	n/a	S	16 ± 1 / 15–18	S	n/a	S
s2	30 ± 3 / 24–33	S	n/a	S	21 ± 2 / 19–23	S	n/a	S
s3	46 ± 3 / 43–50	B	n/a	S	42 ± 2 / 39–45	B	n/a	S
s4	27 ± 1 / 25–28	S	n/a	S	21 ± 1 / 20–23	S	n/a	S
s5	30 ± 2 / 27–32	S	n/a	S	24 ± 1 / 22–26	S	n/a	S
s6	43 ± 3 / 40–48	B	n/a	S	35 ± 2 / 32–37	B	n/a	S
r1	17 ± 1 / 17–19	S	n/a	S	17 ± 1 / 15–19	S	n/a	n/a
r2	23 ± 2 / 21–26	S	n/a	S	24 ± 2 / 22–28	S	n/a	S
r3	49 ± 1 / 48–52	B	n/a	S	40 ± 2 / 36–42	B	n/a	n/a
r4	33 ± 2 / 30–35	B	n/a	S	26 ± 3 / 22–29	B	n/a	S
r5	37 ± 2 / 33–40	B	n/a	S	31 ± 2 / 28–35	B	n/a	S

n/a—data not available.; type of seta: S—smooth; B—barbed.

Ventral idiosoma (Figure 6). Epigynal and peritrematal shields shaped typically for genus. Seta *r3* with subapical barbs. Sternal shield fully covered with reticulate ornamentation, setae *st1–st5* similar in length, 16–27, smooth and pointed. Ventrianal shield length 221–242, width (at level of *Jv2* setae) 319–333. Ventrianal shield with 21 smooth and pointed setae. Ventrianal shield covered with dotted and reticulate ornamentation in the anterior part (to level of *Zv3* setae), remaining posterior surface of ventrianal shield without reticulate ornamentation, finely dotted. Setae *Jv1*, *Jv2*, *Zv1–Zv4* 17–24, *Jv3* 26–31, *Jv4* and para-anal setae 35–45, *Jv5* 49–54 and postanal seta 45–50 long. Three parallel lines of denser dots visible posterior to postanal seta (length of each line does not exceed distance between para-anal setae). Anus length 22–27, width 17–20. Location of ventral glands: *gv1* close to insertion of *st3*, *gv2* multiple and typically located; *gvi* in the inguinal region; *gv3* (posterior para-anal glands) posterior to line connecting para-anal setae, close to line connecting setae *Jv4*; *gp* anterior to peritreme. Location of ventral poroids: *iv1* posterior to insertion of *st1*; *iv2* posterior to insertion of *st2*; *iv3* at the posterior edge of sternal shield, adaxial to insertion of *st3*; *iv5* on the genital shield, posterior to seta *st5*; *ip1* antero-adaxial to *gp*; *ip2* postero-adaxial to stigma; *ivo1* and *ivo2* located at level of *Jv2–Zv2* setae; *ivo3* close to lateral edge of ventrianal shield, close and posterior to line connecting insertions of setae *Zv4*; *ivo4* not visible; *ivi* in the inguinal region; *ivp* single, anterior to line connecting setae *Jv5*, closer to insertion of *Jv5*.

TABLE 2. Length (mean ± SD / range in µm) and smoothness of opisthonotal setae with longitudinal distances between insertions of setae in female and male of *Zercon hamaricus* **sp. nov.** with comparison to *Z. forsslundi* Sellnick, 1958 and *Z. polonicus* Błaszak, 1970 with notes on the body length/width and *Z5–Z5* distance.

	♀♀						♂♂					
	Z. hamaricus		*Z. forsslundi*		*Z. polonicus*		*Z. hamaricus*		*Z. forsslundi*		*Z. polonicus*	
	length	type	length	type	length	type	length	type	length	type	length	type
J1	19 ± 1 / 17–20	S	n/a	S	14	S	14 ± 1 / 13–16	S	n/a	S	12	S
J1–J2	44 ± 5 / 38–50		n/a		36–40		38 ± 3 / 31–41		n/a		33–37	
J2	19 ± 1 / 18–20	S	n/a	S	14	S	13 ± 1 / 12–14	S	n/a	S	12	S
J2–J3	36 ± 5 / 32–46		n/a		44–48		28 ± 4 / 22–34		n/a		24–29	
J3	14 ± 1 / 13–15	S	n/a	S	14	S	11 ± 1 / 10–14	S	n/a	S	12	S
J3–J4	37 ± 7 / 31–51		n/a		22		29 ± 4 / 19–34		n/a		18	
J4	16 ± 1 / 14–17	S	n/a	S	16	S	10 ± 1 / 8–11	S	n/a	S	14	S
J4–J5	38 ± 5 / 30–47		n/a		26		30 ± 8 / 24–48		n/a		14	
J5	74 ± 4 / 70–83	B	70	B	63–72	B	10 ± 1 / 9–11	S	n/a	S	30–38	B
Z1	20 ± 1 / 18–22	S	n/a	S	12	S	15 ± 2 / 13–17	S	n/a	S	10	S
Z1–Z2	52 ± 5 / 45–62		n/a		42–48		37 ± 4 / 32–44		n/a		31–35	
Z2	19 ± 1 / 18–21	S	n/a	S	12	S	13 ± 1 / 11–15	S	n/a	S	10	S
Z2–Z3	45 ± 6 / 33–53		n/a		28–32		33 ± 7 / 22–46		n/a		20–24	
Z3	20 ± 1 / 18–22	S	n/a	S	44–48	B	15 ± 1 / 14–16	S	n/a	S	39–43	B
Z3–Z4	65 ± 6 / 56–74		n/a		44–48		49 ± 5 / 37–57		n/a		32–36	
Z4	88 ± 2 / 86–92	B	76	B	68–72	B	77 ± 4 / 71–82	B	64	B	47–56	B
Z4–Z5	84 ± 2 / 81–88		n/a		n/a		64 ± 2 / 58–66		n/a		n/a	
Z5	111 ± 4 / 101–115	B	84	B	70–74	B	102 ± 2 / 100–104	B	76	B	48–55	B
S1	35 ± 2 / 32–38	B	n/a	S	n/a	S	29 ± 1 / 27–30	B	n/a	S	n/a	S
S1–S2	66 ± 4 / 60–71		n/a		n/a		50 ± 5 / 44–57		n/a		n/a	
S2	23 ± 2 / 20–26	S	n/a	S	13	S	20 ± 1 / 18–21	S	n/a	S	12	S
S2–S3	50 ± 4 / 44–55		n/a		46–50		36 ± 4 / 30–42		n/a		29–33	
S3	35 ± 2 / 33–38	S	n/a	S	13	S	32 ± 1 / 28–33	S	n/a	S	12	S
S3–S4	73 ± 6 / 60–80		n/a		58–62		56 ± 5 / 47–67		n/a		38–42	
S4	64 ± 4 / 57–70	B	52	B	35–39	S	53 ± 4 / 47–63	B	44	B	27–31	S
S4–S5	76 ± 5 / 72–85		n/a		46–50		56 ± 6 / 44–61		n/a		38–42	
S5	80 ± 3 / 75–84	B	64	B	52–57	B	67 ± 3 / 61–73	B	52	B	44–48	B
Jv5	51 ± 2 / 49–54	S	n/a	S	24	S	43 ± 2 / 40–46	S	n/a	S	16	S
Z5–Z5	219 ± 4 / 214–225		176		120		174 ± 6 / 165–183		152		100	
idiosoma length	518 ± 10 / 505–529		495		450–490		412 ± 12 / 395–427		390		350–380	
idiosoma width	407 ± 4 / 403–410		375–405		320–350		310 ± 8 / 298–318		288		240–265	

n/a—data not available; type of seta: S—smooth; B—barbed.

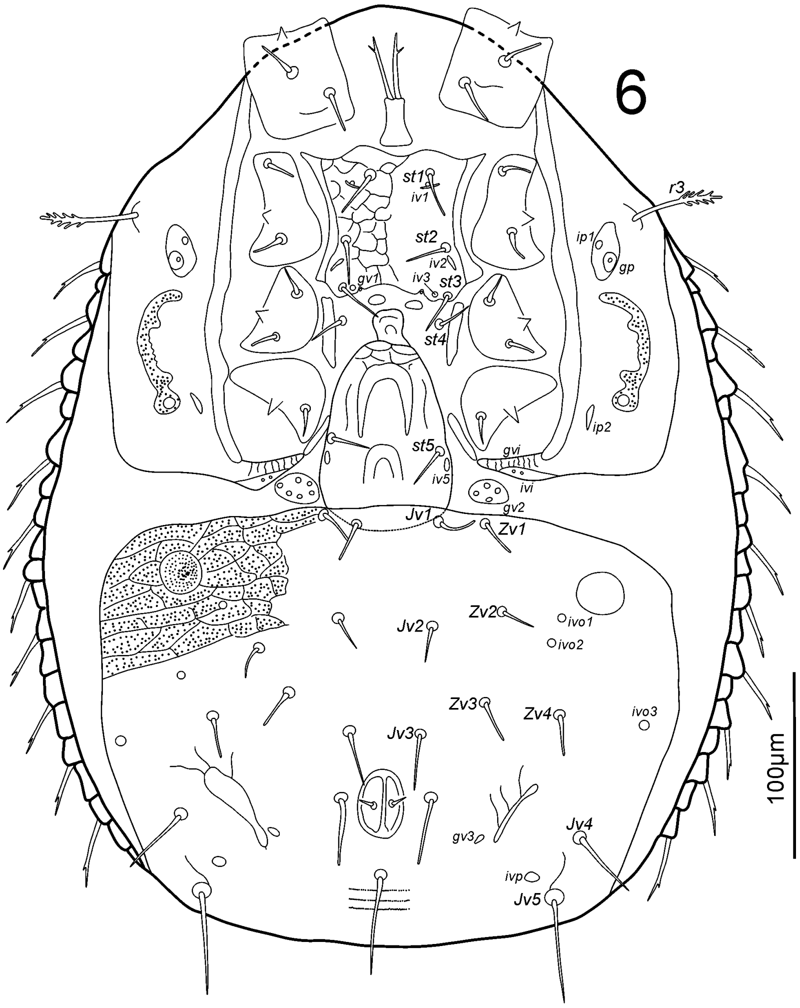
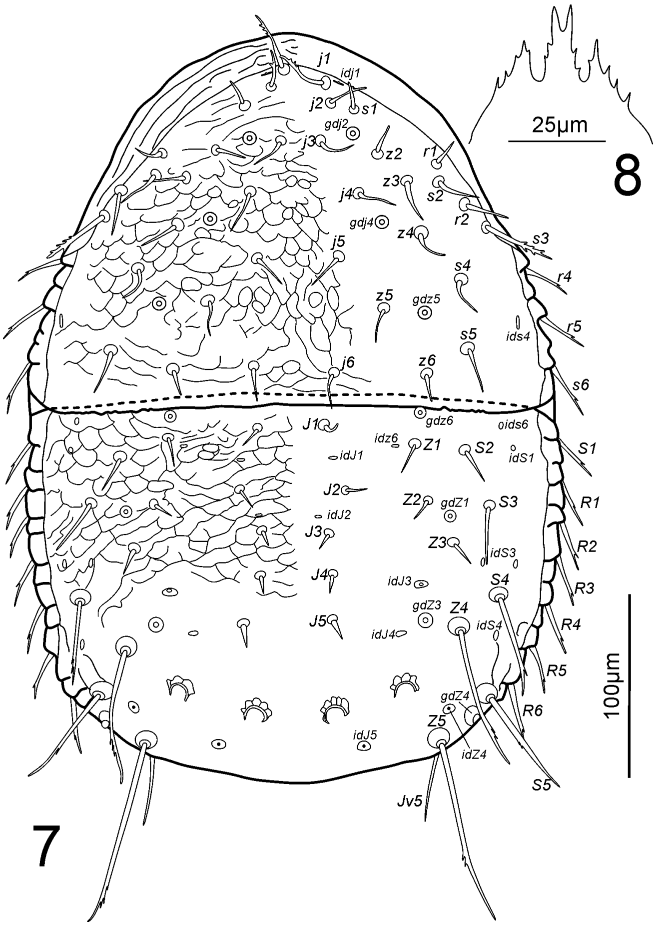


