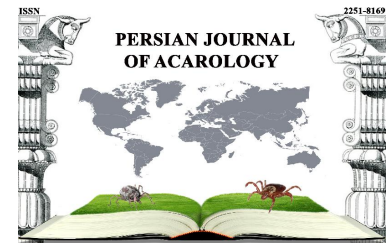




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Article

Study on predatory mites of *Aceria tristriatus* (Nalepa, 1890) from Hamedan and Lorestan provinces, Western Iran

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ABSTRACT

The walnut leaf gall mite (*Aceria tristriatus*) is one of the major pests of walnut in western Iran. Therefore, a study to determine the predatory mites associated with this pest in Hamedan and Lorestan provinces was carried out during 2014–2017. In this survey, totally 10 species belong to six genera and three different families including Phytoseiidae: *Kuzinellus kuzini* Wainstein, *Typhlodromus bagdasarjani* Wainstein & Arutunjan, *Typhlodromus khosrovensis* Arutunjan, *Euseius finlandicus* Oudemans; Iolinidae: *Neopronematus iranensis* Ahmad-Hosseini *et al.*, *Neopronematus solani* Ripka *et al.*, *Pronematus rykei* Meyer & Rodrigues; Tydeidae: *Tydeus caryae* Khanjani & Ueckermann, *Tydeus goetzi* Schruft, and *Tydeus electus* Kuznetsov were collected and identified. *Kuzinellus kuzini* Wainstein had the highest frequency and distribution in this survey. Among the collected species, *Typhlodromus khosrovensis*, *Typhlodromus bagdasarjani*, *E. finlandicus*, *N. solani*, *Tydeus caryae*, *Tydeus goetzi* and *Tydeus electus* are re-described in the present paper. *Tydeus goetzi* and *Neopronematus solani* are reported for the first time for Hamedan and Lorestan provinces.

KEY WORDS: Acari; Iolinidae; Iran; Phytoseiidae; Tydeidae; walnut leaf gall mite.

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INTRODUCTION

Walnut is one of the most important fruit crops in Iran, especially in Western parts of the country. Iran has the third highest walnut production in the world. Hamedan and Lorestan provinces are the second and third highest producers of walnut in the country, respectively (Young Journalists Club 2018). Various phytophagous mite and insect species such as *Aceria tristriatus* feed on walnut trees and can cause loss in fruit production. *Aceria tristriatus* (Nalepa) (Persian walnut leaf gall mite or blister mite) is one of the most important pests in western Iran. Several species of biological agents from insects and mites are predators of this pest (Khanjani and Ueckermann 2007). Biological control is considered a key component of sustainable integrated pest management strategies which reduce the usage of pesticides (Van Driesche and Bellows 1996).

The superfamily Tydeoidea (Acari: Prostigmata) is globally distributed. Its species are soft-bodied, striated or reticulated mites, some of which have been recorded as plant feeders (phytophagous), others as predators while most as scavengers or fungivores (Kaźmierski 1998;

Gerson *et al.* 2003). The superfamily Tydeoidea comprises four families, namely Tydeidae, Iolinidae, Ereyneidae, and Edbakerrelidae (André and Fain 2000). Da Silva *et al.* (2016) presented the catalog of the mite family Tydeidae as the largest family in the Tydeoidea, which includes 30 genera and 328 species in the world. The family Iolinidae includes 37 genera and 133 known species, which are identified based on their dorsal and leg chaetotaxy, epimeral formula and palpal chaetotaxy (Darbemamieh *et al.* 2016; Ahmad-Hosseini *et al.* 2017a). Some studies have reported the feeding of the tydeoid mites on eriophyid mites e.g. feeding of *Homeopronematus anconai* on *Aculops lycopersici* (Hessein and Perring 1986), *Tydeus goetzi* Schruft on *Colomerus vitis* and *Calepitrimerus vitis*; *Tydeus caudatus* as predator of *Calepitrimerus vitis*, and also feeding of *Tydeus* sp. on *Phyllocoptruta oleivora* (Gerson *et al.* 2003). Abou-Awad *et al.* (1999) examined the life table of *Pronematus ubiquitous* McGregor, 1932 on *Eriophyes ficus* (Cotté, 1920) and *Rhyncaphytoptus ficifoliae* (Keifer, 1939). Khanjani and Ueckermann (2007) observed *Tydeus caryae* Khanjani & Ueckermann, 2003 preying on walnut leaf gall mites vagrant on the leaf surface and buds.

The family Phytoseiidae contains 91 genera and 2709 described species (2436 valid species), and the genus *Typhlodromus* with 457 species is the largest genus (Demite *et al.* 2016). Phytoseiid mites are efficient natural enemies of pest mites of several crops, and their presence is frequently associated with eriophyid mites (Ferraugt *et al.* 2008; Johann *et al.* 2009). Khanjani and Ueckermann (2007) reported that *Kuzinellus kuzini* (Wainstein) is the dominant natural enemy of *Aceria tristriatus* (Nalepa) in Western Iran. *Euseius finlandicus*, originally described as *Seiulus finlandicus* by Oudemans (1915), was reported by Kamali *et al.* (2001) as a predator of eriophyid mites on walnuts and several other fruit trees in East and West Azerbaijan, Gorgan, and Kermanshah provinces. Also, Hajizadeh *et al.* (2002) and Hajizadeh and Mortazavi (2015) collected *Euseius finlandicus* on walnut leaves infested with *Aceria erinea* (Nalepa) in Guilan province. *Typhlodromus* (*Anthoseius*) *bagdasarjani* Wainstein & Arutunjan, 1967 and *T. (A.) khosrovensis* Arutunjan, 1971, have been reported as natural enemies of eriophyid mites on on walnut in Ilam province (Shirkhani *et al.* 2011) and on grapevine in Hamedan province (Javadi Khederi and Khanjani 2014).

This study was carried out to determine the predatory mites associated with walnut leaves infested with *A. tristriatus* in Hamedan and Lorestan provinces during 2014–2017. In total, 10 predatory mites from three families (Tydeidae, Iolinidae and Phytoseiidae) were collected and identified.

MATERIAL AND METHODS

The specimens were collected from walnut (*Juglans regia* L.: Juglandaceae) leaves and buds infested by leaf gall mite, *A. tristriatus* in Hamedan and Lorestan provinces, Iran. The mites were directly mounted on microscope slides in Hoyer's medium. The slides were dried in an oven at about 50 °C for 7–10 days and examined under an Olympus BX51 microscope (Phase Contrast & Differential Interference Contrast). All specimens were collected and identified by M. Ahmad-Hosseini. The classification system for family Phytoseiidae follows that of Chant and McMurtry (2007). Setal nomenclature is that of Rowell *et al.* (1978) and Chant and Yoshida-Shaul (1991) for dorsal and ventral surfaces of the idiosoma, respectively. Idiosomal setal patterns are those of Chant and Yoshida-Shaul (1992). Setal notations of the idiosoma and appendages used for species of superfamily of Tydeoidea follows that of André (1980), Kaźmierski (1998) and Panou *et al.* (2000). All measurements are presented in micrometers (µm).

RESULTS

Family Phytoseiidae Berlese, 1916

Genus *Euseius* Wainstein, 1962

Euseius finlandicus Oudemans, 1915 (Figs. 1–7)

Diagnosis (female)

Dorsal shield with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*); setae *r3* and *R1* on dorsal integument, setae *j5* and *j6* are equal in length, peritremes relatively short and extending to the level of setae *j1*, calyx of spermatheca short and bulged, movable and fixed digits of chelicera with five and one teeth, respectively. Genu IV, tibia IV and basitarsus IV each on with one sharp-tipped macroseta.

Female (Figs. 1–5)

Idiosoma oval; setal pattern: 10A-9B/JV-3: ZV. All setae smooth.

Dorsum (Fig. 1) – Dorsal shield reticulated, concave near *R1*, 345–358 long, 198–207 wide at level of setae *R1*. Length of setae: *j1* 30–32, *j3* 33–35, *j4* 17–18, *j5* 16–17, *j6* 16–18, *J2* 20–22, *J5* 6–7, *z2* 25–27, *z4* 27–29, *z5* 16–17, *Z4* 19–22, *Z5* 55–58, *s4* 39–41, *S2* 24–27, *S4* 22–23, *S5* 22–24, *r3* 18–19, *R1* 15–16.

Venter (Fig. 2) – Venter of idiosoma with 13 pairs of setae or 27 setae (postanal seta unpaired), sternal shield smooth, with 3 pairs of equally long setae *ST1–ST3* (31–33) and two pairs of lyrifissures (*iv1–2*); without posterior margin, distance between of setae: *ST1–ST1* 56–61, *ST1–ST2* 31–34, *ST1–ST3* 59–63. The fourth sternal setae *ST4* (29–30) set on soft integument. Genital shield 130–137 long, 80–86 wide at level setae *ST5*, with one pair setae, *ST5* 31–33 long. Venter of idiosoma with two pairs of elongate metapodal platelets (29–33 and 14–16 long). Ventrianal shield 107–112 long, 56–60 wide at level of *Zv2* and 70–74 wide at level of anus. Pre-anal region with three pairs of pre-anal setae *JV1* 24–26, *JV2* 25–27 and *ZV2* 23–25 long and with one pair pre-anal pores; anal opening surrounded with 3 setae, paranal setae *PA* 17–18 and post anal seta *PST* 19–21 long. Opisthogastric cuticle bearing four pairs of setae, *JV4* 14–15 and *JV5* 35–38, *ZV1* 29–31, *ZV3* 13–14, long, all smooth, and six pairs of lyrifissures.

Chelicerae 94–98 long; fixed digit with five teeth and 25–27 long, *pilus dentilis* 5–6 long, movable digit 23–24 long and with a one tooth (Fig. 3). Calyx of spermatheca (Fig. 4) bulged and 10–11 long, minor and major ductus are well visible. Peritreme stippled, extending to level of setae *r3*, 168–173 long. Length of legs I–IV (excluding pretarsus): 368–375, 298–305, 303–309, 402–406, respectively. Legs IV with three smooth and sharp-tipped macrosetae, genua (*SgeIV*) 38–42, tibia (*StiIV*) 36–39, basitarsus (*StIV*) 63–67 (Fig. 5). Setal formulae of legs (I–IV): femur 12-10-6-6, genu 10-7-7-7, tibia 10-7-7-6.

