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Article

A new species of *Proctotydaeus* Berlese (Tydeoidea: Iolinidae) from Iran

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ABSTRACT
In this research, a new species *Proctotydaeus hajiqanbari* Darbemamieh, Ahadiyat & Farmahiny-Farahani **sp. nov.** is described from the galleries of two pest bark beetles *Scolytus amygdali* Guérin-Méneville and *Orthotomicus erosus* (Wollaston) from Iran. Mentioned galleries collected from damaged apricot and pine trees in Tehran province.

KEY WORDS: New taxa; Pronematinae; *Proctotydulus*; Scolytinae; Trombidiformes.

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INTRODUCTION

Bark beetles (Coleoptera: Curculionidae: Scolytinae) are one of the most destructive pests of fruit, ornamental and forest trees providing diverse microhabitats for living various microorganisms, including mites, fungi, nematodes, and other insects under bark of trees and in their galleries with various interactions and food habits (Kinn 1971; Kiełczewski *et al*. 1983; Blackwell *et al*. 1989; Cardoza *et al*. 2008; Hofstetter 2011; Yousuf *et al*. 2014; Hofstetter *et al*. 2014, 2015; Pfammatter and Raffa 2015). They act not only as the carriers of various species of mites, but also as the vectors of tree fungal pathogens together with some mite species (Lindquist 1969; Moser and Roton 1971; Moser 1975; Owen *et al*. 1987; Moser *et al*. 1995; Lombardero *et al*. 2000; Klepzig *et al*. 2001; Linnakoski *et al*. 2012; Knee *et al*. 2013; Vissa and Hofstetter 2017). The almond bark beetle, *Scolytus amygdali* Guérin-Méneville, and the Mediterranean pine engraver beetle, *Orthotomicus erosus* (Wollaston) are two pest beetles of rosaceous fruit and pine trees in Iran, respectively, causing serious damage (Abaii 2000; Ahadiyat and Ostovan 2006). Mites associated with fruit, elm and pine tree bark beetles have been previously investigated in Iran (Ostovan and Kamali 1997; Ahadiyat *et al*. 2004, 2012; Ahadiyat and Akrami, 2015; Farmahiny-Farahani *et al*. 2013, 2017; Magowski *et al*. 2017; Babaei *et al*. 2018).

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The superfamily Tydeoidea Kramer, 1877 comprises four families, including Ereynetidae Oudemans, 1931, Iolinidae Pritchard, 1956, Tydeidae Kramer, 1877, and Triophtydeidae André, 1980 (André and Fain 2000); among them some species of the first three families are extensively found in association with bark beetles worldwide (Hunter 1964; Baker 1968; Kinn 1971; Moser and Roton 1971; Moser *et al*. 1974; Kiełczewski and Wiśniewski 1980; Hunter *et al*. 1989; Khaustov 1997; Ostovan and Kamali 1997; Ahadiyat *et al*. 2004; Hofstetter 2011; Pfammatter *et al*. 2013; Hofstetter *et al*. 2015; Farmahiny-Farahani *et al*. 2017; Khaustov *et al*. 2018).

The genus *Proctotydaeus* Berlese, 1911, belonging to the subfamily Pronematinae André, 1979 (Iolinidae), comprises 20 species in four subgenera (listed below), which are mostly found in association with insects, e.g. locusts, grasshoppers, bark beetles, bees, birds, plants and straw in all continents (Fain and Evans 1966; Khaustov 1997; Kaźmierski 1998; Da-Costa *et al*. 2020): 1) *Neotydeolus* Flechtmann and Camargo, 1974: four species, all associated with bees (Da-Costa *et al*. 2020); 2) *Oriolella* Baker, 1968: six species, in association with bees, straw, birds, and beetles, including *Proctotydaeus* (*O.*) *farbae* (Baker, 1968) collected from gallery of unknown bark beetle in USA (Baker 1968; Da-Costa *et al*. 2020); 3) *Proctotydaeus* Berlese, 1911: four species, all associated with grasshoppers of the family Acrididae (Da-Costa *et al*. 2020); 4) *Proctotydulus* Kaźmierski, 1998, six species, in association with plants, straw, on noctuid moths, and in galleries of bark beetles (Kaźmierski 1998; Da-Costa *et al*. 2020), two of which have been collected from galleries of bark beetles, including *Proctotydaeus* (*P.*) *hypobori* Khaustov, 1997 from the fig bark beetle, *Hypoborus ficus* Erichson, in Crimea, and *Proctotydaeus* (*Proctotydulus*) *oblongus* (Kuznetzov, 1973) from the almond bark beetle, *Scolytus amygdali* in Iran (Khaustov 1997; Ahadiyat *et al*. 2004, respectively). So far, three identified and two unidentified species of this genus have been recorded from Iran: *P.* (*Oriolella*) *sinhai*, *P.* (*Proctotydulus*) *oblongus*, *P.* (*Proctotydaeus*) *schistocercae* Fain and Evans, 1966, *Proctotydaeus* sp. and *P.* (*Oriolella*) sp. (Ostovan 2011; Darbemamieh *et al*. 2021), among them *P.* (*Proctotydulus*) *oblongus* and *Proctotydaeus* sp. have been found in galleries of *S. amygdali* respectively in Alborz and Qazvin provinces (Ahadiyat 2003; Ahadiyat *et al*. 2004; Babaei *et al*. 2018).

