Contributions to the knowledge of the mite genus

*Stigmaeus* Koch, 1836 (Acari: Stigmaeidae) of Turkey

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**Abstract.** Based on the mite specimens collected within the scope of a study on Erzincan (Turkey) mite biodiversity, two species of the genus *Stigmaeus* are described and illustrated here: *S. bifurcus* sp. nov. as new to science and *S. miandoabiensis* Bagheri & Zarei, 2012 as a new record for Turkey. Some morphological abnormalities in the new species are noted. The deutonymph of *S. miandoabiensis* is described for the first time in this study. Discovery of this stage from soil and litter under *Pinus sylvestris* in Turkey adds more data to our knowledge of the species.

**Keywords.** Mite, taxonomy, *Stigmaeus*, new species, new record, description, Turkey.


**Introduction**

*Stigmaeus* Koch, 1836 is the most diverse genus in the family Stigmaeidae with 133 valid species (Fan & Zhang 2005; Doğan et al. 2015a, 2016; Dilkaraoğlu et al. 2016a, 2016b, Fan et al. 2016). To date, 36 species of the genus have been recorded from Turkey (Özkan et al. 1988, 1994; Erman et al. 2007; Doğan 2007; Doğan et al. 2015a, 2016; Dilkaraoğlu et al. 2016a, 2016b).

The descriptions of *Stigmaeus bifurcus* sp. nov. and *S. miandoabiensis* Bagheri & Zarei, 2012—originally found in Iran, newly recorded for the Turkish fauna—are given in this survey. The deutonymph of *S. miandoabiensis* is described for the first time.
Material and methods

The specimens were collected from Erzincan in 2014 and 2015. Methods used for specimen collection, extraction, material preservation and preparation were as discussed by Doğan (2006). The specimens were illustrated using a Leica DM 4000 B phase-contrast microscope. The nomenclature of the idiosomal shields follows that of Summers (1962). Dorsal setal and leg setal designations follow Kethley (1990) and Grandjean (1944), respectively. Setal counts of leg segments are given with solenidia in parentheses. All measurements are given in micrometers (μm) and refer to the length of the structure unless otherwise stated. For the new species, measurements of the holotype are given first followed in parentheses by those of paratypes as a range. In newly recorded species, mean values are given first and the range is given parenthetically. Body length measurements represent the distance between the base of the gnathosoma and the posterior part of the idiosoma; width was measured at the broadest point of the idiosoma. Setae were measured from the setal base to the tip of the seta; distances between setae were measured between the setal bases. Leg length was measured from the tip of the claws to the trochanter base. Palp length was measured from the tarsal tip to the trochanter base. Specimens examined were deposited in the collection of the Acarology Laboratory of Erzincan University, Turkey.

Abbreviations

Gnathosoma

- $\omega$ = solenidion on palptarsus
- elcp = supracoxal setae of palp
- $m$ = anterior or innermost pair of subcapitular setae
- $n$ = posterior pair of subcapitular setae
- or$_1$ = 1$^{st}$ pair of adoral setae
- or$_2$ = 2$^{nd}$ pair of rostral setae

Idiosoma

- 1a = 1$^{st}$ pair of intercoxal setae
- 3a = 2$^{nd}$ pair of intercoxal setae
- 4a = 3$^{rd}$ pair of intercoxal setae
- ag$_1$ = 1$^{st}$ pair of aggenital setae
- ag$_2$ = 2$^{nd}$ pair of aggenital setae
- ag$_3$ = 3$^{rd}$ pair of aggenital setae
- ag$_4$ = 4$^{th}$ pair of aggenital setae
- c$_1$ = internal pair of humeral setae
- c$_2$ = external pair of humeral setae
- d$_1$ = internal pair of dorsal setae
- d$_2$ = external pair of dorsal setae
- e$_1$ = internal pair of lumbral setae
- e$_2$ = external pair of lumbral setae
- f$^1$ = internal pair of sacral setae
- g$_1$ = 1$^{st}$ pair of genital setae
- g$_2$ = 2$^{nd}$ pair of genital setae
- h$_1$ = 1$^{st}$ pair of clunan setae
- h$_2$ = 2$^{nd}$ pair of clunan setae
- h$_3$ = 3$^{rd}$ pair of clunan setae
- pob = post-ocular bodies
Contributions to the knowledge of the mite genus *Stigmaeus*