Male (Figs. 6, 7)

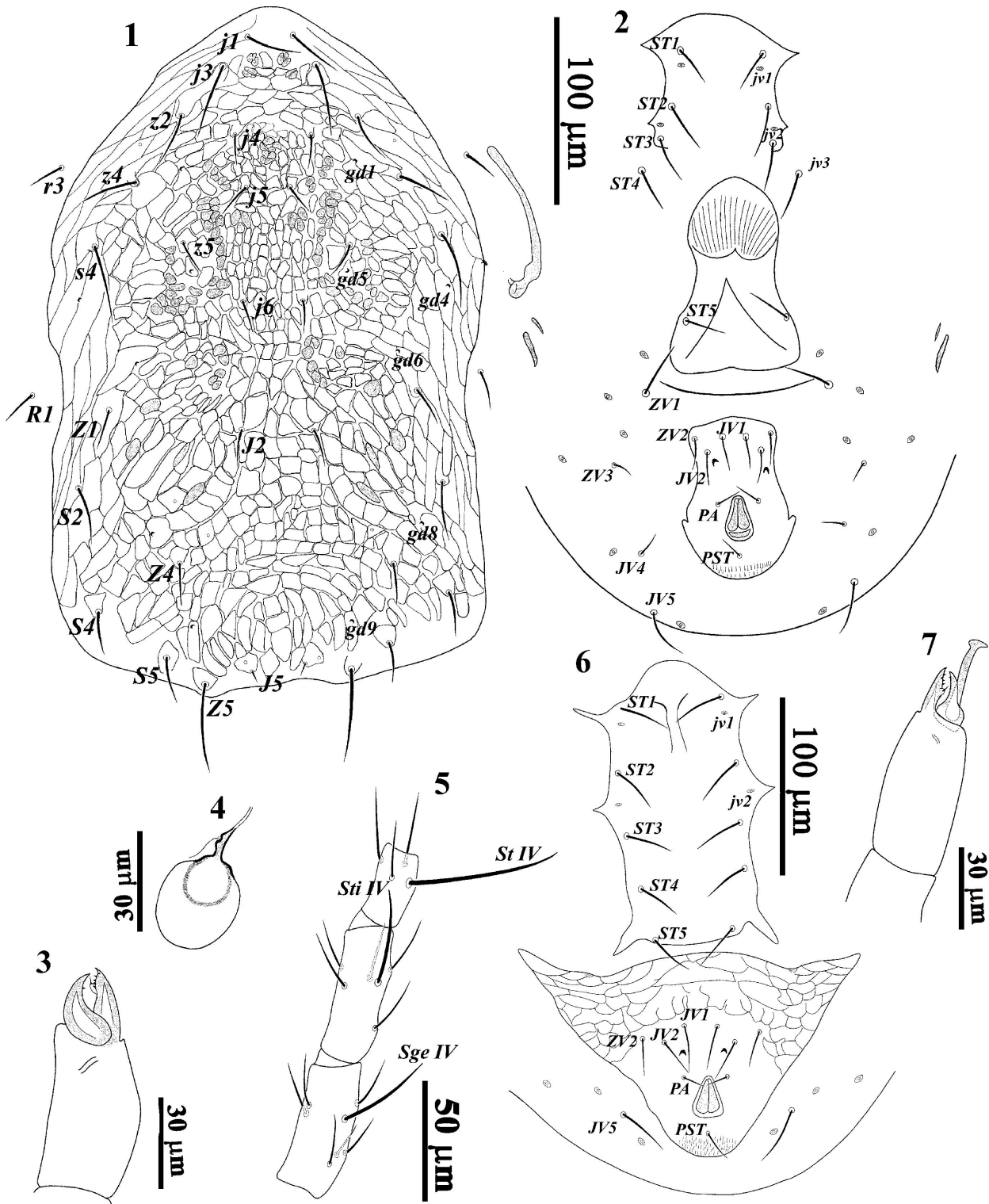
Setal pattern: 10A-9B/JV-3,4: ZV-1,3. All setae smooth, setae *r3* and *R1* on dorsal integument.

Dorsum – Dorsal shield reticulated, concave near *R1*, 335–343 long, 193–205 wide at level of setae *R1*. Length of setae: *j1* 29, *j3* 31, *j4* 18, *j5* 17, *J2* 16, *J5* 5, *z4* 27, *z5* 15, *Z4* 20, *Z5* 44, *s4* 36, *S2* 20, *S4* 19, *S5* 20, *r3* 16, *R1* 14.

Venter (Fig. 6) – Sternogenital shield smooth, with 5 pairs of setae (*ST1* 25, *ST2* 26, *ST3* 23, *ST4* 24, *ST5* 23) and two pairs of lyrifissures (*iv1–2*). Ventrianal shield triangular, reticulated in anterior half and smooth in posterior half, anterior margin convex, 95 long, 147 wide at level of setae *ZV2*, with three pairs of pre-anal setae (*JV1* 20, *JV2* 21 and *ZV2* 19); one pair of lyrifissures and one pair pre-anal pores. Para-anal setae *PA* 12 and post anal seta *PST* 17 long. Opisthogastric cuticle with one pair of setae (*JV5* 26) and three pairs of lyrifissures.

Chelicerae 82 long; fixed digit 22 long, with four teeth; *pilus dentilis* 4 long; movable digit 19 long, with one tooth, shaft of spermadactyl 24 long, straighten and inflated distally (Fig. 7). Length

of legs I–IV (excluding pretarsus): 313, 250, 248, 330, respectively. Legs IV with three smooth and sharp-tipped macrosetae, genua (*Sge IV*) 30, tibia (*Sti IV*) 32, basitarsus (*St IV*) 52. Setal formulae of legs (I–IV) are identical to the female.



Figures 1–7. *Euseius finlandicus* (Oudemans, 1915) – 1. Dorsal view of idiosoma (adult female); 2. Ventral view of idiosoma (adult female); 3. Chelicera (adult female); 4. Spermatheca (adult female); 5. Leg IV (adult female); 6. Ventral view of idiosoma (adult male); 7. Chelicera (adult male).

Remarks

Knowledge about this species is fragmentary, though the short bulged spermatheca seems to be its major distinguishing character. Our specimens resemble the re-description (figures) of Papadoulis *et al.* (2009) from Greece in all respects. However, in the Iranian specimens, the fixed cheliceral digit has five teeth instead of three in the specimens from Greece.

Material examined

Hamedan Province: Heydareh village (34° 48' N; 48° 28' E) – 19 Sep. 2014 (n = 5), 9 Oct. 2015 (n = 3), 3 Dec. 2015 (n = 7), 29 Oct. 2016 (n = 3); Shahrestaneh village (34° 70' N; 48° 35' E) – 18 Nov. 2014 (n = 12), 15 Aug. 2017 (n = 6); Avarzaman village (34° 17' N; 48° 49' E) – 2 Oct. 2016 (n = 3), Ganjnameh (34° 45' N; 48° 26' E) – 1 Nov. 2015 (n = 5). Lorestan Province: Kahman canyon (33° 57' N; 48° 19' E) – 30 Aug. 2015 (n = 5), 4 Sep. 2015 (n = 4), Aleshtar county (33° 32' N; 49° 27' E) – 4 Sep. 2015 (n = 6), Kakareza village (33° 43' N, 48° 15' E) – 25 Sep. 2016 (n = 5).

Genus *Kuzinellus* Wainstein, 1976

***Kuzinellus kuzini* Wainstein, 1962**

Diagnosis (female)

Dorsal shield with 5 pairs of solenostomes (*gd2*, *gd4*, *gd6*, *gd8*, *gd9*); dorsal shield setae inserted on small tubercles seta *z6* presence in female, *JV2* and *JV3* present, with four pairs of pre-anal setae and one pair of pre-anal pores, seta *R1* on membrane; setae *J5* smooth and *Z4* serrate, calyx of spermatheca tubular shape, flaring distally near the vesicle; leg IV with a macroseta on basitarsus which is sharp-tipped in adult, movable and fixed digits of chelicera with 2 and 4 teeth, respectively.

In this study, this species had the highest association among other predatory mites found together with *Aceria tristriatus* in Hamedan and Lorestan provinces. Immature stages (larva, protonymph and deutonymph) and adults (female and male) of *K. kuzini* are described and re-described, respectively, by Ahmad-Hosseini *et al.* (2017b).

Material examined

In order to avoid repeating, geographical coordinates of sampling locations that previously presented not mentioned again.

Hamedan province: Heydareh village – 7 Oct. 2014 (n = 15), 8 Oct. 2015 (n = 18), 23 Aug. 2016 (n = 11), 9 Oct. 2016 (n = 6), 29 Oct. 2016 (n = 4), 9 Sep. 2017 (n = 6), 13 Sep. 2017 (n = 7); Shahrestaneh village – 18 Sep. 2014 (n = 20), 23 Nov. 2015 (n = 7), 17 Oct. 2016 (n = 5), 14 Sep. 2016 (n = 14); Ganjnameh – 26 Aug. 2017 (n = 9), 1 Sep. 2017 (n = 8); Asadabad (34° 37' N; 47° 51' E) – 2 Aug. 2016 (n = 11), 30 Oct. 2015 (n = 10), 27 Aug. 2016 (n = 4), 9 Nov. 2016 (n = 5); Hamedan vicinity (34° 46' N; 48° 31' E) – 15 Aug. 2015 (n = 5), 5 Jul. 2017 (n = 15); Faculty of Agriculture of Bu-Ali Sina University (34° 48' N, 48° 29' E) – 16 Oct. 2015 (n = 3), 19 Sep. 2016 (n = 18), 30 Sep. 2016 (n = 14); Divin village (34° 45' N; 48° 30' E) – 4 Aug. 2016 (n = 5), 8 Sep. 2016 (n = 3); Sarab Gamasiab (34° 02' N; 48° 22' E) – 10 Aug. 2016 (n = 6); Bahar vicinity (34° 55' N; 48° 19' E) – 29 Oct. 2016 (n = 9), 2 Aug. 2017 (n = 6); Maryanaj vicinity (34° 54' N; 48° 29' E) – 18 Nov. 2016 (n = 6); Abasabad village (34° 47' N; 48° 28' E) – 20 Jul. 2015 (n = 6); Darreh Morad Beyg village (34° 44' N; 48° 30' E) – 23 Jul. 2017 (n = 4). Lorestan Province: Kahman canyon – 30 Aug. 2015 (n = 8), 26 Sep. 2015 (n = 5), 13 Oct. 2015 (n = 13); Aleshtar county – 4 Sep. 2015 (n = 15); Firouz Abad county (34° 58' N, 48° 24' E) – 13 Nov. 2015 (n = 7), 10 Aug. 2016 (n = 8); Robatnamaki village (33° 47' N, 48° 18' E) – 10 Aug. 2016 (n = 5).