FIGURE 6. *Zercon hamaricus* **sp. nov.**, female, ventral aspect.

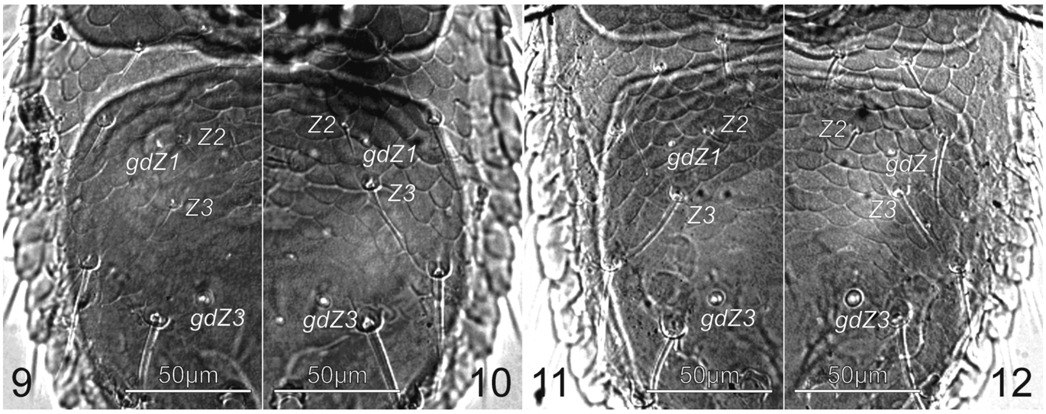
Male (n=8)

Idiosoma length 395–427, width (at level of anterior edge of ventrianal shield) 298–318.

Dorsal idiosoma (Figures 7, 9–12). Podonotal shield with 21 pairs of setae. All podonotal setae without hyaline endings. Lengths of podonotal setae of males summarized in Table 1. Seta *j1* longest of *j*-series, other *j*-series setae of comparable length. Seta *j1* with subapical barbs, *j2* with one subapical barb. Setae *j3–j6* smooth and pointed. All *z*-series setae smooth and pointed, *z6* shortest, *z2–z5* longer and of comparable length. Seta *s1* shortest of the *s*-series. Setae *s3* and *s6* of comparable length and longest of *s*-series. Seta *s3* with subapical barbs, seta *s6* with one subapical barb, other *s*-series setae smooth and pointed. Setae *r1* and *r2* smooth and pointed, setae *r4–r5* with one subapical barb. Seta *r1* shortest and *r5* longest of *r*-series of podonotal shield. Podonotal shield covered entirely with irregular tile-like sculpture. Location of podonotal glands: same as in female. Location of podonotal poroids: *idj1* abaxial to insertion of seta *j1*; *ids4* as in female; *idj3*, *idj6* and *idz4* not visible. Opisthonotal shield with 21 pairs of setae. All opisthonotal setae without hyaline endings. Lengths of opisthonotal setae and longitudinal distances between insertions of setae in specific series of males summarized in Table 2. Setae *J1–J5* short, smooth and pointed. Seta *J5* clearly thickened when compared to *J1–J4*. Setae of *Z*-series similar to those in female. Seta *Z4* clearly reach beyond lateral edge of opisthonotum, and reach beyond insertion of *Z5*. Seta *Z5* longer (1.2–1.4 times) than *Z4*. In most of studied males the length of *Z3* seta ranged from 14 to 16. In two males we found unusual length of *Z3* setae. In one male the left *Z3* seta was short (13) while the right one was clearly longer (34) (Figures 9–10). In another male both *Z3* setae were longer than usual (34 and 37) (Figures 11–12). Distance between setae *Z5* 165–183. Setae of *S*-series similar to those in female. Seta *S3* clearly longer (1.3–1.8 times) than *S2*. Seta *S4* clearly longer (1.4–2.0 times) than *S3*. Setae *R1–R6* 23–35, pointed, with one subapical barb. Opisthonotal shield covered with tile-like structure in anterior corners between shield margin and *Z1–Z2–Z3–S4* line and further with net-like pattern to *J4–Z4* line. Remaining posterior surface of opisthonotum without sculpture, finely dotted. Posterodorsal cavities crescent-like with undulated anterior margins. Location of opisthonotal glands: same as in female. Location of opisthonotal poroids: *idz6* posterior to line connecting insertions of setae *J1* and *Z1*, closer to *Z1*; *idJ1* on the line connecting insertions of setae *J1* and *J2*; *idJ2* close and adaxial to line connecting insertions of setae *J2* and *J3*; *idJ3* posterior to line connecting insertions of setae *J4* and *Z3*, closer to *Z3*; *idJ4* posterior to line connecting insertions of setae *J5* and *Z4*; *idJ5* posterior and adjacent to line connecting posterior edges of inner posterodorsal cavities; *idZ4* close to line connecting setae *Z4* and *Z5*, closer to *Z5*; *ids6* close to antero-abaxial edge of opisthonotum; *idS1* equidistant from seta *S2* and lateral edge of opisthonotum; *idS3* doubled, close to line connecting setae *S3* and *S4*, closer to *S4*; *idS4* posterior to setae *S4*, at the level of setae *Z4*; *idR3* not visible.



FIGURES 7–8. *Zercon hamaricus* **sp. nov.**, male. 7. Dorsal aspect; 8. Epistome.



FIGURES 9–12. *Zercon hamaricus* **sp. nov.**, unusual chaetotaxy in male. 9–10. Male with one seta *Z3* short and the other clearly longer; 11–12. Male with both setae *Z3* longer than usual.

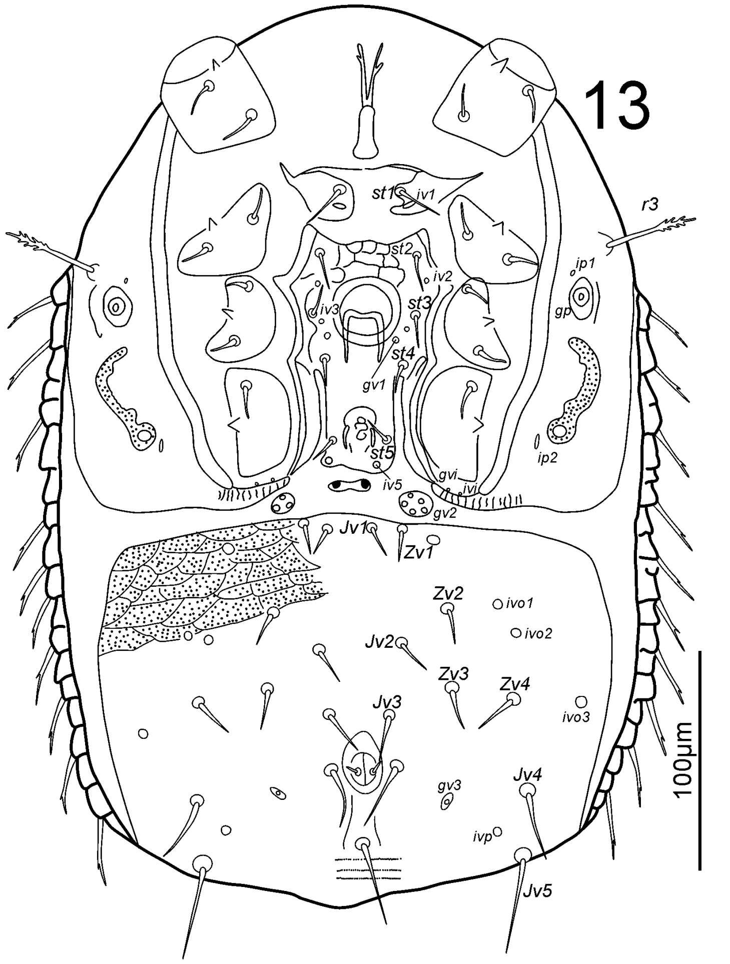
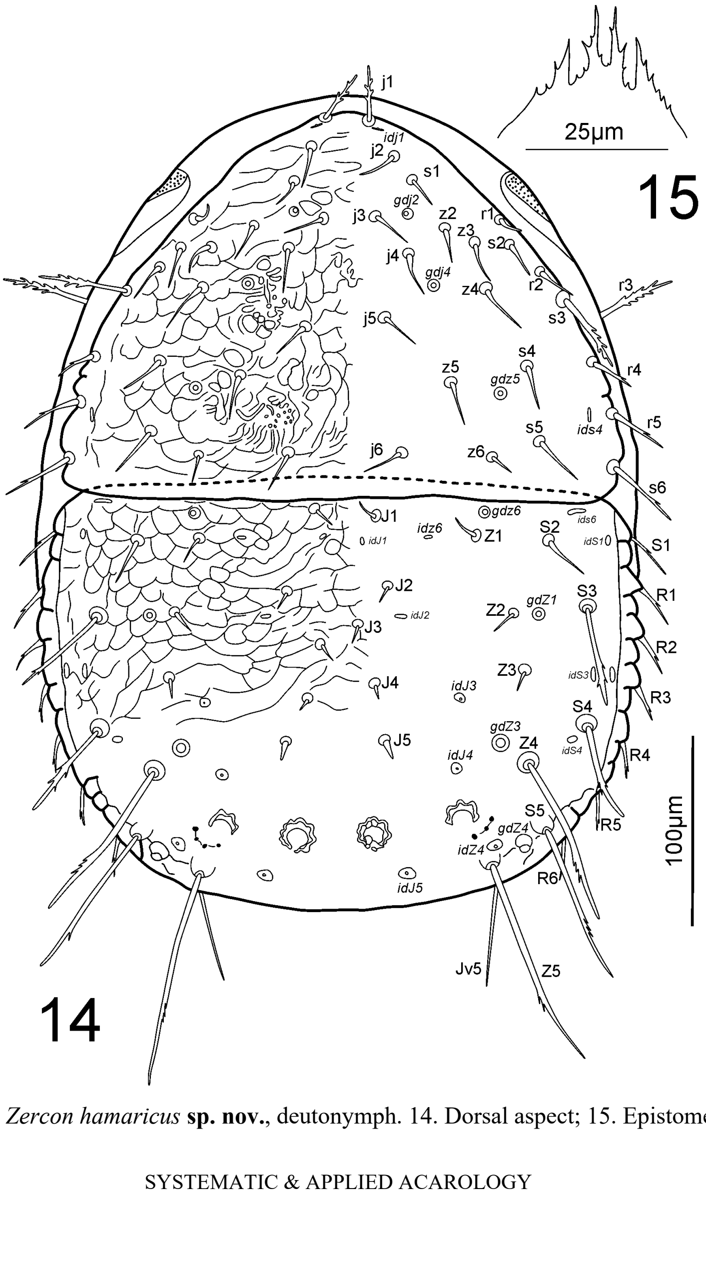