Up to now, among mites of the superfamily Tydeoidea, 13 species of the families Ereynetidae (two), Iolinidae (four) and Tydeidae (seven) have been reported in association with four species of bark beetles in Iran, excluding the new species described in this paper (Ostovan and Kamali 1997; Ahadiyat 2003; Ahadiyat *et al*. 2004; Farmahiny-Farahani *et al*. 2017; Babaei *et al*. 2018). Among them, *Lorriya*, with three species, is considered as the most specious genus, followed by *Ereynetes*, *Proctotydaeus* and *Tydeus*, each with two species. Among the bark beetles, *S. amygdali* and *O. erosus*, are the most diverse species, with 10 and three species of mite associates, respectively. The purpose of this study is to describe a new species of *Proctotydaeus* (*Proctotydulus*) found in galleries of two species of bark beetles, *S. amygdali* and *O. erosus*, in Iran.

MATERIAL AND METHODS

Mite materials were taken in two periods, spring 2002 and summer 2010, from damaged apricot and pine trees, respectively infested by *Scolytus amygdali* and *Orthotomicus erosus*, in Shahriyaar and Sharifabad, both in Tehran province. After separation of tree bark from wood, they were placed in Berlese-Tullgren funnel. Thereafter, mites were placed in lactophenol for a few days and later mounted in Hoyer's medium on microscope slides. Finally, they were studied with a phase contrast microscope (Olympus BX51) supplied with a camera lucida and a digital photographic camera. The drawings were made using Adobe Illustrator 2020. The nomenclature of the idiosomal chaetotaxy and poroidotaxy follows Kaźmierski (1998) and Panou *et al*. (2000). All measurements were given in micrometers (μm).

Taxonomy

Family Iolinidae Pritchard, 1956
Subfamily Pronematinae André, 1979
Genus *Proctotydaeus* Berlese, 1911
Subgenus *P.* (*Proctotydulus*) Kaźmierski, 1998

Type species: *Pronematus rusticus* Meyer & Rodrigues, 1966.

Diagnosis as in Kaźmierski (1998).

Other species of the subgenus *P.* (*Proctotydulus*)
1. *P.* (*P.*) *pyrrohippeus* (Treat, 1961)
2. *P.* (*P.*) *rusticus* (Meyer & Rodrigues, 1966)
3. P. (*P.*) *oblongus* (Kuznetzov, 1973)
4. *P.* (*P.*) *pteroni* (Ueckermann & Smith Meyer, 1988)
5. *P.* (*P.*) *hypobori* Khaustov, 1997
6. *P.* (*P.*) *longitrichus* Khaustov, 1997

Proctotydaeus (*Proctotydulus*) *hajiqanbari* Darbemamieh, Ahadiyat & Farmahiny-Farahani sp. nov. (Figs. 1–4)