Genus *Typhlodromus* Scheuten, 1857
Subgenus *Anthoseius* De Leon, 1959

***Typhlodromus (Anthoseius) khosrovensis* Arutunjan, 1971 (Figs. 8–14)**

Diagnosis (female)

Dorsal shield with four pairs of solenostomes (*gd2*, *gd6*, *gd8*, *gd9*); setae *Z4* and *Z5* serrated, ventrianal shield with four pairs of pre-anal setae and without pre-anal pores; fixed digits of chelicera with 4 teeth and movable digit with 1 tooth, basitarsus IV with knobbed macroseta.

Female (Figs. 8–12)

Idiosoma oval; setal pattern: 12A-8A/JV: ZV. All setae smooth, except *Z4* and *Z5*, serrated.

Dorsum (Fig. 8) – Dorsal shield reticulated, 315–325 long, 152–168 wide at level of setae *R1*. Length of setae: *j1* 21–23, *j3* 31–33, *j4* 19–21, *j5* 20–23, *j6* 24–27, *J2* 27–30, *J5* 4–5, *z2* 22–24, *z3* 28–31, *z4* 29–31, *z5* 20–21, *Z4* 44–47, *Z5* 58–61, *s4* 34–37, *s6* 35–38, *S2* 40–42, *S4* 36–38, *S5* 15–16, *r3* 26–28, *R1* 27–29.

Venter (Fig. 9) – Sternal shield smooth and posterior margin with median lobe, with 2 pairs of equally long setae *ST1-2* (29–31) and 2 pairs of lyrifissures (*iv1-2*). The third (*ST3* 30–32) and fourth (*ST4* 28–31) each set on a platelet. Genital shield 117–125 long, 60–65 wide at level setae *ST5*, with 1 pair setae, *ST5* 28–33 long. Ventrianal shield reticulated, 110–115 long, 74–79 wide at level of *ZV2*. Pre-anal region with 4 pairs of pre-anal setae and without pre-anal pores. Opisthogastric cuticle bearing 4 pairs smooth setae and 5 pairs of lyrifissures.

Chelicerae 127–134 long; fixed digit with 4 teeth and 26–29 long, *pilus dentilis* 5–6 long, movable digit 25–27 long and with 1 tooth (Fig. 10). Calyx of spermatheca bell shaped 10–11 long and 8–9 wide at junction with vesicle (Fig. 11). Peritreme stippled, 65–69 long and reaching to level of setae *r3* (Fig. 8). Length of legs I–IV (excluding pretarsus): 275–284, 230–239, 235–245, 305–318, respectively. Leg IV with a knobbed macroseta on basitarsus 49–52 long (Fig. 12). Setal formulae of legs (I–IV): femur 12-10-6-6, genu 10-8-7-7, tibia 10-7-7-6.

Male (Figs. 13, 14)

Idiosoma oval; Setal pattern: 12A-8A/JV-4: ZV-1,3.

Dorsum – Dorsal shield reticulated, 245-260 long, 130–138 wide at level of setae *R1*. Length of setae: *j1* 16–18, *j3* 24–27, *j4* 16–18, *j5* 17–19, *j6* 18–21, *J2* 22–24, *J5* 4–5, *z2* 17–19, *z3* 24–27, *z4* 25–28, *z5* 17–18, *Z4* 38–42, *Z5* 40–43, *s4* 26–29, *s6* 28–31, *S2* 29–32, *S4* 24–28, *S5* 17–19, *r3* 21–23, *R1* 18–20.

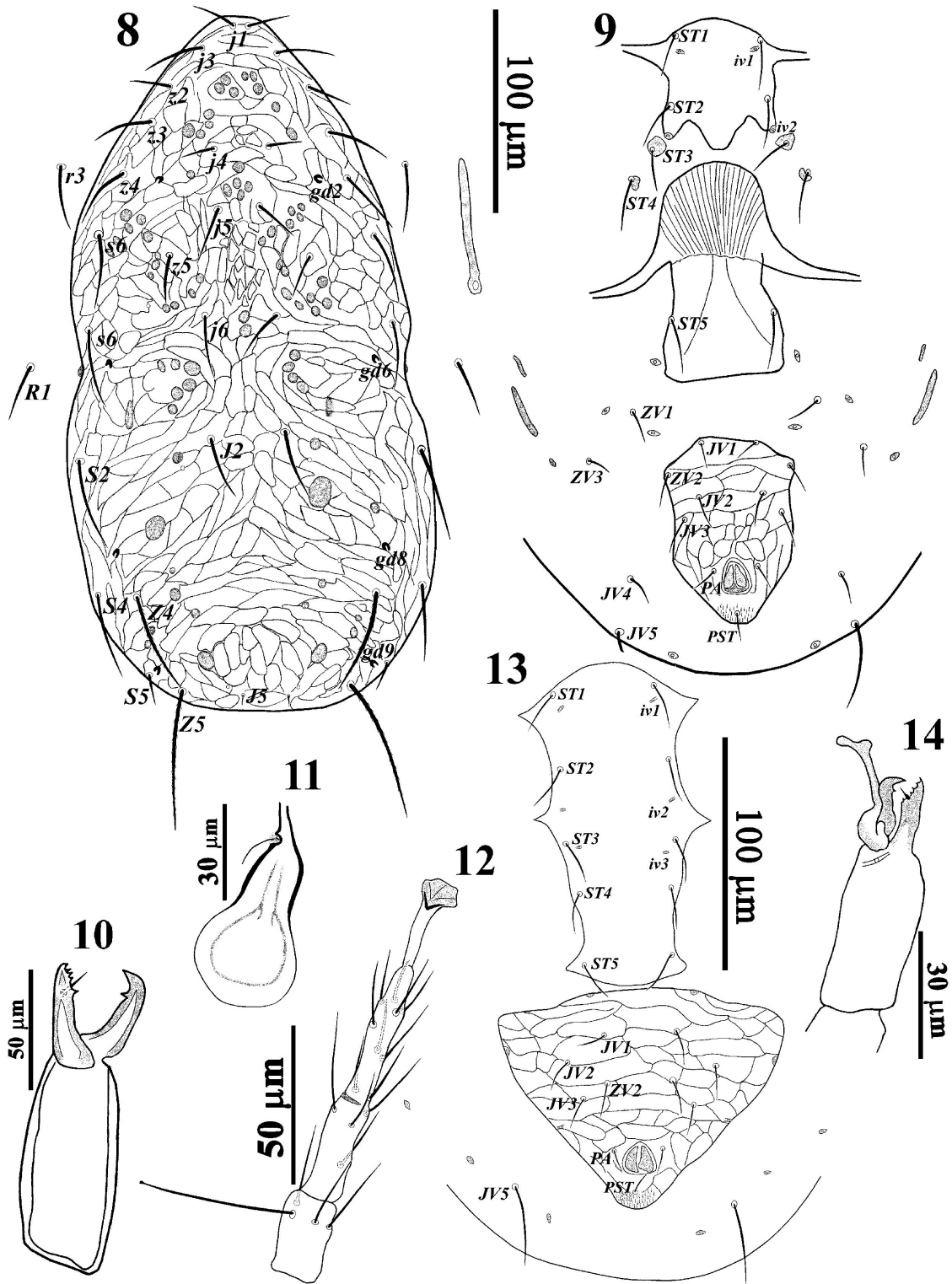
Venter (Fig. 13) – Sternal shield smooth, with 5 pairs of setae subequal in length (*ST1-5* 18–21) and three pairs of lyrifissures (*iv1-3*); ventrianal shield reticulated, subtriangular; anterior margin convex. Pre-anal region with 4 pairs of pre-anal setae and 3 pairs of pre-anal pores. Opisthogastric cuticle bearing 1 pair of smooth setae and 3 pairs of lyrifissures.

Chelicerae 78–85 long; fixed digit with 4 teeth, *pilus dentilis* 3–4 long, movable digit with 1 tooth. Spermadactyl 17–19 long and inverse boot shaped (Fig. 14). Peritreme 34–38 long and extending to level of setae *r3*. Length of legs I–IV (excluding pretarsus): 235–244, 198–205, 195–205, 259–268, respectively. Leg IV with a knobbed macroseta on basitarsus 33–37 long. Setal formulae of legs is identical to the female.

Material examined

Hamedan Province: Heydareh village – 9 Sep. 2014 (n = 11), 9 Oct. 2015 (n = 16), 3 Dec. 2015 (n = 3), 11 Sep. 2016 (n = 9), 9 Oct. 2016 (n = 8), 18 Nov. 2016 (n = 12), 30 Oct. 2017 (n = 3); Shahrestaneh village – 19 Nov. 2014 (n = 9), 17 Oct. 2016 (n = 8), 15 Sep. 2017 (n = 11); Ganjnameh – 18 Sep. 2015 (n = 5), 1 Nov. 2015 (n = 12); Asadabad – 19 Oct. 2015 (n = 4), 9 Nov.

2016 (n = 12); Faculty of Agriculture of Bu-Ali Sina University – 21 Oct. 2015 (n = 8); Velashjerd village – 5 Sep. 2017 (n = 4). Lorestan Province: Kahman canyon – 26 Sep. 2015 (n = 6); Aleshtar county – 4 Sep. 2015 (n = 3); Kakareza village – 25 Sep. 2016 (n = 6).