FIGURE 13. *Zercon hamaricus* **sp. nov.**, male, ventral aspect.

Gnathosoma. Epistome (Figure 8) typically shaped for genus with medial process bifurcated. One male with medial process tripartite.

Ventral idiosoma (Figure 13). Genital and peritrematal shields shaped typically for genus. Seta *r3* with subapical barbs. Sternal shield anteriorly covered with reticulate ornamentation. Sternal setae smooth and pointed, *st1–st2* 17–23, and *st3–st5* 12–15 long. Ventrianal shield length 177–200, width (at level of *Jv2* setae) 254–271. Ventrianal shield with 21 smooth and pointed setae. Ventrianal shield covered with dotted and reticulate ornamentation in the anterior part (to level of *Zv3* setae), remaining posterior surface of shield without reticulate ornamentation and finely dotted. Setae *Jv1*, *Jv2*, *Zv1–Zv4* 14–21, *Jv3* 20–25, *Jv4* and para-anal setae 28–34, *Jv5* 40–46 and postanal seta 37–41 long. Three parallel lines of denser dots visible posterior to postanal seta (length of each line does not exceed distance between para-anal setae). Anus length 17–20, width 10–16. Location of ventral glands: *gv1* adaxial to line connecting insertions of setae *st3* and *st4*; location of other glands same as in female. Location of ventral poroids: *iv3* posterior to insertion of *st3*; *iv5* on the sternal shield, posterior to insertion of seta *st5*; location of other poroids same as in female.



FIGURES 14–15. *Zercon hamaricus* **sp. nov.**, deutonymph. 14. Dorsal aspect; 15. Epistome.

Deutonymph (n=8)

Idiosoma length 414–436, width (at level of anterior edge of ventrianal shield) 311–344.

Dorsal idiosoma (Figure 14). Podonotal shield with 21 pairs of setae. All podonotal setae without hyaline endings. Lengths of podonotal setae of deutonymphs summarized in Table 3. Seta *j1* longest of *j*-series, other *j*-series setae of comparable length. Seta *j1* with subapical barbs, other *j*-series setae smooth and pointed. All *z*-series setae smooth and pointed, *z6* shortest and *z4* longest. Seta *s1* shortest of *s*-series. Setae *s2*, *s4* and *s5* of comparable length. Setae *s3* and *s6* of comparable length and longest of *s*-series. Seta *s3* with subapical barbs, seta *s6* with one subapical barb, other *s*-series setae smooth and pointed. Setae *r1* and *r2* smooth and pointed, setae *r4–r5* with one subapical barb. Seta *r1* shortest and *r5* longest of *r*-series. Podonotal shield partly covered with irregular net-like sculpture and laterally with tile-like pattern with some more densely corrugated pattern between *j*-series and *z*-series. Location of podonotal glands and poroids: same as in male. Opisthonotal shield with 21 pairs of setae. All opisthonotal setae without hyaline endings. Lengths of opisthonotal setae and longitudinal distances between insertions of setae in specific series of deutonymphs summarized in Table 4. Setae *J1–J5* as in male: short, smooth and pointed; seta *J5* clearly thickened when compared to *J1–J4*. Setae of *Z*-series similar to those in female. Seta *Z4* clearly reach beyond lateral edge of opisthonotum, and reach beyond insertion of *Z5*. Seta *Z5* longer (1.2–1.3 times) than *Z4*. Distance between setae *Z5* 155–161. Seta *S1* with one subapical barb. Seta *S2* shortest of *S*-series, smooth and pointed. Setae *S3–S5* with subapical barbs. Seta *S3* clearly longer (2.1–3.0 times) than *S2*. Seta *S2* never reach and *S3* almost reach the insertion of next seta in series. Setae *S3* and *S4* of comparable length. Seta *S5* longer (1.2–1.4 times) than *S4*. Seta *R1* always slightly longer (24–30) than other setae of *R*-series (17–24). All *R*-setae with one subapical barb. Opisthonotal shield covered with tile-like pattern in antero-lateral corners and net-like pattern to line *J4–Z3–S4*. Remaining posterior surface of opisthonotum without sculpture, finely dotted. Posterodorsal cavities with undulated anterior margin; outer cavities crescent-like, inner ones more rounded. Location of opisthonotal glands: *gdz6* (*Po1*) anterolateral to *Z1*; *gdZ1* (*Po2*) on the line connecting insertions of setae *Z2* and *S3*, closer to insertion of *Z2*; *gdZ3* (*Po3*) anterior to line connecting insertions of setae *J5* and *Z4*, closer to insertion of *Z4*; *gdZ4* (*Po4*) on the line connecting insertions of setae *Z5* and *S5*; *gdJ3* not visible. Location of opisthonotal poroids: *idz6* posterior to line connecting insertions of setae *J1* and *Z1*; *idJ1* close and adaxial to line connecting insertions of setae *J1* and *J2*; *idJ2* close and abaxial to line connecting insertions of setae *J2* and *J4*, closer to *J2*; *idJ3* posterior to line connecting insertions of setae *J4* and *Z3*; *idJ4* posterior to line connecting insertions of setae *J5* and *Z4*; *idJ5* posterior to line connecting posterior edges of inner posterodorsal cavities; *idZ4* close to line connecting setae *Z4* and *Z5*, closer to *Z5*; *ids6* close to antero-abaxial edge of opisthonotum; *idS1* on the line connecting insertions of setae *S1* and *S2*, closer to *S1*; *idS3* doubled, close to line connecting setae *S3* and *S4*; *idS4* posterior to seta *S4*, at the level of *gdZ3*; *idR3* not visible.

Gnathosoma. Epistome (Figure 15) typically shaped for genus.

Ventral idiosoma (Figure 16). Seta *r3* with subapical barbs. Sternal shield in anterior part with delicate reticulate ornamentation, posterior part dotted (barely visible). Setae *st1–st5* 12–21, smooth and pointed (*st5* off the shield). Ventrianal shield length 152–165, width (at level of *Jv3* setae) 248–263. Ventrianal shield with 17 smooth and pointed setae (*Jv1* and *Zv1* off the shield). Ventrianal shield covered with dotted and reticulate ornamentation in the anterior part (to level of *Jv3–Zv4* setae), remaining posterior surface of ventrianal shield without reticulate ornamentation and finely dotted. Setae *Jv1*, *Jv2* and *Zv1* 12–20, *Jv3* and *Jv4* 19–25, *Zv2* 9–13, *Zv3* and *Zv4* 13–19, *Jv5* 52–59, para-anal setae 27–30 and postanal seta 44–46 long. Three parallel lines of denser dots visible posterior to postanal seta (length of each line does not exceed distance between para-anal setae). Anus length 17–23, width 15–16. Location of ventral glands: *gv1* between insertions of setae *st3* and *st4*; *gv2* multiple and typically located; *gv3* (posterior para-anal glands) posterior to line connecting para-anal setae, close to line connecting setae *Jv4*; *gp* close to peritreme, at the level of coxa III; *gvi* close to posterior edge of coxa IV. Location of ventral poroids: *iv1*–*iv3* similar to those in male; *iv5* posterior to insertion of seta *st5*, at the level of *gv2*; *ip1* at the level of coxa II; *ip2* similar to those in adults; *ivo1* and *ivo2* located at level of *Jv2*–*Zv2* setae; *ivo3* close to lateral edge of ventrianal shield, close to line adjacent to anterior edge of anus; *ivo4* not visible; *ivp* single, anterior to line connecting setae *Jv5*, closer to insertion of *Jv5*; *ivi* close to posterior edge of coxa IV.

TABLE 3. Length (mean ± SD / range in μm) and smoothness of podonotal setae in deutonymphs (D), protonymphs (P) and larvae (L) of *Zercon hamaricus* **sp. nov.** with comparison to *Z. polonicus* Błaszak, 1970.