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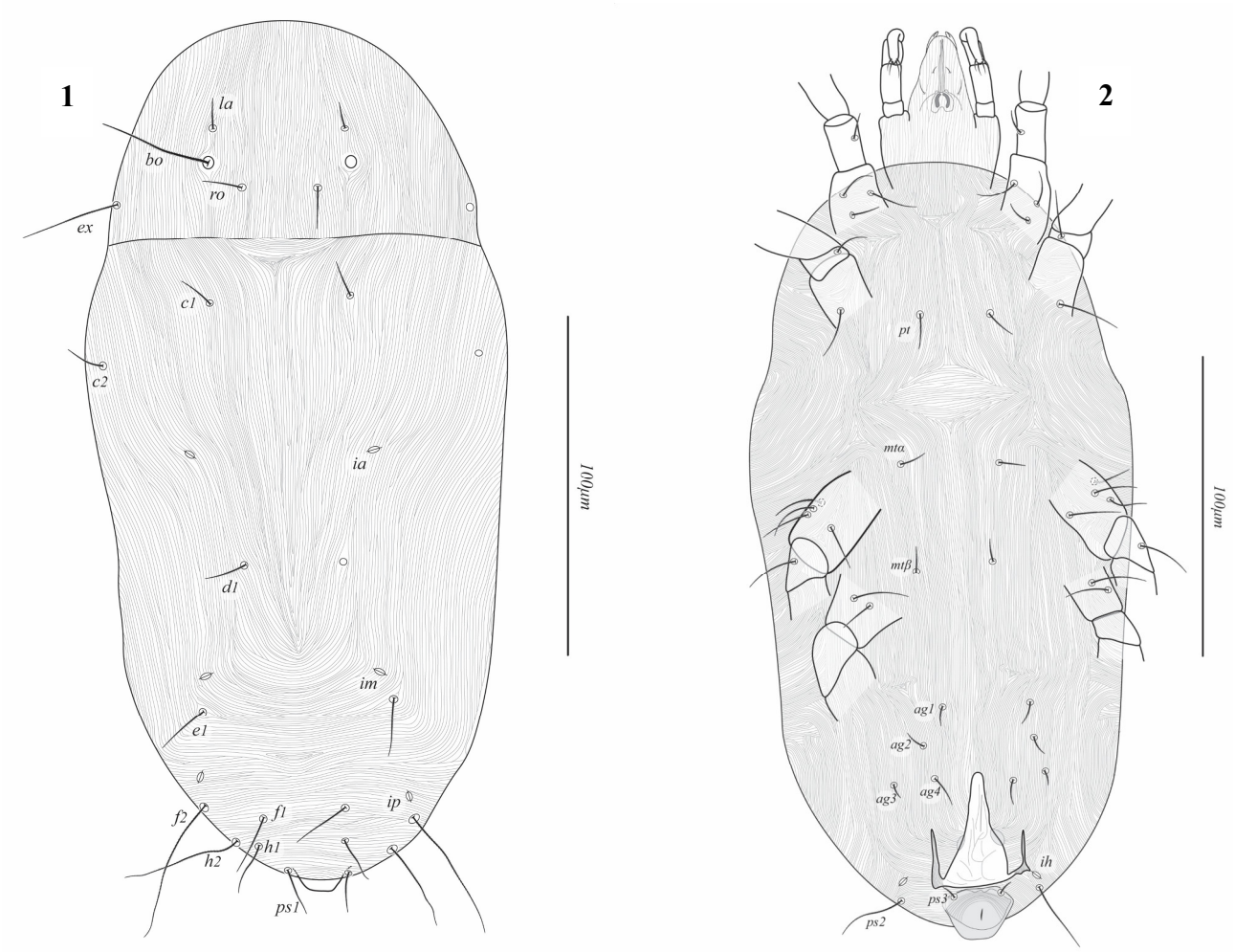
Description

Idiosoma – Holotype female (Fig. 1): length 257, width 125. Paratype deutonymph (Figs. 3D, E, F, 4): length146, width 98.