Figures 8–14. *Typhlodromus (Anthoseius) khosrovensis* (Arutunjan, 1971) – 8. Dorsal view of idiosoma (adult female); 9. Ventral view of idiosoma (adult female); 10. Chelicera (adult female); 11. Spermatheca (adult female); 12. Leg IV (adult female); 13. Ventral view of idiosoma (adult male); 14. Chelicera (adult male).

***Typhlodromus (Anthoseius) bagdasarjani* Wainstein & Arutunjan, 1967**

Diagnosis (female)

Dorsal shield with 5 pairs of solenostomes (*gd2*, *gd4*, *gd6*, *gd8*, *gd9*); setae *Z4* and *Z5* serrated, ventrianal shield with 4 pairs of pre-anal setae and without pre-anal pores; fixed digits of chelicera with 2 teeth and movable digit toothless; calyx of spermatheca fundibular, leg IV with a knobbed macroseta on basitarsus.

Female

Idiosoma oval; setal pattern: 12A-8A/JV: ZV. All setae smooth, except *Z4* and *Z5*, serrated.

Dorsum – Dorsal shield reticulated, 347–362 long, 170–185 wide at level of setae *R1*. Length of setae: *j1* 23–25, *j3* 31–34, *j4* 19–22, *j5* 19–21, *j6* 25–27, *J2* 27–30, *J5* 9–10, *z2* 26–28, *z3* 29–31, *z4* 29–32, *z5* 20–23, *Z4* 53–56, *Z5* 66–71, *s4* 35–38, *s6* 38–41, *S2* 42–44, *S4* 36–38, *S5* 30–33, *r3* 31–33, *R1* 28–31.

Venter – Sternal shield smooth, with 2 pairs of equal length setae *ST1-2* (30–33) and 2 pairs of lyrifissures (*iv1-2*); posterior margin with median lobe. The third (*ST3* 30–33) and fourth (*ST4* 28–32) each set on a platelet, the latter with one small lyrifissure. Genital shield 116–128 long, 64–74 wide at level setae *ST5*, with 1 pair of setae, *ST5* 31–33 long. Ventrianal shield reticulated, 115–118 long, 82–90 wide at level of *ZV2*. Pre-anal region with 4 pairs of pre-anal setae and without pre-anal pores. Opisthogastric cuticle bearing 4 pairs smooth setae and 4 pairs of lyrifissures.

Chelicerae 116–125 long; fixed digit with 2 teeth and 26–28 long, *pilus dentilis* 4 long, movable digit 23–25 long and without tooth. Calyx of spermatheca fundibular shaped, 17–20 long and 9–10 wide at junction with vesicle. Peritreme stippled, 87–98 long and extending to level of setae *z3*. Length of legs I–IV (excluding pretarsus): 295–313, 247–259, 245–264, 314–334, respectively. Leg IV with a knobbed macroseta on basitarsus 48–52 long. Setal formulae of legs (I–IV): femur 12-10-6-6, genu 10-7-7-7, tibia 10-7-7-6.

Male

Setal pattern: 12A-8A/JV-4: ZV-1,3.

Dorsum – Dorsal shield reticulated, 275–287 long, 161–180 wide at level of setae *R1*. Length of setae: *j1* 21–23, *j3* 26–30, *j4* 18–20, *j5* 16–18, *j6* 17–19, *J2* 21–23, *J5* 9–10, *z2* 18–22, *z3* 24–26, *z4* 25–28, *z5* 17–19, *Z4* 46–51, *Z5* 48–53, *s4* 26–29, *s6* 29–32, *S2* 31–35, *S4* 24–27, *S5* 24–28, *r3* 23–26, *R1* 20–23.

Venter – Sternal shield smooth, with 5 pairs of subequal in length setae (*ST1-5* 23–27) and 3 pairs of lyrifissures (*iv1-3*); ventrianal shield reticulated, subtriangular; anterior margin convex. Pre-anal region with four pairs of pre-anal setae and three pairs of pre-anal pores. Opisthogastric cuticle bearing one pairs smooth setae and two pairs of lyrifissures.

Chelicerae 116–125 long; fixed digit with two teeth, *pilus dentilis* 3–4 long, movable digit without tooth. Spermadactyl arched and slightly inflated distally 22–26 long. Length of legs I–IV (excluding pretarsus): 224–231, 200–208, 192–198, 258–268, respectively. Leg IV with a knobbed macroseta on basitarsus 36–41 long. Setal formulae of legs is the same with female.

The morphology, setae measurements and organotaxy in collected specimens in this study are resemble the re-description of Asali Fayaz *et al.* (2017).

Material examined

Hamedan Province: Heydareh village – 8 Sep. 2014 (n = 8), 7 Oct. 2014 (n = 20), 9 Oct. 2015 (n = 11), 3 Dec. 2015 (n = 14), 11 Sep. 2016 (n = 7), 9 Oct. 2016 (n = 12), 29 Oct. 2016 (n = 6); Shahrestaneh village – 19 Nov. 2014 (n = 10), 17 Oct. 2016 (n = 9), 5 Aug. 2017 (n = 9); Ganjnameh – 18 Sep. 2015 (n = 14), 1 Nov. 2015 (n = 6); Asadabad – 19 Oct. 2015 (n=9), 9 Nov. 2016 (n = 12); Faculty of Agriculture of Bu-Ali Sina University – 21 Oct. 2015 (n = 8), 30 Sep.

2016 (n = 5); Abasabad village – 19 Oct. 2015 (n = 9), 9 Nov. 2016 (n = 12); Velashjerd village – 5 Sep. 2017 (n = 6). Lorestan Province: Kahman canyon – 26 Sep. 2015 (n = 7); Kakareza village – 25 Sep. 2016 (n = 11); Aleshtar county – 4 Sep. 2015 (n = 9).

Family Tydeidae Kramer, 1877
Genus Tydeus Koch, 1835 sensu Kazmierski (1989)

Diagnosis

Prodorsum recurved; opisthosoma with 10 pairs of setae (*ps3* included); genital organotaxy in adults: no eugenital setae in female, but male with 4 pairs of eugenital setae; 4 or 6 pairs of genital setae present and 4 pairs of aggenital setae in both adults; coxa I with coxal organ; chaetotaxy of legs I-IV respectively (from tarsus to trochanter): 8+(ω)-3+ κ -3-3-1, 6+(ω)-2 -2-2-0, 5-2 -1-1-1, 5-2 -1-1-0, epimeral formula adults: 3-1-4-2; femur IV entire; palp chaetotaxy: 6+(ω)-2-2 (André 2005).

***Tydeus caryae* Khanjani & Ueckermann, 2003**

Diagnosis (female)

All dorsal setae are similar in shape, long, serrated and somewhat thick. Trichobothrium seta (*bo*) narrow and less serrated, subequal in length to *ro*, *la*, *c1*, *d1* and shorter than other dorsal setae. Genital shield with 6 setae. Palpal tarsus longer than cheliceral stiletos, eupathidium on palp tarsus straight, stae *ba* very short so that shorter than half of palp tarsus width.

Female (Figs. 15–19)

Body oval 348–370 length (excluding gnathosoma), width 223–238 (at level of seta *c2*).

Dorsum (Fig. 15) – Completely striated with 13 pair setae, striations longitudinal on prodorsum, between setae *c1*, striations are U shaped and between setae *d1*, are V shaped, from *d1* up to *fl* striations are transverse. Opisthosoma caudally (from base of *fl* to end of body) with striae forming an inverted “V”-pattern. Length of dorsal setae: *bo* 35–41, *ro* 32–40, *la* 33–39, *ex* 41–50, *c1* 25–27, *c2* 33–40, *d1* 35–40, *e1* 44–51, *fl* 45–52, *f2* 47–52, *h1* 45–51, *h2* 43–50, *ps1* 27–30. Distances between dorsal setae: *ro-ro* 22–29, *la-la* 95–110, *bo-bo* 60–71, *c1-c1* 69–80, *c2-c2* 195–210, *d1-d1* 52–58, *e1-e1* 115–126, *fl-fl* 25–32, *f2-f2* 73–80, *h1-h1* 26–30, *h2-h2* 58–62, *ps1-ps1* 25–29. Lyrifissures *ia* and *im* in dorsal (posteriorly to *c2* and anterior of *e1*) and *ih* in ventral surface (posterior to anal opening) of hysterosoma.