	D				P				L	
	Z. hamaricus		*Z. polonicus*		*Z. hamaricus*		*Z. polonicus*		*Z. hamaricus*	
	length	type	length	type	length	type	length	type	length	type
j1	30 ± 2 / 27–32	B	n/a	B	24 ± 1 / 23–24	B	n/a	B	22 ± 2 / 20–24	S
j2	21 ± 1 / 19–23	S	n/a	S	17 ± 1 / 15–18	S	n/a	S	nds	-
j3	22 ± 3 / 19–25	S	n/a	S	22 ± 1 / 21–22	S	n/a	S	19 ± 1 / 18–19	S
j4	22 ± 2 / 18–24	S	n/a	S	22 ± 1 / 20–23	S	n/a	S	20 ± 1 / 19–21	S
j5	21 ± 1 / 20–23	S	n/a	S	20 ± 1 / 18–21	S	n/a	S	19 ± 1 / 18–20	S
j6	20 ± 1 / 19–22	S	n/a	B	19 ± 1 / 18–21	S	n/a	S	20 ± 1 / 19–20	S
z1	not developed in *Zercon*									
z2	17 ± 2 / 14–21	S	n/a	S	20 ± 1 / 18–20	S	n/a	S	17 ± 1 / 16–17	S
z3	22 ± 2 / 20–25	S	n/a	S	nds	-	nds	-	nds	-
z4	28 ± 2 / 25–31	S	n/a	S	31 ± 1 / 29–33	B	n/a	S	34 ± 2 / 32–37	B
z5	23 ± 1 / 21–25	S	n/a	S	20 ± 1 / 19–21	S	n/a	S	20 ± 1 / 18–21	S
z6	12 ± 1 / 11–15	S	n/a	S	nds	-	nds	-	nds	-
s1	15 ± 1 / 13–16	S	n/a	S	nds	-	nds	-	nds	-
s2	20 ± 1 / 19–21	S	n/a	S	nds	-	nds	-	nds	-
s3	49 ± 4 / 43–55	B	n/a	B	nds	-	nds	-	nds	-
s4	25 ± 2 / 21–29	S	n/a	S	30 ± 1 / 28–32	B	n/a	S	49 ± 1 / 48–51	B
s5	27 ± 2 / 23–29	S	n/a	S	30 ± 1 / 29–31	S	n/a	S	nds	-
s6	40 ± 3 / 36–44	B	n/a	S	28 ± 1 / 27–29	B	n/a	S	6 ± 0.5 / 5–6	S
r1	14 ± 1 / 13–16	S	n/a	S	nds	-	nds	-	nds	-
r2	22 ± 1 / 20–24	S	n/a	S	42 ± 3 / 38–46	B	32	B	nds	-
r3	41 ± 2 / 39–45	B	n/a	n/a	27 ± 1 / 26–27	B	n/a	n/a	nds	-
r4	20 ± 2 / 17–23	B	n/a	S	nds	-	nds	-	nds	-
r5	29 ± 2 / 23–31	B	n/a	S	14 ± 1 / 13–16	S	n/a	S	nds	-

n/a—data not available; nds—not developed in stage; type of seta: S—smooth; B—barbed.

Protonymph (n=3)

Idiosoma length 329–340, width (at level of anterior edge of opisthonotal shield) 235–252.

Dorsal idiosoma (Figure 17). Podonotal shield with 12 pairs of setae. All podonotal setae without hyaline endings. Lengths of podonotal setae of protonymphs summarized in Table 3. Seta *j1* longest of *j*-series, other *j*-series setae of comparable length. Seta *j1* with subapical barbs, other *j*-series setae smooth and pointed. Seta *z4* longest of *z*-series, with subapical barbs, other *z*-series setae of comparable length, smooth and pointed. Setae of *s*-series of comparable length. Setae *s4* and *s6* with one subapical barb. Seta *s6* off the podonotal shield. Seta *r2* on the podonotal shield, clearly longer, with subapical barbs. Seta *r5* off the podonotal shield, short, smooth and pointed. Podonotal shield covered entirely with irregular lines (delicately corrugated). Location of podonotal glands: *gdj2* (*po1*) posterior to insertion of seta *j2*, anterior to line connecting insertions of setae *j3*; *gdj4* (*po2*) and *gdz5* (*po3*) as in female and male. Location of podonotal poroids: *ids4* antero-abaxial to insertion of seta *s4*; other poroids as in female. Opisthonotal shield with 14 pairs of setae. All opisthonotal setae without hyaline endings. Lengths of opisthonotal setae and longitudinal distances between insertions of setae in specific series of protonymphs summarized in Table 4. Setae *J1–J5* short, smooth and pointed. Setae *Z1–Z3* short, smooth and pointed. Setae *Z4* and *Z5* clearly longer, with barbs located at about one third or one fourth from seta termination. Seta *Z4* clearly reach beyond lateral edge of opisthonotum, and reach beyond insertion of *Z5*. Seta *Z5* longer (1.1–1.4 times) than *Z4*. Distance between *Z5* setae 97–99. Seta *S2* shortest of *S*-series, smooth and pointed. Setae *S3–S5* longer with subapical barbs. Seta *S3* clearly longer (1.5–1.8 times) than *S2*. Setae *S2–S4* clearly reach the insertions of next setae in series. Setae *S3* and *S4* of comparable length (*S4* 1.1–1.2 times longer than *S3*). Seta *S5* longer (1.2–1.3 times) than *S4*. Seta *R1* off the opisthonotal shield, short (14–16), smooth and pointed. Opisthonotal shield covered with similar pattern to line *J4–S4*. Remaining posterior surface of opisthonotum finely dotted. Posterodorsal cavities with undulated anterior margin; outer cavities crescent-like, inner ones more rounded. Location of opisthonotal glands: *gdz6* (*Po1*) anterior to insertion of *Z1*; *gdZ1* (*Po2*) anterior to line connecting insertions of setae *Z2* and *S3*; *gdZ3* (*Po3*) close to line connecting insertions of setae *Z3* and *Z4*, close to insertion of *Z4*; *gdZ4* (*Po4*) on the line connecting insertions of setae *Z5* and *S5*, close to insertion of *Jv5*; *gdJ3* not visible. Location of opisthonotal poroids: *idz6* posterior to line connecting insertions of setae *J1* and *Z1*, equidistant; *idJ1* close and adaxial to line connecting insertions of setae *J1* and *J2*; *idJ2* on line connecting insertions of setae *J2* and *J4*, closer to *J2*; *idJ3* posterior to line connecting insertions of setae *J4* and *Z3*; *idJ4* anterior to line connecting insertions of setae *J5* and *Z4*, closer to *J5*; *idJ5* on the line connecting *Z5* setae, closer to insertion of *Z5*; *idZ4* close and anterior to insertion of seta *Z5*; *ids6* close to antero-abaxial edge of opisthonotum, anterior to insertion of seta *S2*; *idS1* anterior to insertion of seta *S3*, at the level of seta *S2*; *idS3* doubled, close to line connecting setae *S3* and *S4*, at the level of seta *Z3*; *idS4* posterior to seta *S4*, at the level of seta *Z4*; *idR3* not visible.

Gnathosoma. Epistome (Figure 18) typically shaped for genus.

Ventral idiosoma (Figure 19). Setae *r3* with subapical barbs. Sternal shield without ornamentation. Setae *st1–st3* 12–16, *st5* off the sternal shield and shorter 6–7. Ventrianal shield with 9 smooth and pointed setae (*Jv1* off the shield). Ventrianal shield without visible sculpture, with some corrugations. Setae *Jv1*, *Jv2* and *Zv2* of comparable length (14–17), para-anal setae longer 19–22, postanal seta 42–45 and *Jv5* 48–53 long. Two parallel lines of denser dots visible posterior to postanal seta (length of each line does not exceed distance between para-anal setae). Anus length 17–19, width 13–14. Location of ventral glands: *gv2* abaxial to *Jv1* setae, on the line connecting insertions of these setae; *gv3* (posterior para-anal glands) posterior to line connecting para-anal setae; *gp* anterior to short peritreme, at the level of coxa III. Location of ventral poroids: *ip1* at the level of coxa II; *ip2* posterior or postero-abaxial to stigma; *iv1* posterior to insertion of *st1*; *iv2* posterior to insertion of *st2*; *ivo1* and *ivo2* located at level of *Jv2–Zv2* setae, *ivo1* close to anterior edge of ventrianal shield; *ivo3* close to lateral edge of ventrianal shield, at the level of para-anal setae; *ivo4* not visible; *ivp* single, antero-abaxial to insertion of seta *Jv5*.

Larva (n=6)

Idiosoma length 230–271, width (at level of setae *S3*) 191–243.

Dorsal idiosoma (Figure 20). Podonotal shield with nine pairs of setae. All podonotal setae without hyaline endings. Lengths of podonotal setae of larvae summarized in Table 3. All *j*-series setae of comparable length, smooth and pointed. Setae *z2* and *z5* short, smooth and of comparable length, seta *z4* clearly longer, with one subapical barb. Seta *s4* longest of podonotal shield, with one subapical barb. Seta *s6* off the shield, diminutive. Location of podonotal glands: *gdj4* and *gdz5* not visible. Location of podonotal poroids: *idj3*, *idj6*, *idz4* and *ids4* not visible. Opisthonotal shield with 6 pairs of setae. All opisthonotal setae without hyaline endings. Lengths of opisthonotal setae in larvae summarized in Table 4. Setae *J2* and *S3* off shield, diminutive. Setae *J3*, *J4* and *S4* similar in length, diminutive, smooth and pointed. Setae *Z3*, *Z4* and *J5* with subapical barbs and curved terminations. Seta *Z4* longer (1.3–1.4 times) than *Z3*. Seta *J5* longest of opisthonotal shield, longer (1.3–1.5 times) than *Z4*. Location of opisthonotal glands: *gdJ3* not visible; *gdZ3* (*Po3*) anterior to line connecting insertions of setae *J4* and *Z4*, closer to insertion of *Z4*. Location of opisthonotal poroids: *idz6* anterior to line connecting insertions of setae *S3*, abaxial to insertion of *J2*; *idJ3* adaxial to insertions of setae *Z3*, on the line connecting insertions of these setae; *idJ5* between anterior and posterior pair of dorsal cavities; *idR3* not visible. Podonotal and opisthonotal shields with irregular pattern, delicately corrugated. Soft cuticular area between dorsal shields with visible parallel corrugations. Posterodorsal cavities circular with smooth edges, arranged typically for the genus.