Dorsum (Fig. 1) – Prodorsum procurved. Aspidosomal chaetotaxy- 4: *ro* (situated posteriad line *la-la*), *la*, *ex*, *bo* (bothridial setae); setae *bo* whip-like and finely serrate. Sejugal furrow well developed. No eyes. Ten pairs of hysterosomal setae. Hysterosomal chaetotaxy: *cl*, *c2*, *dl*, *el*, *f1*, *f2*, *h1*, *h2*, *ps1*, *ps2* and *ps3* (on ventral side). Dorsal setae weakly barbed or serrate. Dorsal hysterosomal setae short with exception of *f2*, *h2* and *ps2* which visibly longer than others, finely serrate, with exception of nude *ps3. ro* > *la*; *c1* and *d1* short, *c1* four times shorter than *c1-d1* distance. Setae *ps1* situated terminally, *ps2* lateroventrally, and *ps3* set on anal valves ventrally. Poroidotaxy: four pairs of lyrifissures: *ia*, *im*, *ip*, *ih*. Dorsal idiosoma narrowly striated. Dorsal ornamentation consists of longitudinal stria on aspidosoma and central part of hysterosoma to level of *dl-dl* and changes to "V" shape between *dl-dl* and *e1-e1*. Posterior part of opisthosoma covered by transverse stria from *im* to posterior margin. Adult and deutonymph have caudal part or pygidium at the end of opisthosoma. Length of setae (*bo*> *ex*> *ro*> *la*; Fig. 3A): *bo*: 34, *ro*: 12, *la*: 9, *ex*: 29, *c1*: 11, *c2*: 12, *dl*: 13, *e1*: 17, *f1*: 18, *f2*: 42, *h1*: 16, *h2*: 34, *ps1*: 14, *ps2*: 25, *ps3*: 6. Distances between setae: *c1-c1*: 41, *d1-d1*: 29, *e1-e1*: 57, *f1-f1*:25, *h1-h1*: 26, *f2-f2*: 63, *h2-h2*: 46 *c1-dl*: 79, *d1-e1*: 45.

Venter (Fig. 2) – Ornamentation finely striated; more lines in comparison with dorsum, ventral setae shorter and more delicate, all serrate; stria longitudinal between *pt*, *mtα*, *mtß* and *ag1*. Transverse stria in area between pairs of *pt* and *mtα* setae. Striae are longitudinal in ventral part but become transverse between legs II and III that form an eye shape. Length of ventral setae: *pt*: 120, *mtα*: 10, *mtß*: 9, *ag1*: 8, *ag2*: 7, *ag3*: 6, *ag4*: 10. One pair of genital acetabula, four pairs of aggenital setae. Epimeral formula (3-1-4-2).

Legs (Figs. 3B, C) – Tarsal setae serrate; Genua Ill and IV and femur IV each with very small delicate apophysis situated in dorso-paraxial position and hardly visible. Leg chaetotaxy of adult as follows (tarsus—trochanter): Legs I (8+*ω*–3 + *k* + *φ*–3–3–1), II (7 + *ω*–2–3–3–1), III (7–2–2–2–1), IV (7–2–1– (1–1) –0).



Figures 1–2. *Proctotydaeus* (*Proctotydulus*) *hajiqanbari* Darbemamieh, Ahadiyat & Farmahiny-Farahani **sp. nov.** (female) – 1. Dorsal view of idiosoma; 2. Ventral view of body.

Lengths of legs: leg I (157–158); leg II (104–105); leg III (119–120) and leg IV (111–112). Tarsus I (Fig. 3B) (14/7); solenidion *ω1* short and less than half of tarsal width; length of *ω1* 3; length of *tc'ζ* 20; *tc''ζ* 28; length of seta *k* 2. Other legs each with two claws (*ol*) and ciliate empodium. Empodial hooks absent. Tarsus II (21/7) (length to base of apotele) (Fig. 3C) with minute, spherical, scarcely visible solenidion *ωII* (1).

Gnathosoma (Figs. 3D, E, F) – Width: 40, total length without palp: 50 (Fig. 3F). Visible from above, subcapitulum triangular reaching distal end of femur I. *sc1*(4); *sc2*(6) Cheliceral frame fused in great part, stylets shorter than palp tarsus. Cheliceral stylet (Fig. 3E): 8. Palpal tarsus (Fig. 3D): length 12, width 3. Palp (6-1-2) with a double eupathidia at tip of tarsus. Palpal eupathidium (*pζ*) terminate with straight cleft distally (length 7), (*pζ*), *1''*, *1'*, *d*, *v*, *ba* (very small), *ω*.

Deutonymph (Fig. 4) – Smaller than female; with dehiscence line on aspidiosoma situated anteriad *ro* and *la*.