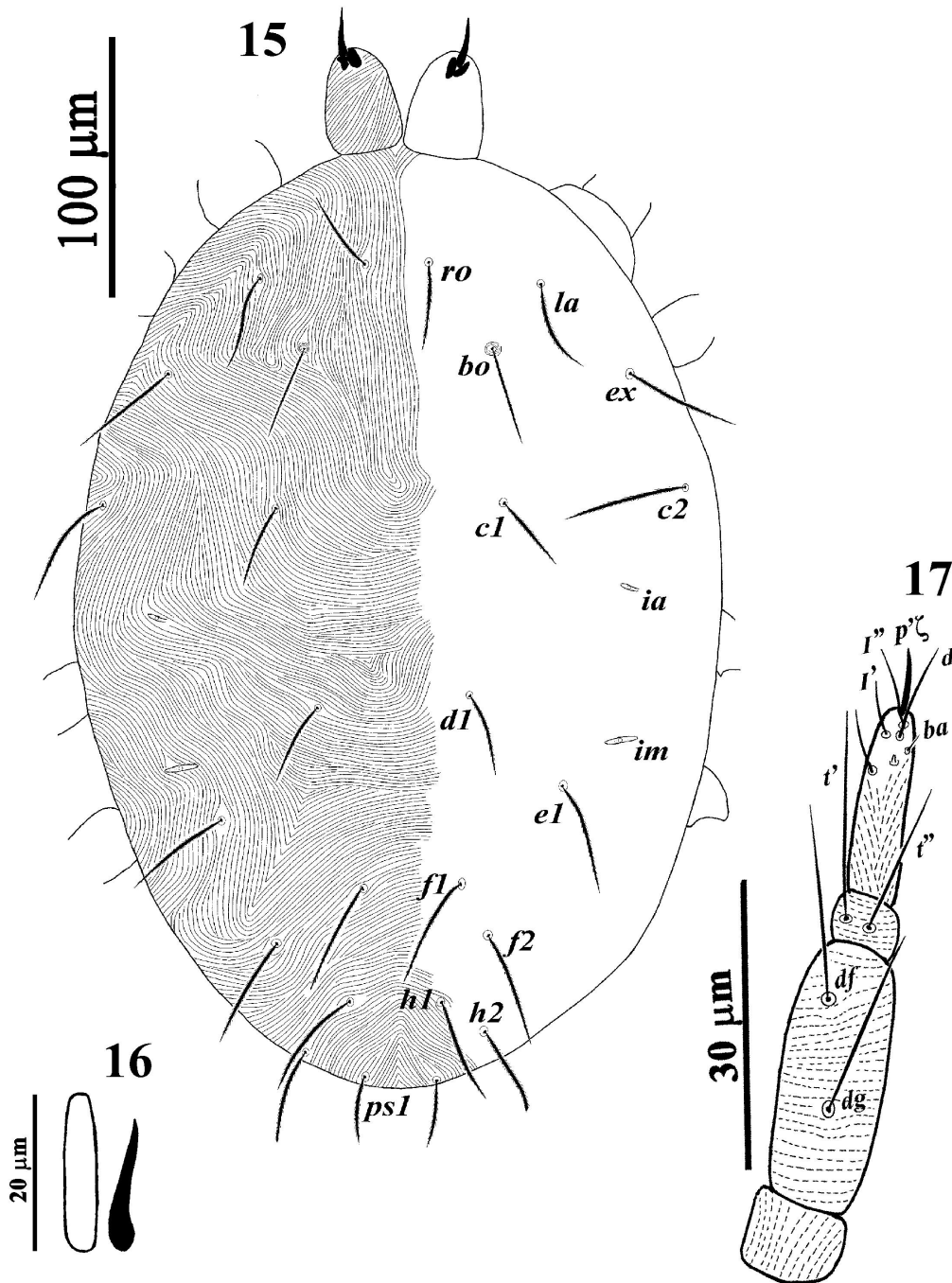
Venter – Ventral cuticle and coxisternal shields striated, striations between *pt* setae longitudinal, between *pt* up to *mta* transverse and between *mta* up to *mtβ* are longitudinal (Fig. 18). Lengths of ventral setae: *1b* 28–31, *1c* 27–29, *2a* 25–28, *3b* 31–34, *3c* 25–28, *3d* 25–27, *4b* 24–26, *pt* 27–31, *mta* 17–19, *mtβ* 17–20, *agl* 15–17, *ag2* 15–17, *ag3* 14–16, *ag4* 16–18, *ps3* 21–23.

Gnathosoma – Not visible completely from above. Subcapitulum with striae oblique, *Sc1* 8–10, *Sc2* 29–33. Palpal femur-genu: length 29, width 12. Palp distally with eupathidium (*pζ*) straight, 7 long. Palp chaetotaxy (6+ ω -1-2) (Fig. 17). Cheliceral stiletto 18 shorter than palpal tarsus 20–21 (Fig. 16). Legs measurements from trochanter to tarsus (excluding pretarsus): leg I 202–213; leg II 183–194; leg III 193–208, leg IV 210–225; coxa I with a coxal organ (*cg*) stretched circle shape. Measurements: tarsus + apotele I length/width: 72/13. Length of setae on tarsus I: *ft'ζ* 20–23, *ft''ζ* 28–32, *tc'ζ* 18–20, *tc''ζ* 33–36, *ωI* 5 (Fig. 19). Tarsus II with small solenidion not easily to visible, *ωII* 1 long.

Remarks

This redescription resembles original description by Khanjani and Ueckermann (2003), except

that length of some dorsal setae (such as *c1*, *c2*, *f2*) in our study is shorter than original description.

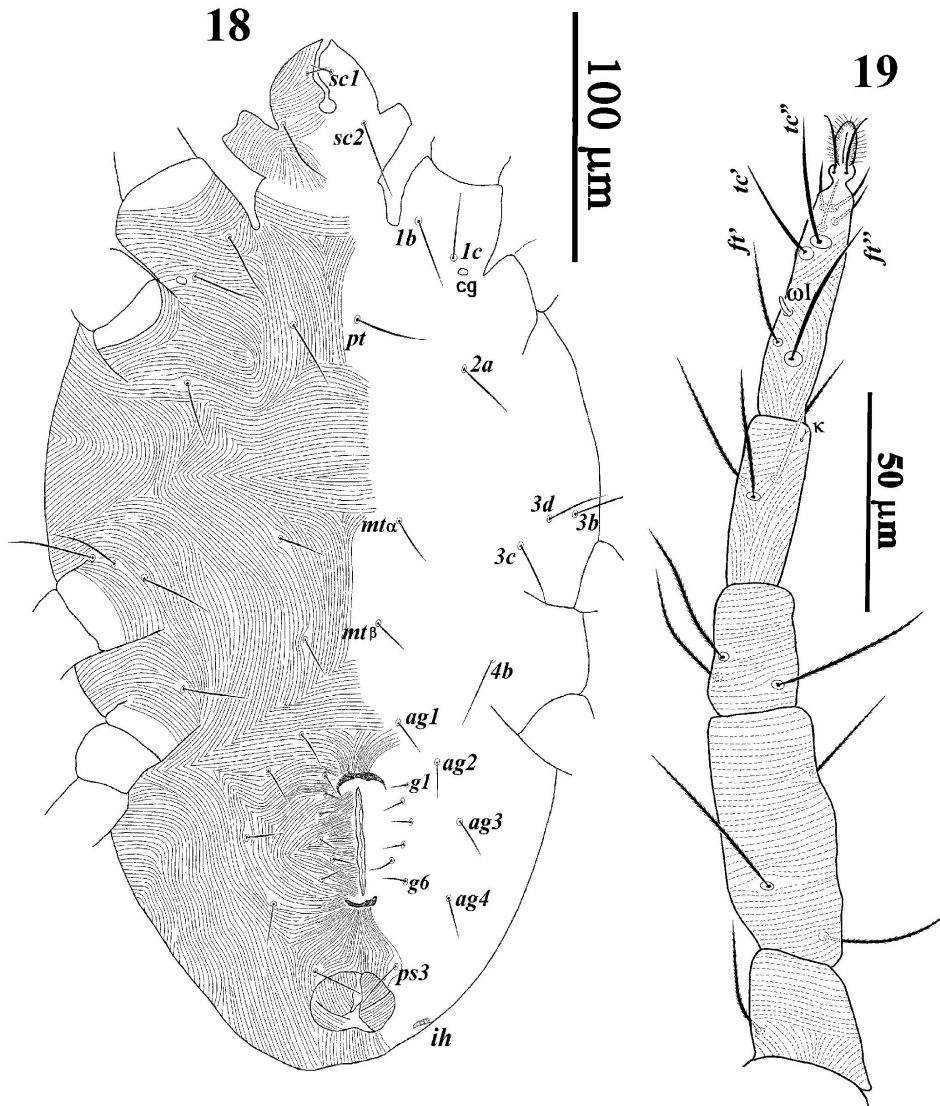


Figures 15–17. *Tydeus caryae* (Khanjani & Ueckermann, 2003) (Adult female) – 15. Dorsal view of idiosoma; 16. Cheliceral stiletto and palpal tarsus; 17. Palp.

Material examined

Hamedan province: Heydareh village – 6 Oct. 2016 (n = 4), 26 Oct. 2015 (n = 8), 9 Oct. 2016 (n = 10), 29 Oct. 2016 (n = 2), 23 Aug. 2016 (n = 16), 13 Sep. 2017 (n = 7); Shahrestaneh village – 17 Oct. 2016 (n = 5), 15 Aug. 2017 (n = 3); Ganjnameh – 18 Sep. 2015 (n = 11); Asadabad – 9 Sep. 2016 (n = 3), 7 Sep. 2017 (n = 12); Hamedan vicinity – 19 Aug. 2015 (n = 6), 8 Sep. 2016 (n = 6); Faculty of Agriculture of Bu-Ali Sina University – 13 Sep. 2014 (n = 6), 17 Oct. 2015 (n = 8), 17 Sep. 2016 (n = 3), 4 Aug. 2017 (n = 11); Divin village – 31 Aug. 2016 (n = 5), 15 Nov. 2016 (n = 6); Sarab Gamasiab – 10 Aug. 2016 (n = 6); Bahar vicinity – 21 Sep. 2014 (n = 5), 2 Aug. 2017 (n =

8); Abshineh village – 2 Oct. 2015 (n = 9), 1 Nov. 2015 (n = 6), 11 Sep. 2017 (n = 5); Velashjerd village – 5 Sep. 2017 (n = 4). Lorestan province: Kahman canyon – 13 Oct. 2015 (n = 5); Aleshtar county – 4 Sep. 2015 (n = 4); Robotnamaki village – 10 Aug. 2016 (n = 12); Kakareza village – 25 Sep. 2016 (n = 5).



Figures 18–19. *Tydeus caryae* (Khanjani & Ueckermann, 2003) (Adult female) – 18. Ventral view of idiosoma; 19. Leg I.