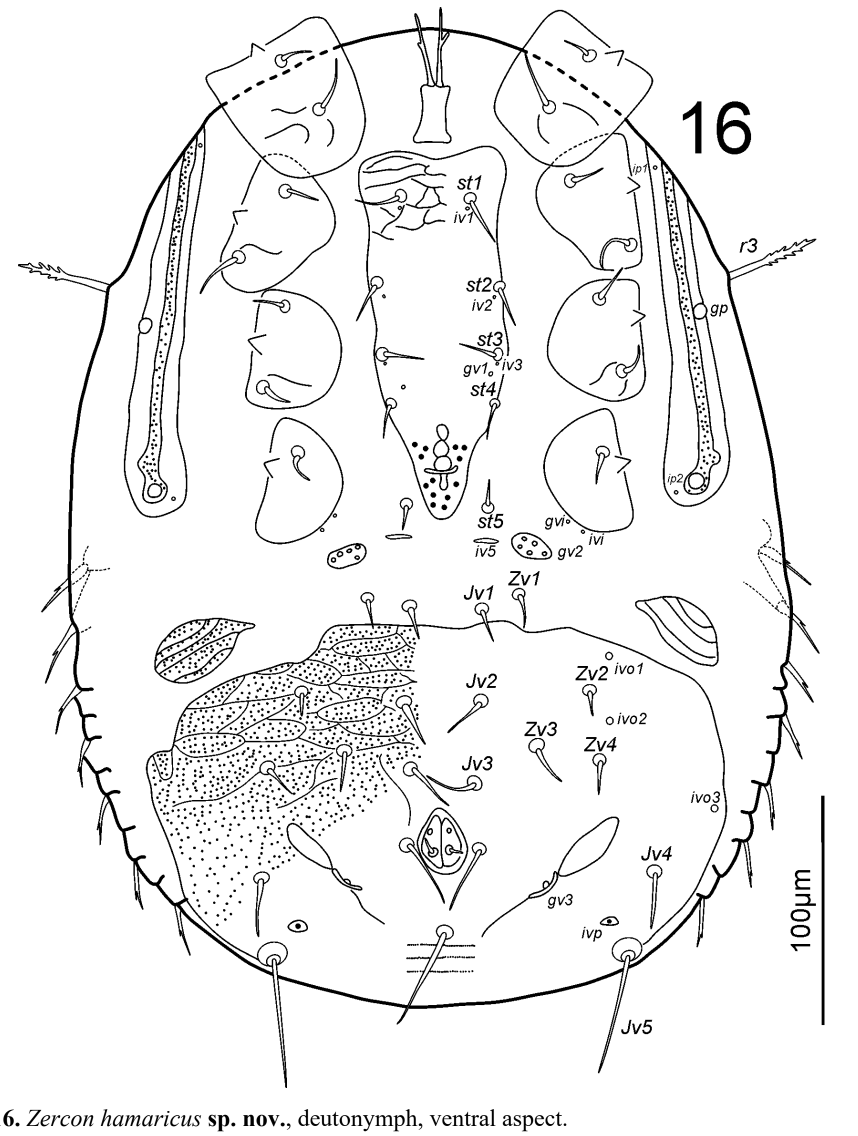


FIGURE 16. *Zercon hamaricus* **sp. nov.**, deutonymph, ventral aspect.

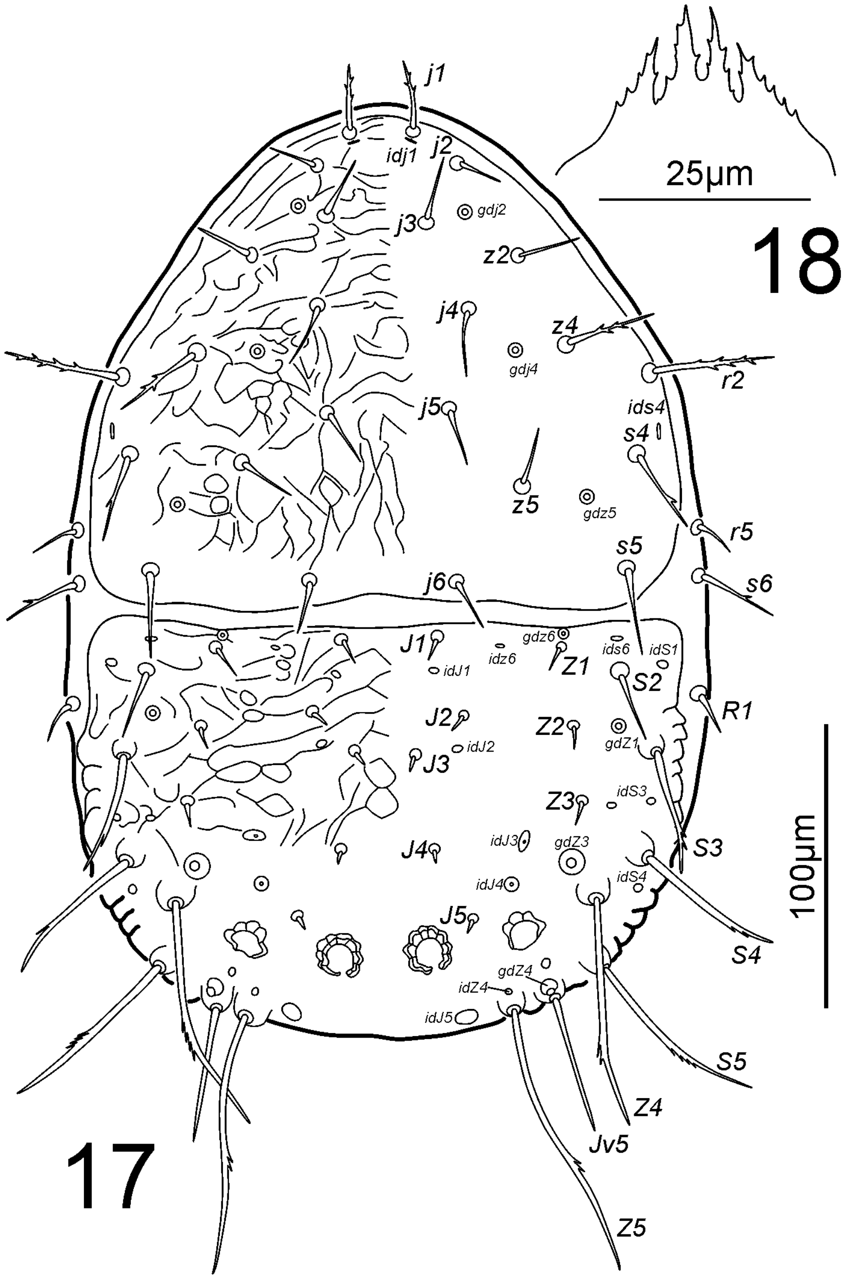
TABLE 4. Length (mean ± SD / range in µm) and smoothness of opisthonotal setae with longitudinal distances between insertions of setae in deutonymphs (D), protonymphs (P) and larvae (L) of *Zercon hamaricus* **sp. nov.** with comparison to *Z. polonicus* Błaszak, 1970 and notes on the body length/width and *Z5–Z5* distance.

	D				P				L	
	Z. hamaricus		*Z. polonicus*		*Z. hamaricus*		*Z. polonicus*		*Z. hamaricus*	
	length	type	length	type	length	type	length	type	length	type
J1	12 ± 2 / 10–14	S	8	S	11 ± 1 / 9–13	S	9	S	nds	-
J1–J2	41 ± 4 / 35–46		36–40		31 ± 1 / 29–32		28		n/a	
J2	11 ± 1 / 10–14	S	8	S	8 ± 1 / 6–9	S	9	S	7 ± 1 / 6–8	S
J2–J3	32 ± 4 / 25–36		26–30		24 ± 3 / 20–29		30		n/m	
J3	10 ± 1 / 9–11	S	8	S	6 ± 1 / 5–7	S	9	S	7 ± 0.5 / 6–7	S
J3–J4	31 ± 5 / 25–41		22		33 ± 3 / 27–36		20		n/m	
J4	9 ± 1 / 8–10	S	11–14	S	6 ± 1 / 5–8	S	10	S	5 ± 1 / 5–6	S
J4–J5	27 ± 3 / 23–34		18		28 ± 2 / 25–29		20		n/m	
J5	10 ± 1 / 8–13	S	12–16	S	6 ± 1 / 5–7	S	10	S	106 ± 3 / 102–110	B
Z1	13 ± 3 / 10–18	S	8	S	12 ± 1 / 10–13	S	8	S	nds	-
Z1–Z2	43 ± 5 / 35–53		34–38		30 ± 2 / 27–34		30		n/a	
Z2	12 ± 2 / 10–15	S	8	S	9 ± 1 / 8–9	S	8	S	nds	-
Z2–Z3	32 ± 4 / 28–40		24–28		27 ± 3 / 24–32		24		n/a	
Z3	11 ± 1 / 10–13	S	44–50	B	8 ± 1 / 7–9	S	38	S	58 ± 1 / 58–61	B
Z3–Z4	52 ± 3 / 48–58		38–42		40 ± 1 / 40–41		36		n/m	
Z4	94 ± 3 / 90–100	B	56–62	B	80 ± 4 / 75–86	B	48	B	77 ± 3 / 73–80	B
Z4–Z5	67 ± 4 / 62–73		n/a		51 ± 1 / 50–52		n/a		n/m	
Z5	118 ± 4 / 113–124	B	64–68	B	100 ± 5 / 94–108	B	70	B	7 ± 1 / 6–7	S
S1	25 ± 1 / 23–27	B	n/a	n/a	nds	-	nds	-	nds	-
S1–S2	44 ± 5 / 36–50		n/a		n/a		n/a		n/a	
S2	22 ± 2 / 20–26	S	9	S	29 ± 3 / 25–31	S	30	S	nds	-
S2–S3	45 ± 4 / 39–52		36–40		34 ± 4 / 30–40		30		n/a	
S3	58 ± 4 / 50–64	B	19–23	S	46 ± 3 / 44–51	B	41	B	6 ± 0.5 / 5–6	S
S3–S4	59 ± 4 / 55–66		46–50		39 ± 1 / 38–41		30		n/m	
S4	64 ± 5 / 54–72	B	46–50	B	53 ± 1 / 51–54	B	46	B	5 ± 0.0	S
S4–S5	57 ± 2 / 54–61		46–50		43 ± 1 / 41–44		34		n/m	
S5	85 ± 3 / 81–88	B	54–58	B	67 ± 1 / 65–69	B	52	B	7 ± 0.4 / 6–7	S
Jv5	56 ± 2 / 52–59	S	26	S	50 ± 2 / 48–53	S	34	S	7 ± 0.4 / 6–7	S
Z5–Z5	157 ± 2 / 155–161		112		98 ± 1 / 97–99		78		n/m	
idiosoma length	427 ± 8 / 414–436		385–405		335 ± 6 / 329–340		302		252 ± 18 / 230–271	
idiosoma width	323 ± 13 / 311–344		270–290		246 ± 9 / 235–252p		172		222 ± 22 / 191–243	

nds—not developed in stage; n/m—not measured; n/a—not applicable or data not available; type of seta: S—smooth; B—barbed.