Material examined

One female, Shahriyaar, Tehran province, latitude: N 35° 39', longitude: E 51° 03', altitude: 997 m a.s.l., gallery of *Scolytus amygdali* attacking apricot (*Prunus armeniaca* Linnaeus, 1753), 24 April 2002, Ali Ahadiyat; one deutonymph, Sharifabad, Tehran province, latitude: N 35° 25' 39", longitude:

E 51° 47' 7", altitude: 1054 m a.s.l., gallery of *Orthotomicus erosus* attacking pine tree (*Pinus* sp.), 11 June 2010, coll. Ali Ahadiyat and Ahmad Valizadeh.

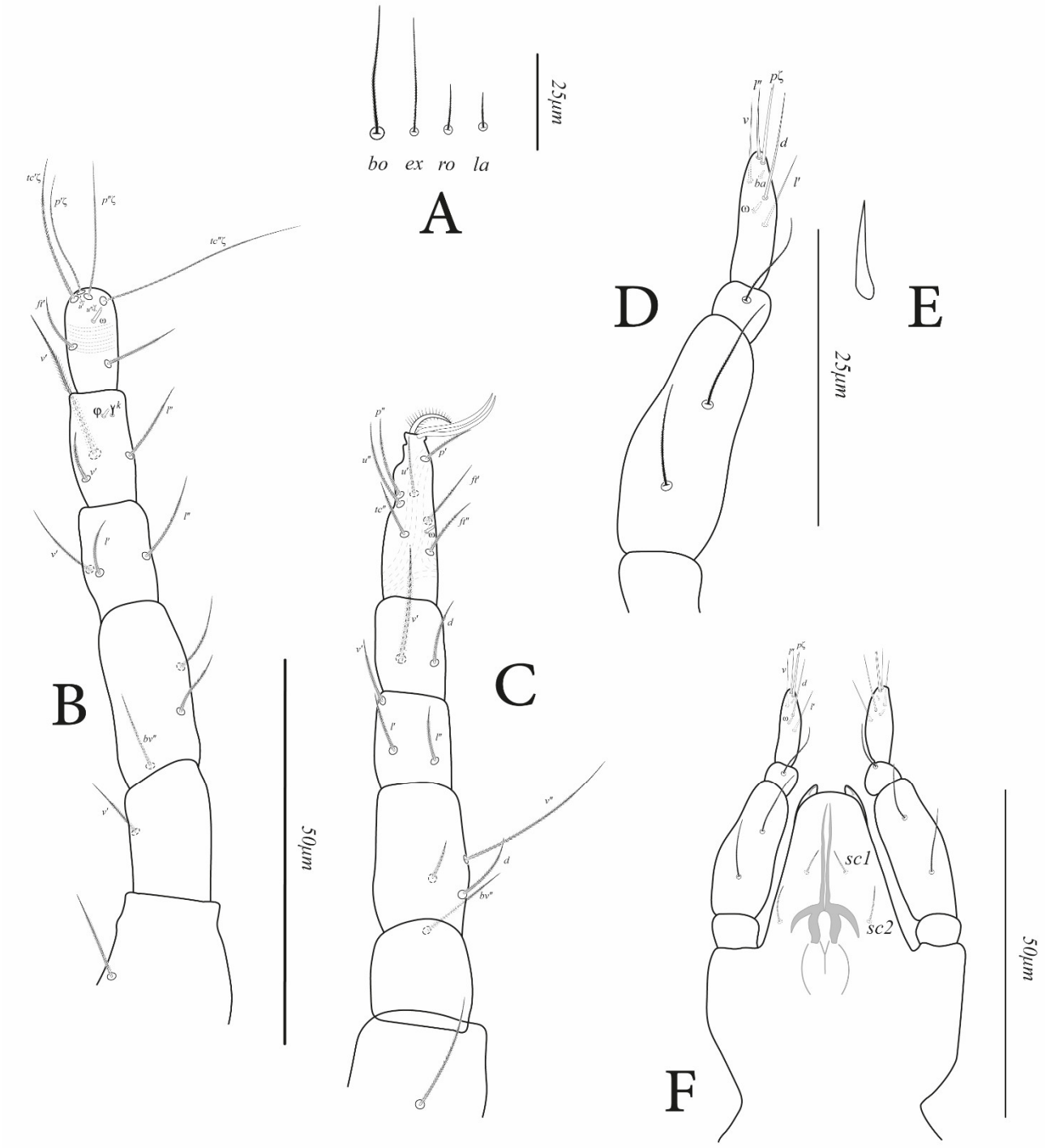


Figure 3. *Proctotydaeus* (*Proctotydulus*) *hajiqanbari* Darbemamieh, Ahadiyat & Farmahiny-Farahani **sp. nov.** (female) – **A.** Aspidiosomal setae; **B.** Leg I; **C.