\[ ps_1 = 1^{st} \text{ pair of pseudanal setae} \]
\[ ps_2 = 2^{nd} \text{ pair of pseudanal setae} \]
\[ ps_3 = 3^{rd} \text{ pair of pseudanal setae} \]
\[ sce = \text{external pair of scapular setae} \]
\[ sci = \text{internal pair of scapular setae} \]
\[ vi = \text{internal pair of vertical setae} \]
\[ ve = \text{external pair of vertical setae} \]

**Legs**
\[ \omega = \text{solenidion on tarsi} \]
\[ \varphi = \text{solenidion on tibia I} \]
\[ \varphi \rho = \text{proximal solenidion on tibiae} \]
\[ \kappa = \text{solenidion on genu I} \]
\[ elcp = \text{supracoxal setae of leg I} \]

**Institutional abbreviation**
ALEU = Acarology Laboratory of Erzincan University, Turkey

**Results**

Subclass Acari Leach, 1817
Superorder Acariformes Zakhvatkin, 1952
Order Trombidiformes Reuter, 1909
Suborder Prostigmata Kramer, 1877
Superfamily Raphignathoidea Kramer, 1877
Family Stigmaeidae Oudemans, 1931

Genus *Stigmaeus* Koch, 1836

**Type species**
*Stigmaeus cruentus* Koch, 1836, by original designation.

**Description**
The genus *Stigmaeus* Koch, 1836 (Acari: Stigmaeidae) can be defined by the following characters: idiosoma oval; chelicerae separate; palptibial claw subequal to or slightly shorter than palptarsus; accessory claw seta-like or spine-like, terminal eupathidion on palptarsus basally fused and split into two or three long prongs; counts of setae and solenidia from palptrochanter to palptarsus: 0, 3, 1–2, 2 + 1 claw + 1 accessory claw, 4 + 1\( \omega \) + 1 subterminal spine-like eupathidion + 2 or 3 eupathidia (basally fused); subcapitulum with two pairs of subcapitular setae; prodorsum typically with a large shield, bearing three pairs of setae and a pair of platelets bearing setae *sce*; eyes present or absent, postocular bodies (*pob*) present or absent; dorsal hysterosomal area typically with one or two shields surrounded by three to five pairs of platelets, setae *d* and *d* never on same shield; humeral shields dorso- or ventrolateral, with setae *c*; intercalary shields entire or divided, with a pair of setae (*f*); suranal shield entire or divided, with two or three pairs of setae; coxisternal shields present, divided along midline; ventral opisthosoma with three to five pairs of aggenital setae; genital and anal valves fused or contiguous, with one to three pairs of genital setae and three pairs of pseudanal setae (Fan & Zhang 2005; Dönel & Doğan 2011; Doğan *et al.* 2015a, 2016).
Etymology
The name of this new species, *bifurcus*, refers to the shape of the eupathidion on the palptarsus.

Type material
Holotype

Paratypes
TURKEY: 8 ♀♀, same data as holotype; 1 ♀, from soil under *Rosa canina*, same locality as holotype, 15 Mar. 2015.

Description
Female

Gnathosoma (Fig. 2B). Gnathosoma punctate and 68 (65–70) long, chelicerae separate and punctate, 78 (74–81) long. Palp punctate and 91 (74–89) long. Counts of setae and solenidia from palptrochanter to palptarsus: 0, 3, 1, 2 + 1 claw + 1 seta-like accessory claw, 4 + 1 solenidion + 1 subterminal seta-like eupathidion + 1 bifurcate eupathidion. Palptibial claw slightly longer than palptarsus. Palp supracoxal setae (*e*1) pudgy. Subcapitulum with two pairs of dorsal setae (*or1, 2*) and two pairs of subcapitular setae (*m, n*). Dimensions and distance between subcapitular setae, m 14 (12–14), n 26 (22–25), m–m 21 (19–22), n–n 24 (23–26), m–n 12 (10–12).