***Tydeus electus* Kuznetzov, 1973**

Diagnosis (female)

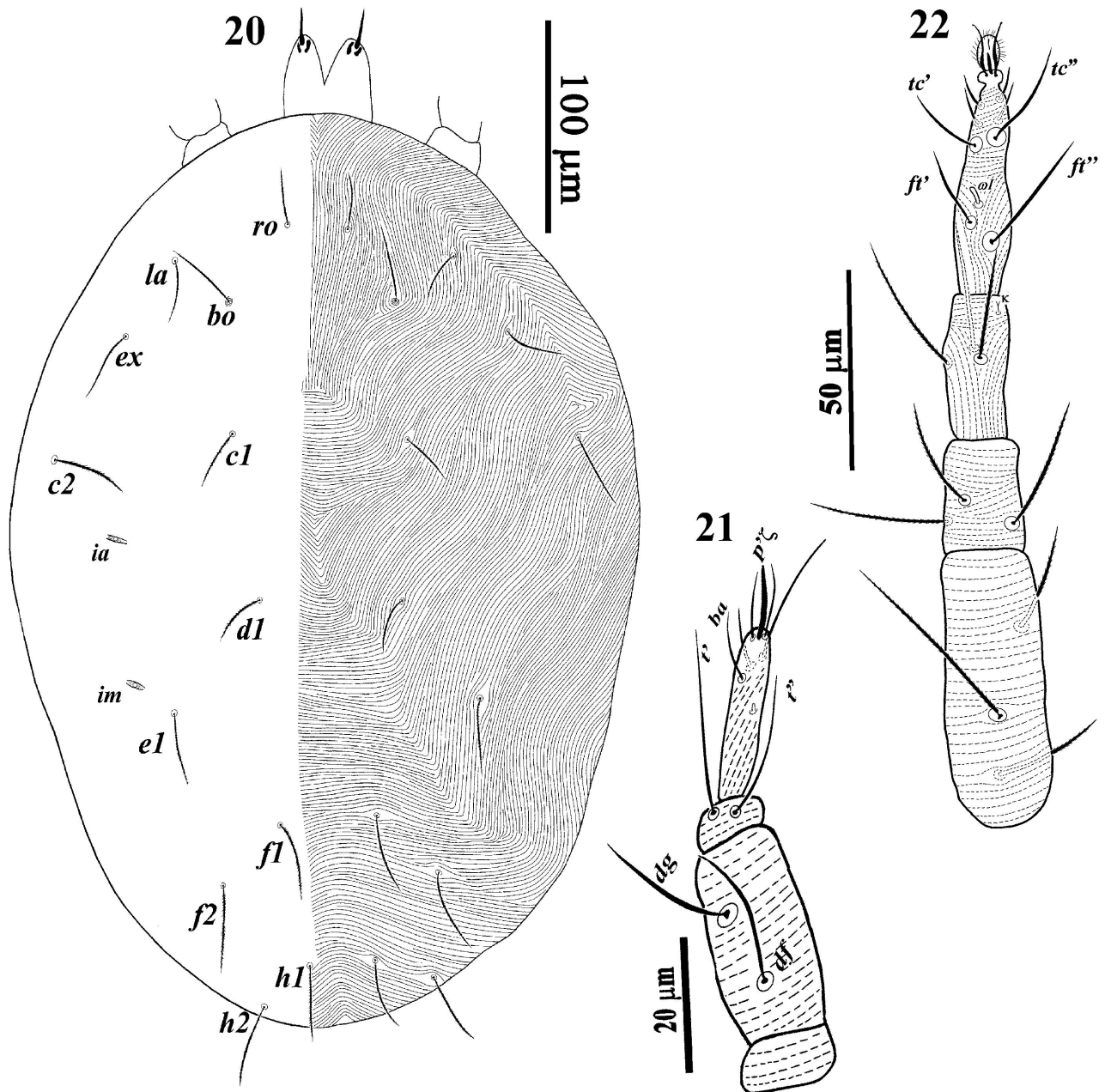
All dorsal setae are similar in shape, somewhat serrated and long (especially setae on end of opisthosoma). Trichobothrium seta (*bo*) is shorter than opisthosomal setae. Genital with 6 setae. Length of palpal tarsus equal to cheliceral stilettoes, eupathidium on palp tarsus straight, solenidion

ωl short and very shorter than half of distance between *tc-ft* and also shorter than half of width of tarsus I.

Female (Figs. 20–22)

Body circular to oval shape 400–435 length (excluding gnathosoma), width 270–295 (at level of seta *c2*).

Dorsum – Completely striated with 13 pairs of setae (Fig. 20), dorsal striation approximately similar to *Tydeus caryae*. Length of dorsal setae: *bo* 36–39, *ro* 26–29, *la* 27–30, *ex* 35–39, *c1* 25–29, *c2* 36–39, *d1* 27–30, *e1* 35–38, *f1* 37–40, *f2* 41–43, *h1* 33–36, *h2* 33–37, *ps1* 25–27. Distances between dorsal setae: *ro-ro* 28–31, *la-la* 123–131, *bo-bo* 75–80, *c1-c1* 76–82, *c2-c2* 235–246, *d1-d1* 54–58, *e1-e1* 137–146, *f1-f1* 43–48, *f2-f2* 103–112, *h1-h1* 28–32, *h2-h2* 61–66, *ps1-ps1* 25–29.



Figures 20–22. *Tydeus electus* (Kuznetzov, 1973) (Adult female) – 20. Dorsal view of idiosoma; 21. Palp; 22. Leg I.

Venter – Ventral cuticle and coxisternal shields striated. Lengths of ventral setae: *lb* 26–28, *lc* 24–26, *2a* 23–25, *3b* 24–25, *3c* 24–27, *3d* 28–31, *4b* 24–25, *pt* 25–27, *mta* 17–19, *mtβ* 16–18, *agl* 15–16, *ag2* 16–17, *ag3* 15–17, *ag4* 17–18, *ps3* 21–24.

Gnathosoma – Not visible completely from above. Palpal femur-genu: length 29–30, width 12. Palp distally with eupathidium (*pζ*) straight, 7 long. Palp chaetotaxy (6+ω–1–2) (Fig. 21). Length of cheliceral stiletto equal to palpal tarsus, 18.

Legs – Measurements from trochanter to tarsus (excluding pretarsus): leg I 195–203; leg II 192–197; leg III 196–199, leg IV 222–231; Shape of *cg* (coxal organ) oval. Measurements: tarsus + apotele I length/width: 64/13. Length of setae on tarsus I: *ft'ζ* 18–20, *ft''ζ* 33–36, *tc'ζ* 18–19, *tc''ζ* 25–28, *ωI* 5 (Fig. 22). Tarsus II with club-like solenidion *ωII* 2 long.

Remarks

This re-description resembles the original description by Kuznetsov (1973) in most respects, but in original description length of seta *fl* nearly as long as distance *fl-h1*, while in this study length of *fl* clearly shorter than *fl-h1*.

Material examined

Hamedan province: Heydareh village – 20 Oct. 2016 (n = 2); Ganjnameh – 1 Nov. 2015 (n = 3). Lorestan province: Aleshtar county – 14 Sep. 2015 (n = 2).

Tydeus goetzi Schruft, 1972

Diagnosis (female)

Dorsal setae different in shape, three pairs of caudal setae (*h1*, *h2* and *ps1*) spatulate, propodosomal trichobotria approximately thick and not much longer than the other dorsal setae. Palpal tarsus length (20) subequal to cheliceral stilettos (19), solenidion *ωI* shorter than half of tarsus I width, setae of genua III-IV and dorsal seta on tibiae III are stout and blunt distally.

Female (Figs. 23–28)

Body oval shape 355–467 length (excluding gnathosoma), width 214–222 (at level of seta *c2*).

Dorsum – Completely striated (Fig. 23), dorsal setae spindle and serrated, length of dorsal setae: *bo* 34–36, *ro* 29–31, *la* 24–26, *ex* 31–33, *c1* 25–27, *c2* 32–35, *d1* 26–28, *e1* 30–33, *f1* 32–34, *f2* 36–43, *h1* 31–33, *h2* 30–32, *ps1* 20–21. Distances between dorsal setae: *ro-ro* 28–31, *la-la* 85–94, *bo-bo* 60–65, *c1-c1* 64–69, *c2-c2* 170–181, *d1-d1* 43–48, *e1-e1* 103–111, *f1-f1* 30–35, *f2-f2* 79–86, *h1-h1* 26–30, *h2-h2* 56–63, *ps1-ps1* 25–29.

Venter – Ventral cuticle and coxisternal shields striated (Fig. 26), lengths of ventral setae: *lb* 27–28, *lc* 24–26, *2a* 19–21, *3b* 29–32, *3c* 25–27, *3d* 26–27, *4b* 24–25, *pt* 29–31, *mta* 19–20, *mtβ* 17–18, *agl* 14, *ag2* 16–17, *ag3* 16–17, *ag4* 17, *ps3* 24–26.