Gnathosoma. Epistome (Figure 21) typically shaped for genus.

Ventral idiosoma (Figure 22). Sternal shield without ornamentation. Setae *st1–st3* 12–16. Ventrianal shield with three setae (*Jv1*, *Jv2*, *Jv5* and *Zv2* off the shield). Setae *Zv2* and *Jv5* 6–9, *Jv1* 11–12, *Jv2* 18–19, para-anal setae 29–30 and postanal seta 50 long. Ventrianal shield subtriangular, bell-shaped (not measured). Anal opening poorly visible (not measured). Setae *Z5* and *S5* diminutive, abaxial to ventrianal shield, on the level of postanal seta. Location of ventral glands: *gdZ4* (*Po4*) anterior to line connecting insertions of para-anal setae, abaxial to line connecting insertions of setae *Jv5* and *S5*; *gp* close to lateral edge of the idiosoma, at the level of setae *Jv1* and *Zv2*; *gv3* not visible. Location of ventral poroids: *ivo4* and *ivp* not visible.



FIGURES 17–18. *Zercon hamaricus* **sp. nov.**, protonymph. 17. Dorsal aspect; 18. Epistome.

Etymology

The new species is named after the place of collection, Hamar—city, municipality and administrative center of Innlandet county in Norway.

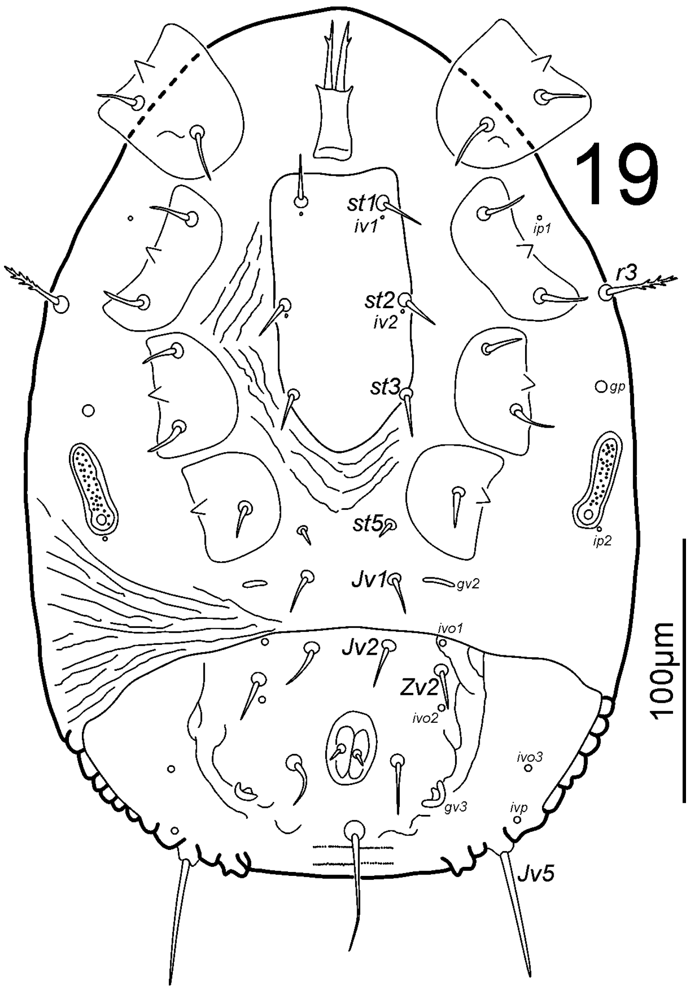
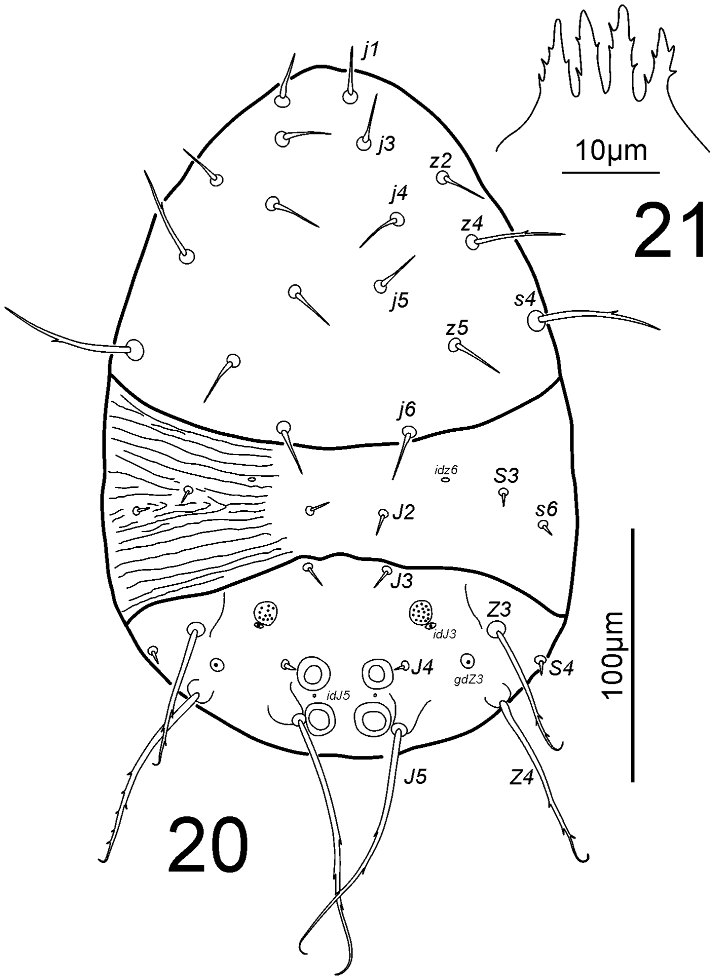


FIGURE 19. *Zercon hamaricus* **sp. nov.**, protonymph, ventral aspect.

Differential diagnosis

Zercon hamaricus **sp. nov.** belongs to a group of species with short *J1–J4* setae and long *J5* setae in females. Other species in this group are *Z. forsslundi*, *Z. polonicus*, *Z. lindquisti*, *Z. columbianus*, *Z. fenestralis*, *Z. canadensis*, *Z. carolinensis*, *Z. lucidus* and *Z. mexicanus.* Two subgroups of species can be distinguished with regard to *S1–S3*, *r4–r5–s6* and *R1–R6* setae (Table 5). The new species, *Z. hamaricus*, *Z. forsslundi* and *Z. polonicus* (the first subgroup) have the *S3* setae smooth, and podonotal *r4–r5–s6* setae similar to opisthonotal *S1–R1–R6* setae. In the other species (the second subgroup) seta *S3* is barbed, and *r4–r5–s6* differ at least from some of *R*-series setae. Setae *S2* and *S3* are equal in length in *Z. polonicus*, *S3* is slightly longer than *S2* in *Z. forsslundi*, while in *Z. hamaricus*, *S3* is at most 1.8 times longer than *S2*. In other species the *S3*/*S2* range from 2.46 (*Z. carolinensis*) to 3.5 (*Z. mexicanus*). Therefore, we conclude that *Z. hamaricus* is most similar to *Z. forsslundi* and *Z. polonicus*.

The females of *Z. forsslundi*, *Z. polonicus* and *Z. hamaricus* can be distinguished based on *J5* range, the length and shape of the *Z*-series and *S*-series setae, the distance between setae *Z5*, and the location of *gdZ3* (Table 6). In *Z. forsslundi* setae *J1*, *J2* and *J3* are generally located at the levels of corresponding *Z*-series setae and *Z3* setae are at level of *S4*. The *J*-series and *Z*-series setae are displaced anteriorly in *Z. polonicus* and *Z. hamaricus* when compared with *Z. forsslundi*. The line connecting *Z4* setae in *Z. forsslundi* is posterior to line connecting *R5* setae, while in *Z. polonicus* and *Z. hamaricus* it is anterior to this line. The line connecting the insertions of *J5* setae in *Z. polonicus* and *Z. hamaricus* is anterior to the line connecting setae *Z4*, while in *Z. forsslundi* setae *J5* and *Z4* are almost on the same line. Therefore, although the *J5* setae are in general similar in length in these three species, these setae clearly reach the posterior edge of the opisthonotum in *Z. forsslundi*, which is not true in the other two species.



FIGURES 20–21. *Zercon hamaricus* **sp. nov.**, larva. 20. Dorsal aspect; 21. Epistome.

Apart from *Z. hamaricus*, the immature stages are known in *Z. canadensis* (larvae and both nymphs), *Z. polonicus* (nymphs) and *Z. columbianus* (deutonymph). The characters useful to distinguish larvae and nymphs of these species are summarized in Table 7.

TABLE 5. Distinguishing characters (females) of two subgroups of species including *Z. hamaricus* **sp. nov.**, *Z. forsslundi, Z. polonicus, Z. lindquisti*, *Z. columbianus*, *Z. fenestralis*, *Z. canadensis*, *Z. carolinensis*, *Z. lucidus* and *Z. mexicanus*.