Fig. 1. *Stigmascus bifurcus* sp. nov. A–B. Holotype (♀). A. Dorsum of body. B. Venter of body. – C–D. Paratype (♀). C. Abnormality: left seta c₁ about 2 times as long as the right. D. Abnormality: seta h₃ absent on right suranal shield in one paratype. Scale bars = 100 μm.
Fig. 2. *Stigmaeus bifurcus* sp. nov., holotype, ♀. A. Some dorsal body setae. B. Palp. C. Leg I. D. Leg II. E. Leg III. F. Leg IV. Scale bars: A–B = 40 μm; C–F = 100 μm.
Table 1. Differences among the *Stigmaeus* species having laterally two extra non setose dorsal shields. – = absent; + = present.

<table>
<thead>
<tr>
<th>Characters</th>
<th>S. bifurcus sp. nov.</th>
<th>S. hashtrudiensis</th>
<th>S. curia</th>
<th>S. kerman-shahieiensis</th>
<th>S. shabestariensis</th>
<th>S. petilus</th>
<th>S. erzincanus</th>
<th>S. additicius</th>
<th>S. oyuani</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shape of accessory claw on palp tibia</strong></td>
<td>seta-like</td>
<td>seta-like</td>
<td>spine-like</td>
<td>spine-like</td>
<td>spine-like</td>
<td>spine-like</td>
<td>seta-like</td>
<td>spine-like</td>
<td>seta-like</td>
</tr>
<tr>
<td><strong>Shape of palp eupathidion</strong></td>
<td>bifurcate</td>
<td>bifurcate</td>
<td>bifurcate</td>
<td>bifurcate</td>
<td>trident</td>
<td>trident</td>
<td>trident</td>
<td>?</td>
<td>trident</td>
</tr>
<tr>
<td><strong>The number of setae on palp tibia (except for claw and accessory claw)</strong></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Shape of dorsal body setae</strong></td>
<td>almost smooth</td>
<td>smooth</td>
<td>almost smooth</td>
<td>almost smooth</td>
<td>smooth</td>
<td>slightly serrated</td>
<td>stout</td>
<td>slightly serrated</td>
<td>slightly spinulate</td>
</tr>
<tr>
<td><strong>Platelets bearing the setae</strong></td>
<td>+</td>
<td>– or +</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Apodemal marking</strong></td>
<td>+</td>
<td>– or +</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Additional a pair of shields next to propodosomal shield</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Median zonal shields</strong></td>
<td>divided</td>
<td>divided</td>
<td>divided</td>
<td>divided</td>
<td>entire</td>
<td>divided</td>
<td>divided</td>
<td>divided</td>
<td>divided</td>
</tr>
<tr>
<td><strong>Suranal shield</strong></td>
<td>divided</td>
<td>divided</td>
<td>divided</td>
<td>divided</td>
<td>entire</td>
<td>entire</td>
<td>entire, but recessed</td>
<td>entire</td>
<td></td>
</tr>
<tr>
<td><strong>The number of setae pairs on suranal shield</strong></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
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<tr>
<td><strong>Aggenital shields</strong></td>
<td>longitudinally divided into two parts</td>
<td>longitudinally divided into two parts</td>
<td>longitudinally divided into two parts</td>
<td>longitudinally divided into two parts</td>
<td>longitudinally divided into two parts</td>
<td>longitudinally divided into two parts</td>
<td>divide into four parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shape of aggenital setae</strong></td>
<td>smooth</td>
<td>smooth</td>
<td>smooth</td>
<td>smooth</td>
<td>smooth</td>
<td>slightly serrated</td>
<td>smooth</td>
<td>smooth</td>
<td></td>
</tr>
<tr>
<td><strong>Pattern on ventral shields</strong></td>
<td>–</td>
<td>– or +</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td><strong>Setal formulae of leg genua</strong></td>
<td>5(+1κ)-3-0-1</td>
<td>5(+1κ)-4-1-2</td>
<td>5(+1κ)-2-0-1</td>
<td>5(+1κ)-3-0-2</td>
<td>5(+1κ)-5-2-2</td>
<td>5(+1κ)-3-0-1</td>
<td>5(+1κ)-5-2-2</td>
<td>5(+1κ)-5-2-2</td>
<td></td>
</tr>
<tr>
<td><strong>Setal formulae of leg tarsi</strong></td>
<td>13(+1ο)-8(1ο)-7(1ο)</td>
<td>13(+1ο)-8(1ο)-7(1ο)</td>
<td>13(+1ο)-8(1ο)-7(1ο)</td>
<td>13(+1ο)-9(1ο)-7(1ο)</td>
<td>13(+1ο)-9(1ο)-7(1ο)</td>
<td>13(+1ο)-9(1ο)-7(1ο)</td>
<td>13(+1ο)-9(1ο)-7(1ο)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The Turkish specimens of *S. hashtrudiensis* Bagheri & Maleki, 2014 have a pair of additional small platelets (Uluçay 2015) but not in the type specimens (Bagheri et al. 2014).*
**Stigmaeus miandoabiensis** Bagheri & Zarei, 2012
Figs 3–5