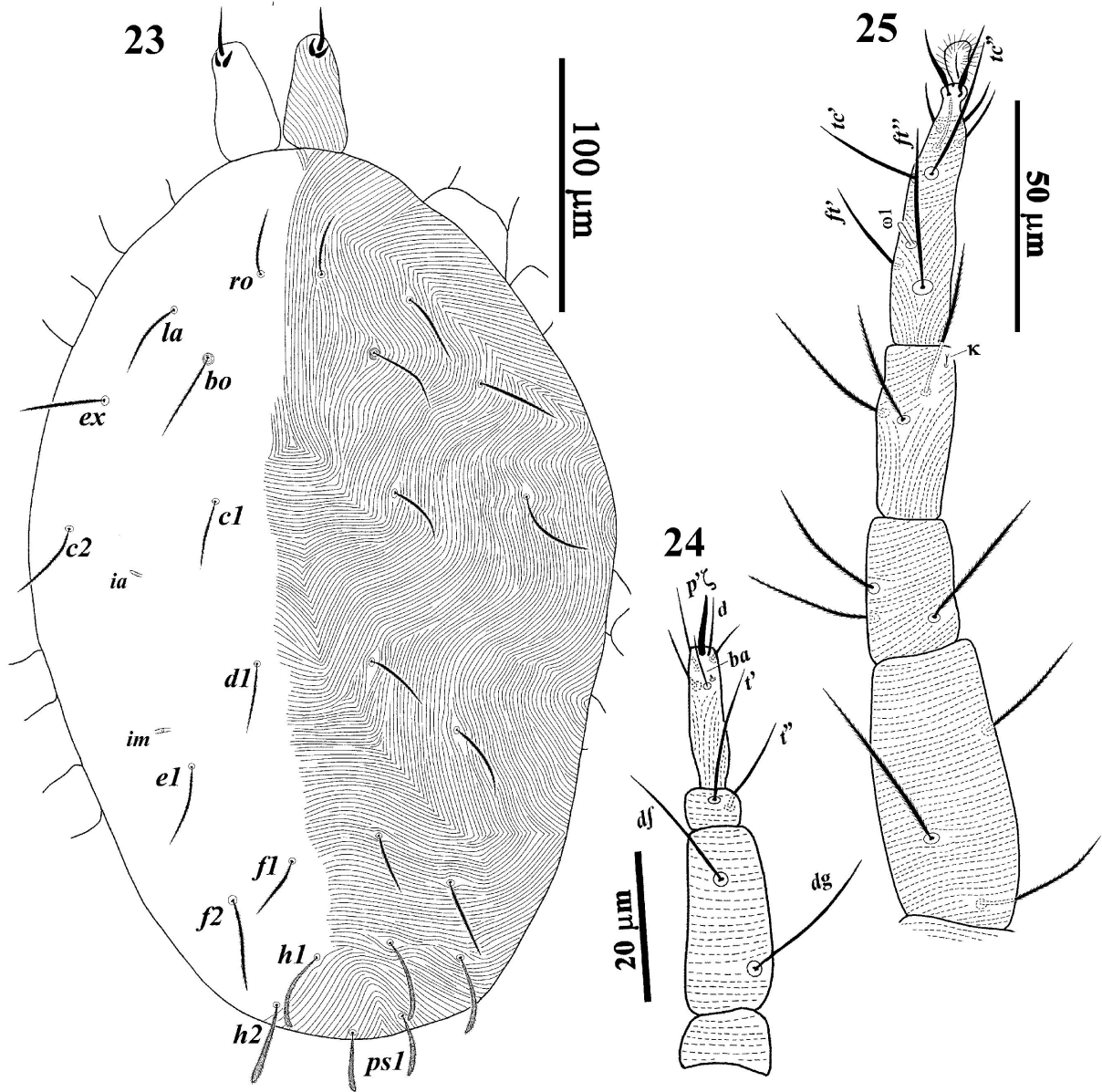
Gnathosoma – Visible completely from above. Palpal femur-genu: length 23, width 12. Palp distally with eupathidium (*pζ*) straight, 8 long. Palp chaetotaxy (6+ω–1–2) (Fig. 4).

Legs – Measurements from trochanter to tarsus (excluding pretarsus): leg I 197–205; leg II 170–176; leg III 183–187; leg IV 207–214; *cg* (coxal organ) narrowed, oval shape. Measurements: tarsus + apotele I length/width: 65/14. Length of setae on tarsus I: *ft'ζ* 18–20, *ft''ζ* 31–33, *tc'ζ* 19–20, *tc''ζ* 28–31, *ωI* 6 (Fig. 25). Tarsus II with club-like solenidion *ωII* 2 long. Setae of genua III-IV and dorsal seta on tibiae III stout and blunt distally (Figs. 27, 28).

Remarks

It is the first record of this species in Hamedan and Lorestan provinces. Re-description of *T. goetzi* in this study resembles previous studies by Baker (1970) and Darbemamieh *et al.* (2016).

Unlike previous studies, more detail and measurements of body setae are presented in this study. Setae of genua III-IV and dorsal seta on tibiae III are blunt in this re-description, but according to former study dorsal setae of genua III and tibiae III-IV are blunt.



Figures 23–25. *Tydeus goetzi* (Schruft, 1972) (Adult female) – 23. Dorsal view of idiosoma; 24. Palp; 25. Leg I.

Material examined

Hamedan province: Avarzaman village – 26 Sep. 2015 (n = 2), Lorestan province: Kahman canyon – 13 Oct. 2015 (n = 1); Firouz Abad county – 13 Nov. 2015 (n = 1).

Family Iolinidae Pritchard, 1956

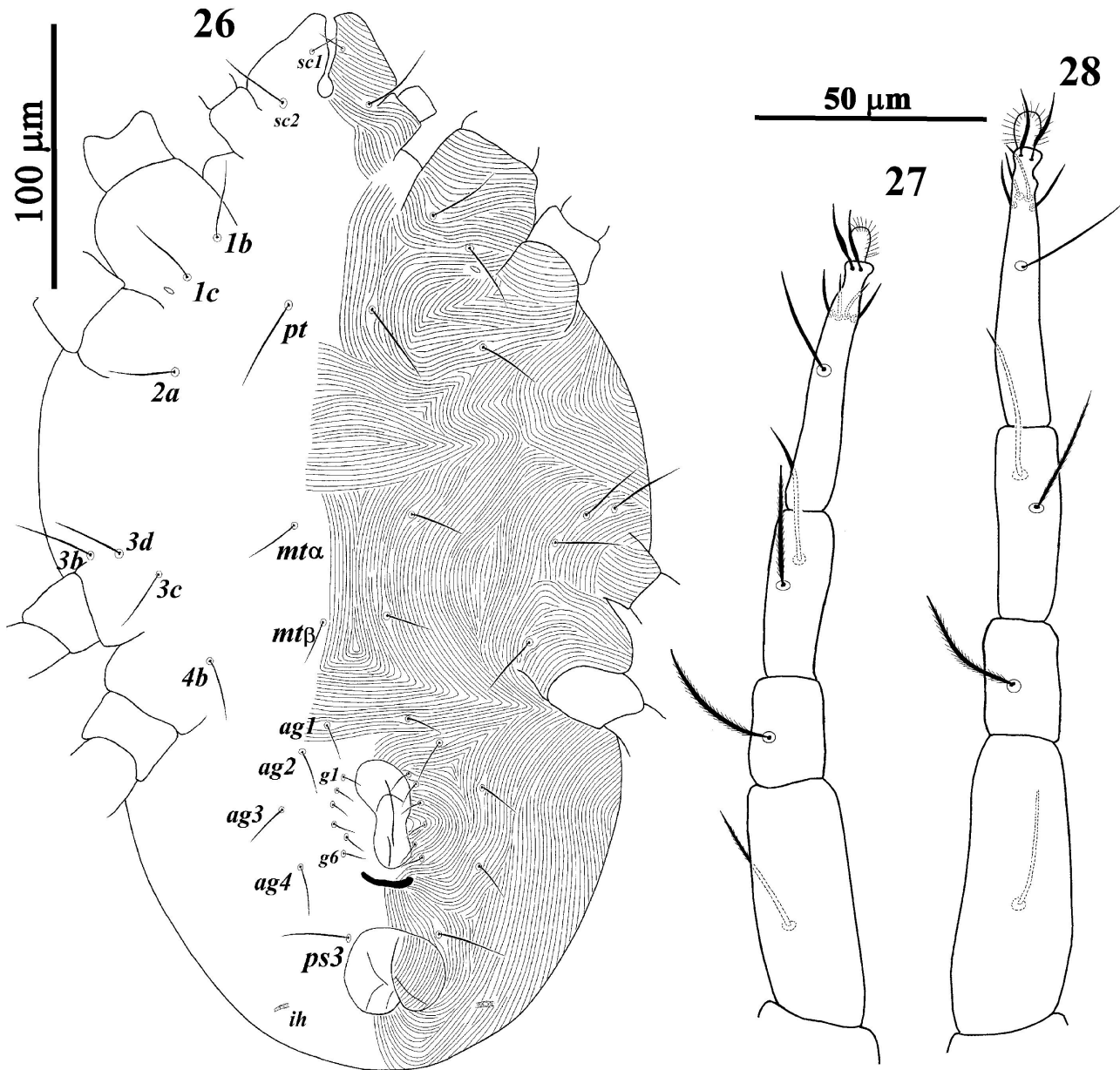
Genus *Neopronematus* Panou, Emmanouel & Kaźmierski, 2000

***Neopronematus solani* Ripka et al., 2013**

Diagnosis (female)

Dorsal idiosomal setae long and serrated, setae *ag3* bifurcate, tarsal solenidion ωI long and

three times shorter than tarsus, famulus κ shorter than solenidion ϕ , cheliceral stiletto longer than palp tarsus and *ag4* longer than *ag1*.



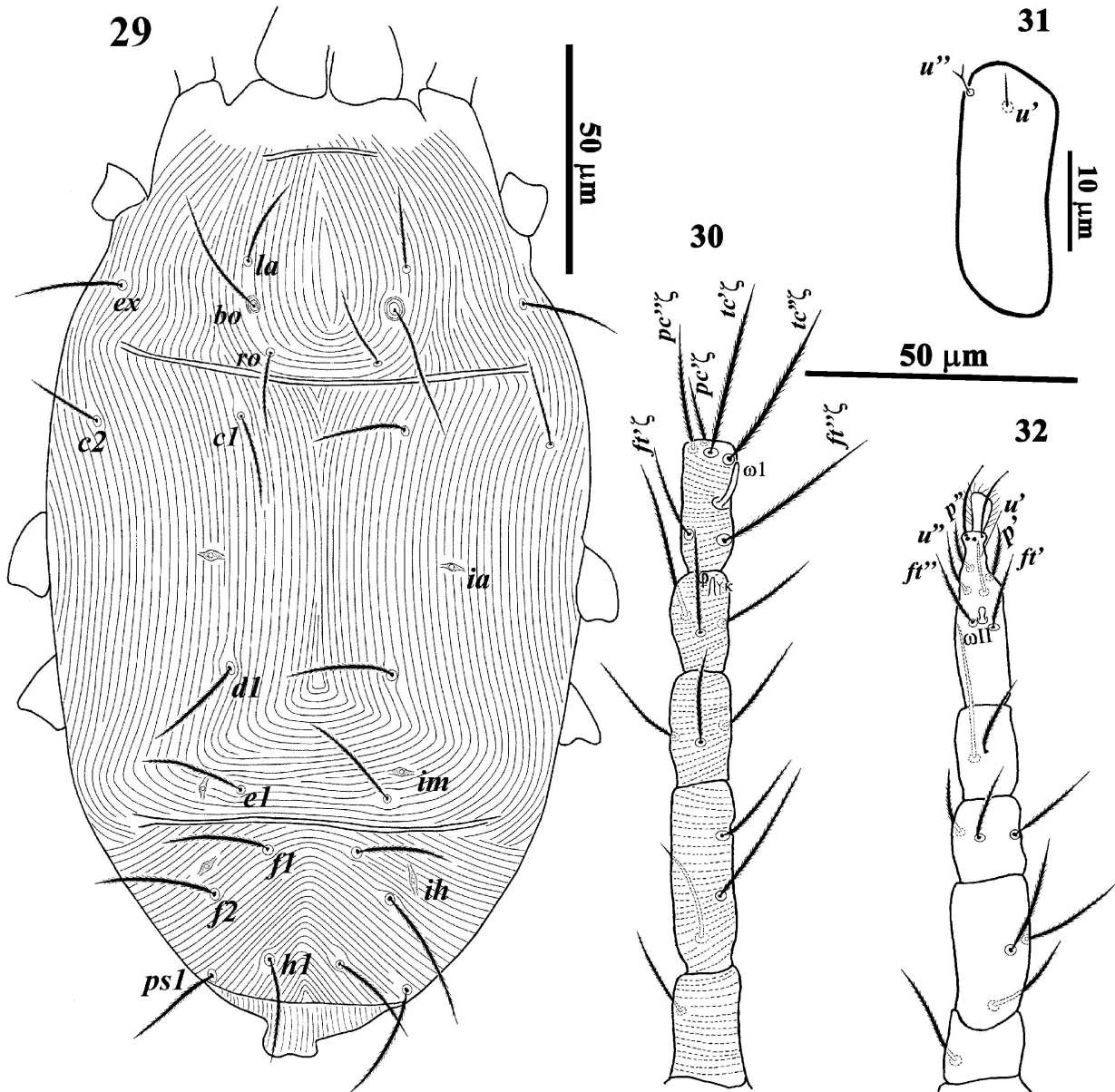
Figures 26–28. *Tydeus goetzi* (Schruft, 1972) (Adult female) – 26. Ventral view of idiosoma; 27. Leg III; 28. Leg IV.