	Z. hamaricus, *Z. forsslundi, Z. polonicus*	*Z. lindquisti*, *Z. columbianus*, *Z. fenestralis*, *Z. canadensis*, *Z. carolinensis*, *Z. lucidus*, *Z. mexicanus*
S3	smooth	barbed
S3: *S2*	1.3–1.8: 1 (*Z. hamaricus*) *S3* slightly longer than *S2* (*Z. forsslundi* acc. to Sellnick's description) 1: 1 (*Z. polonicus*)	2.4: 1 (*Z. carolinensis*) 2.4–2.6: 1 (*Z. fenestralis* acc. to Evans' drawing) 2.5: 1 (*Z. columbianus*, *Z. canadensis*) 3.4: 1 (*Z. lindquisti*, *Z. lucidus*) 3.5: 1 (*Z. mexicanus*)
S1–R1–R6 and *r4–r5–s6*	*S1–R1–R6* similar to *r4–r5–s6*, smooth (*Z. forsslundi, Z. polonicus)* *S1–R1–R6* similar to *r4–r5–s6*, barbed (*Z. hamaricus*)	*S1–R1–R6* smooth, *r4–r5–s6* barbed (*Z. columbianus*, *Z. fenestralis*, *Z. canadensis*, *Z. carolinensis)* *R1–R6* smooth, *S1* and *r4–r5–s6* barbed (*Z. lindquisti*) *R2–R6* smooth, *S1–R1* and *r4–r5–s6* barbed (*Z. mexicanus*) *R3–R6* smooth, *S1–R1–R2* and *r4–r5–s6* barbed (*Z. lucidus*)

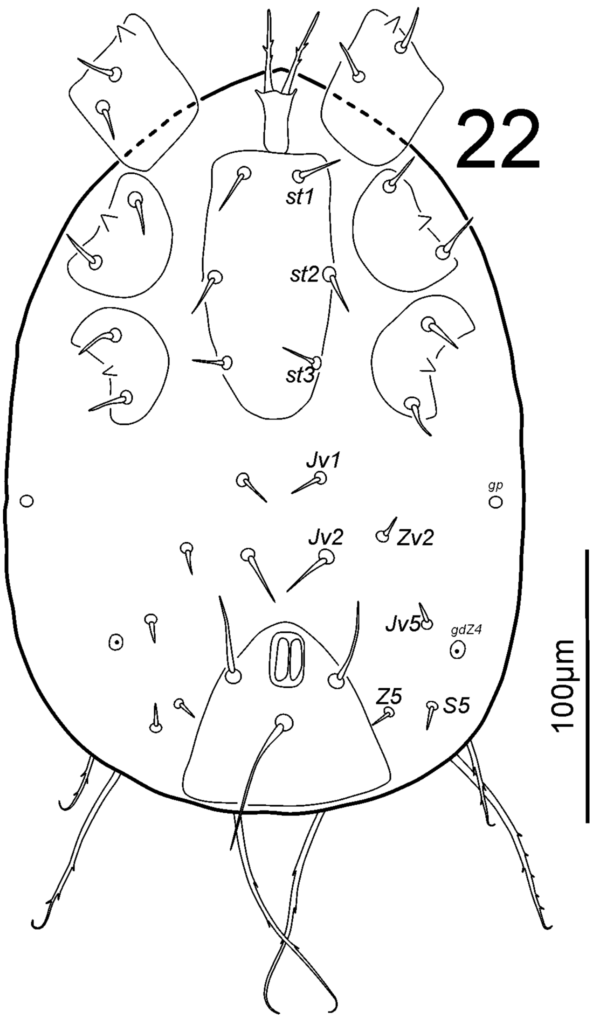
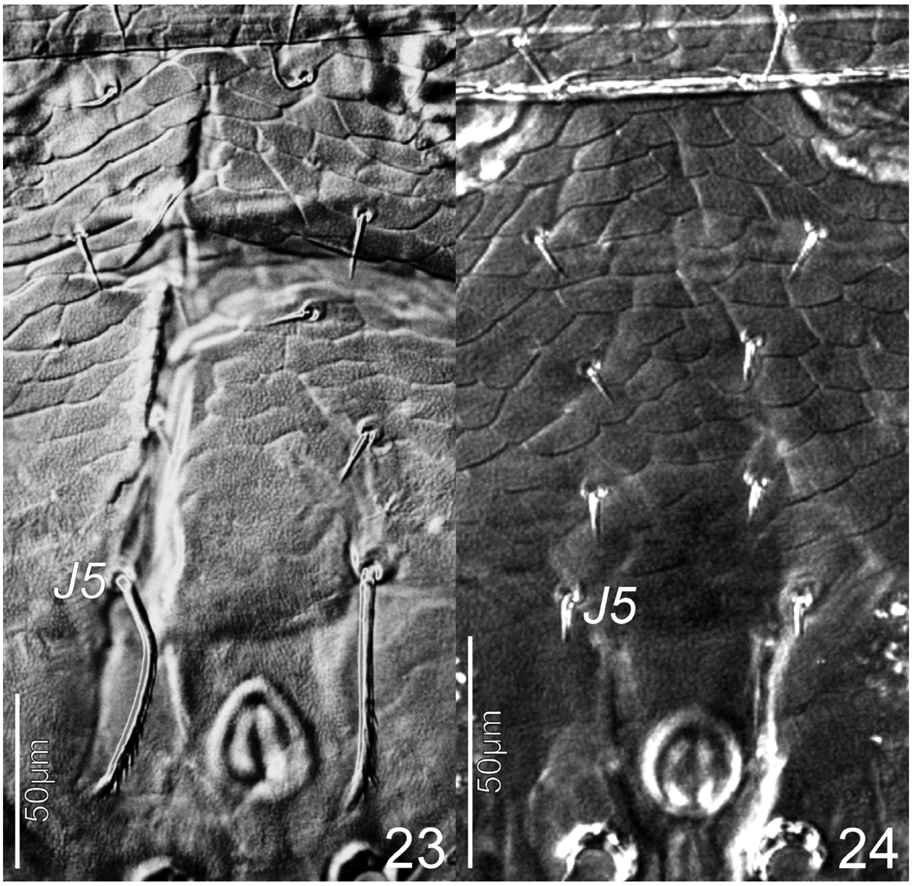


FIGURE 22. *Zercon hamaricus* **sp. nov.**, larva, ventral aspect.

TABLE 6. Distinguishing characters of females of *Z. hamaricus* **sp. nov.**, *Z. forsslundi* and *Z. polonicus*. Measurements in µm.

	Z. hamaricus	*Z. forsslundi*	*Z. polonicus*
J5	does not reach beyond posterior edge of opisthonotum, almost reach inner dorsal cavities	reach far beyond beyond inner dorsal cavities and reach to or beyond posterior edge of opisthonotum	does not reach beyond posterior edge of opisthonotum, clearly rich inner dorsal cavities
J5 and *Z4*	insertions of *J5* anterior to line connecting insertions of *Z4*	insertions of *J5* on the line connecting insertions of *Z4*	insertions of *J5* anterior to line connecting insertions of *Z4*
Z-series setae	*Z1–Z3* of comparable length and clearly shorter than *Z4–Z5*	*Z1–Z3* of comparable length and clearly shorter than *Z4–Z5*	*Z1–Z2* of comparable length, *Z3* clearly longer, *Z4–Z5* longest
Z3	smooth	smooth	barbed
Z5 length	101–115	84	70–74
distance between *Z5* setae, location of *Z5* insertions	214–225, insertions abaxial to outer posterodorsal cavities	176, insertions abaxial to outer posterodorsal cavities	120, insertions adaxial to outer posterodorsal cavities
S-series	*S2* shortest, *S3* longer (1.3–1.8 times) than *S2*	*S2* and *S3* short and of similar length	*S2* and *S3* short and of similar length
gdZ3 pores	abaxial to outer posterodorsal cavities, distant from cavities, on the line *J5–Z4*, clearly closer to *Z4*	in front of outer posterodorsal cavities, close to cavities, slightly anterior to the line *J5–Z4*, slightly closer to *Z4*	in front of outer posterodorsal cavities, close to cavities, behind the line *J5–Z4*, evenly spaced between *J5* and *Z4*



FIGURES 23–24. *Zercon hamaricus* **sp. nov.**, comparison of *J*-series setae. 23. Females; 24. Males.

TABLE 7. Distinguishing characters of immature stages of *Z. hamaricus* **sp. nov.**, *Z. polonicus*, *Z. canadensis* and *Z. columbianus*. Measurements in µm.

	Z. hamaricus	*Z. polonicus*	*Z. canadensis*	*Z. columbianus*
larva	*S3* and *s6* short and of comparable length (5–6) *Z3* 58–61 *Z4* 73–80 *J5* 102–110	n/a	*s6* (15) clearly longer than *S3* (6) *Z3* – 31 *Z4* – 38 *J5* – 50	n/a
protonymph	*Z2* and *Z3* short and of comparable length (7–9) *S2* (25–31)	*Z3* smooth and clearly longer (38) than *Z2* (8) *S2* (30)	*Z3* barbed and clearly longer (31) than *Z2* (6) *S2* (6)	n/a
deutonymph	*Z3* smooth and short (10–13) *gdZ1* on line *Z2–S3* *r4–r5–s6* similar to *S1–R1–R6*	*Z3* barbed and long (44–50) *gdZ1* on line *Z3–S3* *r4–r5–s6* similar to *S1–R1–R6*	*Z3* barbed and long (42) *gdZ1* on line *S2–S3* *s6* differ from *r4*–r5 and *S1–R1–R6*	*Z3* smooth and short (12) *gdZ1* on line *S2–S3* *r4–r5–s6* differ from *S1–R1–R6*

n/a—stage description not available.

Discussion

Apart from the characteristic setation of the *J*-series in this species group, in most species there is a clearly visible anterior displacement of the insertions of some opisthonotal setae, especially *J5* and *Z4*, which is unusual in the Zerconidae. Setae *J5* clearly reach to or beyond the posterior edge of the idiosoma only in *Z. fenestralis* and *Z. forsslundi*, in which setae *J5* and *Z4* are at the same level and posterior to (*Z. forsslundi*) or on the line (*Z. fenestralis*) connecting *R5*. In all other species in this species group, setae *J5* do not reach the posterior edge of the idiosoma. In *Z. lindquisti* the *Z4* setae are on the level of *R5* with *J5* clearly anterior (at the level of *R3*). In *Z. carolinensis* the insertions of *Z4* and *J5* setae are at the same level but anterior to a line connecting *R5*. In all other species the insertions of *Z4* are more or less anterior to the line connecting *R5*, while the insertions of *J5* are more or less anterior to the line connecting *Z4* (with the most anterior *J5* at the level of *R3* in *Z. lindquisti*). The anterior displacement of opisthonotal setae described above creates a large area between setae *J5* and the dorsal cavities, which is also found in *Z. ostovani* Javan et al., 2018 (Javan *et al*. 2018). In most of the above-mentioned species (except *Z. polonicus* and *Z. forsslundi*), pore *gdZ3* is distant from the dorsal cavities.