** Leg II; **D.** Pedipalp of deutonymph; **E.** Cheliceral stylet of deutonymph; **F.** Gnathosoma of deutonymph.

Differential diagnoses

This species is morphologically close to *Proctotydaeus hypobori* Khaustov, 1997, but it can be distinguished with some characters, including forms of dorsal setae, length of cheliceral stylets, length

and the locality of the solenidion *ω1*, and the situation of the dorsal transverse furrow. These differential diagnoses are summarized in Table 1.

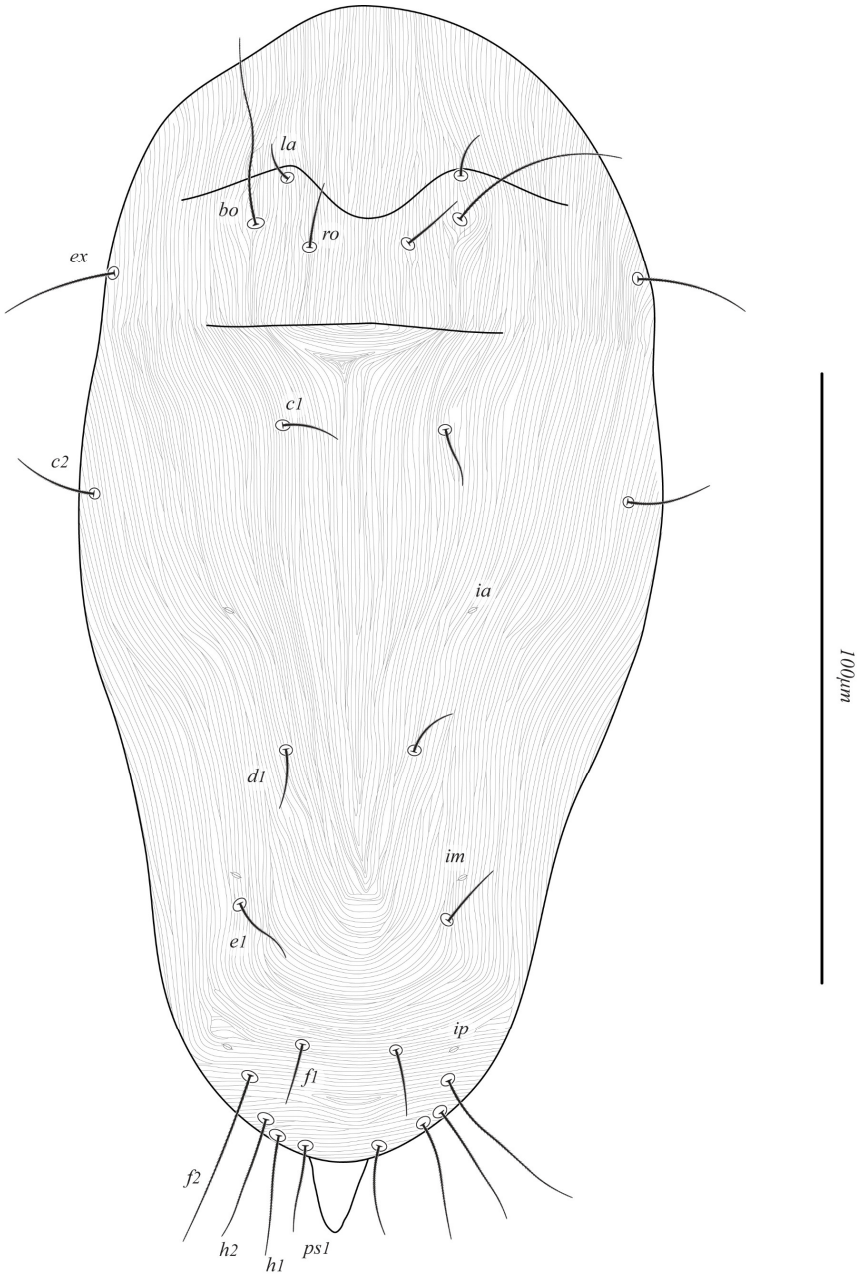


Figure 4. *Proctotydaeus* (*Proctotydulus*) *hajiqanbari* Darbemamieh, Ahadiyat & Farmahiny-Farahani **sp. nov.** (deutonymph) – Dorsal view of idiosoma.