Female (Figs. 29–32)

Body oval. Body length (without gnathosoma) 205–207, width 118–130 at level of seta *c*₂.

Dorsum – Dorsal side of idiosoma completely striated. All dorsal body setae spindle-like, serrated and relatively long. Prodorsum setae narrow and less serrate than opisthosomal setae. Lengths of dorsal setae: *bo* 31–33, *ro* 19–21, *la* 20–21, *ex* 25–27, *c1* 21–22, *c2* 21–23, *d1* 20–23, *e1* 26–28, *f1* 25–27, *f2* 31–33, *h1* 22–23, *ps1* 24–26. Hysterosoma with three pairs of lyrifissures (*ia*, *im* and *ip*) (Fig. 29).

Venter – Ventral cuticle and coxisternal shields striated, ventral setae similar in shape to dorsal setae, but smaller and thinner. Genital opening in shape of inverted “T”, without genital setae. Epimeral formula: 3-1-4-2. Four pairs of aggenital setae (*ag1-4*), *ag3* bifurcate. Pseudanal valves with 1 pair of setae (*ps3*). Lengths of ventral setae: *1b* 17–19, *1c* 16–18, *2a* 20–23, *3b* 21–23, *3c* 20–22, *3d* 19–21, *4b* 18–19, *pt* 11–12, *mta* 11–13, *mtβ* 10–11, *ag1* 11–12, *ag2* 10–12, *ag3* 5–6, *ag4* 14–15, *ps3* 5–6. Palpal femur-genu: length 23–25, width 7. Palps terminate with straight eupathidium (*pζ*), 7 long. Palpal setation ($5+\omega-1-2$).



Figures 29–32. *Neopronematus solani* (Ripka et al., 2013) (Adult female) – 29. Dorsal view of idiosoma; 30. Leg I; 31. Tarsus I; 32. Leg II.

Legs – Measurements from trochanter to tarsus (excluding pretarsus): leg I 115–120; leg II 100–110; leg III 100–112, leg IV 115–120. Setae on segments of legs are serrated. Legs setation (tarsus to trochanter): I ($8+\omega-3+k+\phi-3-3-1$), II ($6+\omega-2-3-3-1$), III ($5-2-2-2-1$), IV ($5-2-1-2-0$). Tarsus I with three pairs of long setae (fastigials, tectals and prorals), one solenidion (ωI) and

one pair of extremely small, vestigial unguinal setae (*u*) closely associated with bases of prorals, *u''* bifurcate (Fig. 30). Setae *u'* on ventral and *u''* on dorsal side of tarsus I (Fig. 31). Measurements: tarsus I length/width: 24–25/9–10, *ft'ζ* 19–20, *ft''ζ* 30–32, *tc'ζ* 33–35, *tc''ζ* 32–33, *p'ζ* 15–17, *p''ζ* 22–23, *u' 2*, *u'' 2*, *ωI* 8–9, tibia I length/width 20/10, famulus *k* 3 (“Y”-shaped), solenidion *φ* 2 (Fig. 30). Tarsus II with club-like solenidion *ωII* 2 long (Fig. 32).

Remarks

This is the first record of *N. solani* for Hamedan and Lorestan provinces. The collected specimens are similar to those considered in the original description of Ripka *et al.* (2013) from Hungary, however, palp eupathidium in this redescription 7 long and not forked distally but in the original description 4 long and forked distally.

Material examined

Hamedan province: Heydareh village – 9 Sep. 2014 (n = 4), 19 Oct. 2015 (n = 3), 11 Sep. 2016 (n = 2); Shahrestaneh village – 19 Nov. 2014 (n = 3), 16 Oct. 2017 (n = 1); Ganjnameh – 18 Sep. 2015 (n = 3); Abasabad village – 1 Sep. 2017 (n = 6); Faculty of Agriculture of Bu-Ali Sina University – 21 Oct. 2015 (n = 4). Lorestan province: Kahman canyon – 26 Sep. 2015 (n = 1); Aleshtar county – 4 Sep. 2015 (n = 2); Kakareza village – 25 Sep. 2016 (n = 3).

Neopronematus iranensis Ahmad–Hosseini *et al.*, 2017

Diagnosis (female)

Dorsal idiosomal setae long and serrated, setae *ag*₃ bifurcate, tarsal solenidion *ωI* short (5) and 5 times shorter than tarsus I (25), famulus *κ* (3) slightly longer than solenidion *φ* (2), cheliceral stilettos (14–15) longer than palp tarsus (10) and *ag*₄ (16–17) longer than *ag*₁ (11–12). Full details of description of this species can be found in Ahmad-Hosseini *et al.* (2017a).

Material examined

Hamedan province: Asadabad – 19 Oct. 2015 (n = 2), 29 Aug. 2016 (n = 3); Abshineh village (34° 46' N; 48° 36' E) – 3 Aug. 2016 (n = 4). Lorestan province: Kahman canyon – 13 Oct. 2015 (n = 6).

Genus *Pronematus* Canestrini, 1886

Pronematus rykei Meyer & Rodrigues, 1966

Diagnosis (female)

Tarsus I longer than tibia I; ventral setae (*pt*, *mtα* and *mtβ*) longer than one third distance between bases of them, Seta *eI* reach bases of *fI*, setae *cI* and *dI* approximately equal in length. Full description of male and female of this species presented in Ahmad-Hosseini *et al.* (2017a).

Material examined

Hamedan province: Heydareh village – 6 Jul. 2015 (n = 5); Shahrestaneh village – 17 Oct. 2016 (n = 5), 15 Aug. 2017 (n = 4); Abshineh village – 5 Aug. 2016 (n = 3), 12 Sep. 2016 (n = 2). Lorestan province: Kahman canyon – 30 Jul. 2015 (n = 9).

DISCUSSION

In this survey, 10 species of predatory mites belonging to six genera and three different families in

studied regions were collected and identified. The frequency of species among collected specimen is as follows: *K. kuzini* 32%, *T. caryae* 21%, *T. bagdasarjani* 19%, *T. khosrovensis* 14%, *E. finlandicus* 6%, *P. rykei* 3%, *Neopronematus solani* 2.2 %, *N. iranensis* 1.8 %, *T. electus* 0.7% and *T. goetzi* 0.3%. The species *K. kuzini* showed the highest abundance (with 321 specimens) among all collected predatory specimens. The results of this study showed that the walnut leaf gall mite, *A. tristriatus* (Nalepa) was affected by natural enemies such as predatory mites.

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بررسی کنه‌های شکارگر کنه گال زگیلی برگ گردو (*Aceria tristriatus* Nalepa) در استان‌های همدان و لرستان، غرب ایران

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چکیده

کنه گال زگیلی برگ گردو یکی از مهم‌ترین آفات گردو در غرب ایران است. این مطالعه به منظور شناسایی کنه‌های شکارگر این آفت در استان‌های همدان و لرستان در طول سال‌های ۱۳۹۳ تا ۱۳۹۶ انجام گرفت. در این بررسی، در مجموع ۱۰ گونه کنه شکارگر متعلق به ۶ جنس و سه خانواده شامل: *Typhlodromus bagdasarjani* Wainstein & Arutunjan، *Kuzinellus kuzini* Wainstein، *Typhlodromus khosrovensis* Arutunjan، *Neopronematus iranensis* Ahmad-Hosseini، *Euseius finlandicus* Oudemans، *Tydeus caryae* Khanjani، *Pronematus rykei* Meyer & Rodrigues، *Neopronematus solani* Ripka et al.، *Tydeus electus* Kuznetov و *Tydeus goetzi* Schruft & Ueckermann جمع‌آوری شده، گونه *K. kuzini* فراوانی را در بین اسلایدهای تهیه شده داشت. در این مقاله گونه‌های *N. solani*، *E. finlandicus*، *Tydeus electus* و *Tydeus goetzi*، *Tydeus caryae*، *Typhlodromus bagdasarjani*، *Typhlodromus khosrovensis* می‌شوند. همچنین گونه‌های *Tydeus goetzi* و *N. solani* برای نخستین بار از استان‌های همدان و لرستان گزارش می‌شوند.

واژگان کلیدی: زیررده کنه‌ها؛ Iolinidae؛ ایران؛ Phytoseiidae؛ Tydeidae؛ کنه گال زگیلی برگ گردو.

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