Błaszak (1970) pointed out the close relationship of *Z. polonicus*, *Z. forsslundi* and *Z. fenestralis*, described from Poland (Tatra Mountains, Pieniny Mountains), Sweden (northern provinces Ångermanland and Lapland) and Alaska (Point Barrow) respectively, apparently because setae *J1–J4* are short and *J5* is clearly longer in these species (Evans 1955; Sellnick 1958). Sellnick (1958) separated *Z. forsslundi* and *Z. fenestralis* in his key because of the location of *gdZ3* (*Po3*). However, females of these species are the only ones in Sellnick's paper in which setae *J5* are long and *J1–J4* are similar in length and clearly shorter than *J5*. In the description of *Zercon rafalianus* Błaszak & Łaniecka, 2007 collected in Delaware (US) the authors indicated its similarity to *Z. canadensis* (found in Quebec and Ontario, Canada) and *Z. fenestralis*. The main difference between these species is that seta *J5* is considerably longer than *J4* in *Z. canadensis* and *Z. fenestralis* and short and similar to *J4* in *Z. rafalianus*. Halašková (1969, 1977) described several species with the *J5* considerably longer than *J1–J4*: the above-mentioned *Z. canadensis*, *Z. lindquisti* (found in Quebec) and *Z. carolinensis* (North Carolina, US). Using material collected in Canada (Harrington, S Quebec), Halašková (1977) supplemented the description of *Z. columbianus* by Berlese (1910) from Columbia (Missouri, according to Halašková 1977). This species also has *J1–J4* of similar length and considerably shorter than *J5*. Two other recently described species with similar *J*-series setation, *Z. mexicanus* Ujvári, 2011 and *Z. lucidus* Sikora, 2014, were found in the alpine zone of Central Mexico (on the volcano Popocatepetl) and Georgia (US, Appalachian Mountains, Tesnatee Gap) respectively. At these localities, supplemented by Sikora (2014), most of the species in which females have short *J1–J4* and clearly longer *J5* setae were found along the Atlantic Coast of US (Great Appalachian Valley) and Eastern Canada. One species (*Z. fenestralis*) was found in Alaska. *Zercon forsslundi* and *Z. hamaricus* were found in northern Europe, while at lower latitudes, the Central European *Z. polonicus* and the Mexican *Z. mexicanus* inhabit mountainous areas.

The other interesting aspect of Zerconidae morphology in the species group that we discuss here is the sexual dimorphism. It is generally known that in Zerconidae the intraspecific differences between males and females are expressed in the size of idiosoma and the morphology of the venter. In *Z. forsslundi*, *Z. hamaricus* and *Z. polonicus* males are in general similar to females with regard to opisthonotal chaetotaxy with one exception—the length of setae *J5*. In *Z. polonicus* the difference is not as great as in the other two species. Sellnick (1958) drew attention to differences between the length of *J5* in males and females of *Z. forsslundi*, and claimed it as the first observation of clear sexual dimorphism in dorsal chaetotaxy in *Zercon*. In *Z. hamaricus* the situation is the same—setae *J5* are short and similar to *J1–J4* in males, while in females the *J5* are clearly longer (4.2–5.1 times, 4.6 on average) than *J1–J4* (Figures 23–24). According to Sellnick's (1958) drawing, seta *J5* in the *Z. forsslundi* female is about five times as long as *J1–J4*. Błaszak (1974) pointed out differences between the relative length of *J1–J4* and *J5* in males and females of *Z. polonicus*. In this species setae *J5* in females are 4–5 times longer than *J1–J4*, while in males *J5* is only 2–3 times longer than *J1–J4*. Differences between sexes with regard to opisthonotal chaetotaxy have also been found in *Z. mexicanus*, *Z. wisniewskii* and *Z. shevtchenkoi* (Błaszak & Skorupski 1992; Ujvári 2011a; Faleńczyk-Koziróg *et al.* 2018). In the latter two species, however, all *J*-setae are short in males, while in females setae *J1–J3* are short and *J4–J5* are considerably longer. Ujvári (2011a) in addition predicted dimorphism in *J*-series setae in *Z. quetzalcoatl* (only male described, same *locus typicus* as in *Z. mexicanus*).

Differences between males and females of *Zercon* can be also expressed in the setation of the anterior edge of the ventrianal shield. The presence or absence of seta *Zv1* is one of the first alternatives in dichotomous keys for Zerconidae (e.g. Halašková 1970, 1977; Błaszak 1974; Sikora 2014; Urhan & Karaca 2019). Interestingly, in males of *Z. canadensis*, *Z. columbianus* and *Z. michaeli* Halašková, 1977 there is only one pair of setae (*Zv1* absent) on the anterior edge of ventrianal shield, while in females there are two pairs—therefore Halašková (1977) pointed out that this character can only be used for females in key to Canadian species of *Zercon*, which was confirmed by Sikora (2014). Moreover, in *Z. quetzalcoatl* the intraspecific variation was found in males, which often lacked *Zv1*, while in some individuals both *Jv1* and *Zv1* were present and normally positioned (Ujvári 2011a).

In their observations on Coprozerconidae, Moraza & Lindquist (1998) commented that differences between the fixed digit of the chelicera in the males and females of Zerconidae and Epicriidae had earlier gone unnoticed, which inspired Călugăr (2004–2006) to study this in the Zerconidae. In five studied species of *Zercon* and one of *Prozercon*, Călugăr (2004–2006) found that the fixed digit of the chelicera in males is straighter than that in females, and it is bifurcated. As in *Coprozercon scopaeus* Moraza & Lindquist, 1998 this can be regarded as adaptation to architocospermous semen transfer (Alberti 1988, 2002). Ujvári (2011b) found similar differences between the fixed digit in males and females in other species of *Zercon* as well as other genera of Zerconidae, and stated that it seems to be a general feature in the family. In *Z. hamaricus* we also found that chelicerae of males differ from those of females—in the male, the fixed digit is straighter than in female and is bifurcated, while in the female the chelicera has both digits curved distally.

Ujvári (2011b) found sexual dimorphism in the shape of some hypostomal and palp-trochantral setae in some species of Zerconidae. In some other genera of Nearctic Zerconidae, Sikora (2014) noted that posterolateral parts of the peritrematal shields are fused with the ventrianal shield at the level of *R1*/*R2* setae in males, but are separated in females, and added some other remarks on morphological differences between sexes in e.g. *Amerozercon*, *Bakeras*, *Blaszakiella*, *Blaszakzercon*, *Bledas*, *Boreozercon*, *Macrozercon*, *Microzercon*, *Neomicrozercon*, *Paramixozercon* and *Parhozercon*.

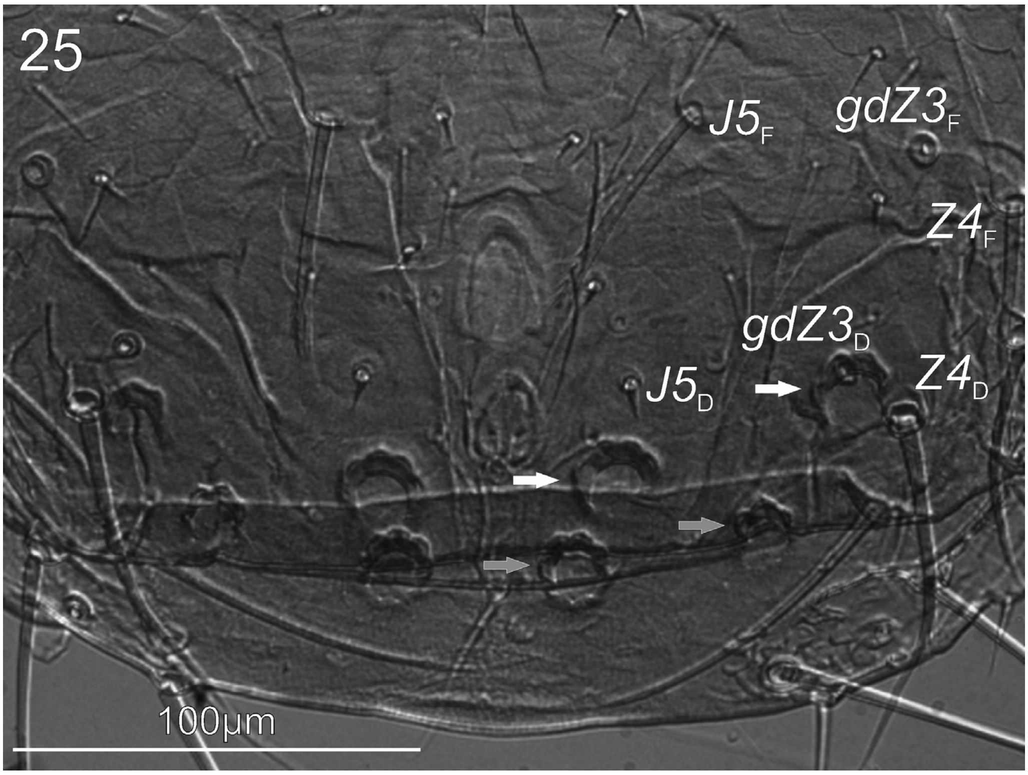


FIGURE 25. *Zercon hamaricus* **sp. nov.**, opisthonotum of deutonymph moulting to female. D in subscript – deutonymph characters, F in subscript – female characters, white arrows – female's posterodorsal cavities, gray arrows – deutonymph's posterodorsal cavities.

Our knowledge of intraspecific morphology of both sexes in Zerconidae is limited as in relatively few taxa males and females have been described. Fortunately, both sexes are known in *Z. forsslundi* and *Z. polonicus*, which makes it possible to compare them with *Z. hamaricus*. However, the immature stages are known only in *Z. polonicus* (except larvae) and newly described species (full ontogeny), making broad comparison of these closely related species impossible. It is worth mentioning that all larvae of *Z. hamaricus* were obtained from our laboratory cultures, making the full ontogeny description possible. The developing fourth pair of legs was visible inside two of our prepared larvae, and in three of our deutonymphs the adult female chaetotaxy is visible (Figure 25). It is interesting that in *Z. hamaricus* and *Z. polonicus* the *J*-setae in deutonymphs are more similar to those of the male than those of the female. Therefore, the next step should be a study of the full ontogeny of *Z. forsslundi* and supplementing the description of *Z. polonicus* with the larva.

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