Table 1. Differential morphological characters between *Proctotydaeus hypobori* and *P. hajiqanbari* **sp. nov.**

Proctotydaeus hypobori	***Proctotydaeus hajiqanbari* sp. nov.**
Setae *la*, *h2* and *f2* smooth	All dorsal setae serrate
Setae *ft"*, *tc* and *p* all serrate at one-third of length at basis	Setae *ft"*, *tc* and *p* all serrate at three-fourth of length at basis
Cheliceral stylets longer (16) than palp tarsus (12)	Cheliceral stylets (8) shorter than palptarsus(12)
Solenidion *ω1* longer (6), reaching the tip of tarsus I	Solenidion *ω1* shorter (4), not reaching the tip of tarsus I
A transverse furrow between setae *e1* and *f1*	No transverse furrow between setae *e1* and *f1*

Etymology

The species is named in memory of the late Dr. Hamidreza Hajiqanbar (1973–2021), an eminent Iranian acarologist who contributed significantly to the fauna of insect associated Prostigmata.

Type repository

Holotype female and paratype deutonymph are deposited at the Acarological Collection, Department of Plant Protection, Razi University, Kermanshah, Iran.

DISCUSSION

Altogether, *Proctotydaeus* species are found in bird nests, insect colonies, plants and barn straw, and comprise 21 species (including *P.* (*Proctotydulus*) *hajiqanbari*) belonging to four subgenera. This research increased the number of the species of the subgenus *Proctotydaeus* (*Proctotydulus*) to seven, among which three species are in association with bark beetles (Khaustov 1997; Ahadiyat *et al*. 2004; this paper). *Proctotydaeus* (*Proctotydulus*) *hypobori* was found from galleries of fig bark beetle, *Hypoborus ficus* Erichson, 1836, in Crimea (Khaustov, 1997), while *P.* (*Proctotydulus*) *oblongus* was collected from *S. amygdali* galleries in cherry trees in Kamaal-Shahr of Karaj, Alborz province, Iran, in early November 2002, with unknown food habit (Ahadiyat 2003). Here, *P.* (*Proctotydulus*) *hajiqanbari* has been found in galleries of *S. amygdali* attacking apricot and *O. erosus* attacking pine tree at altitudes 997–1054 m a.s.l. The previous research conducted by Babaei *et al*. (2018) showed an unidentified species of *Proctotydaeus* collected from galleries of *S. amygdali* in Qazvin province at the altitude 1892 m a.s.l. It seems that bark beetle associated mites of this genus can be found in the medium to high altitudes.

Counting the result of this research, totally 14 species of the superfamily Tydeoidea, including five species of Iolinidae, have been recorded associated with four species of bark beetles in Iran, among which *Proctotydaeus* are considered as one of the most specious genera with three species.

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گونهٔ جدیدی از جنس *Proctotydaeus* Berlese (Tydeoidea: Iolinidae) از ایران

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چکیده

در این پژوهش گونهٔ جدید *Proctotydaeus hajiqanbari* Darbemamieh, Ahadiyat & Farmahiny-Farahani از دالان‌های دو سوسک پوستخوارآفت *Scolytus amygdali* Guérin-Méneville و *Orthotomicus erosus* (Wollaston) در ایران توصیف شده است. این دالان‌ها از درختان زردآلو و کاج آسیب دیده در استان تهران جمع‌آوری شده‌اند.

واژگان کلیدی: آرایهٔ جدید؛ زیرخانوادهٔ Pronematinae؛ زیرجنس *Proctotydulus*؛ زیرخانوادهٔ Scolytinae؛ راستهٔ Trombidiformes.

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