**Material examined**
TURKEY: 2 ♀♀, 1 DN from soil and litter under *Pinus sylvestris*, Erzincan, alt. 1210 m, 39°45'00.8" N, 39°29'17.8" E, 23 Oct. 2014; 1 ♀ from soil under *Rosa canina*, Erzincan, 1275 m, 39°39'39.8" N, 39°29'28.5" E, 15 Mar. 2015.

**Description**

**Female** (Figs 3, 5) (n = 3)


**Gnathosoma** (Fig. 5B). Gnathosoma punctate and 68 (67–71) long, chelicerae separate and punctate, 79 (74–82) long. Palp punctate and 73 (69–79) long. Counts of setae and solenidia from palptrochanter to palptarsus: 0, 3, 1, 2 + 1 claw + 1 seta like accessory claw, 4 + 1 solenidion + 1 subterminal seta-like eupathidium + 1 bifurcate eupathidium. Palptibial claw about subequally as long as palptarsus. Palpal...
Fig. 3. *Stigmaeus miandoabiensis* Bagheri & Zarei, 2012 (♀). A. Dorsum of body. B. Venter of body. C. Leg I. D. Leg II. E. Leg III. F. Leg IV. Scale bars = 100 μm.
Fig. 4. *Stigmaeus miandoabiensis* Bagheri & Zarei, 2012 (deutonymph). A. Dorsum of body. B. Venter of body. C. Leg I. D. Leg II. E. Leg III. F. Leg IV. Scale bars = 100 μm.
supracoxal setae (elcp) pudgy. Subcapitulum with two pairs of adoral setae (or₁,₂) and two pairs of subcapitular setae (m, n). Dimensions and distance between subcapitular setae: m 11 (11–12), n 16 (16–17), m–m 21 (18–24), n–n 23 (23–24), m–n 11 (8–12).


**Fig. 5.** *Stigmaeus miandoabiensis* Bagheri & Zarei, 2012. A. Some dorsal body setae. B. Palp (♀). Scale bars = 40 μm.
**Venter** (Fig. 3B). Almost striate. Back of coxae II and III–IV striate with tubercles. Humeral shields without ornamentation, bearing setae c_{1}. Coxisternal shields divided, without ornamentation, bearing three pairs of setae (1a, 3a, 4a). Lengths and distances of these setae: 1a 12 (11–13), 3a 12 (11–13), 4a 11 (10–13), 1a–1a 19 (17–20), 3a–3a 23 (18–26), 4a–4a 21 (18–23). Genital and anal shields contiguous, two pairs of genital (g_{1,2}) and three pairs of pseudanal setae (ps_{1,2}) on long and divided aggenital shields. Lengths of these setae as follows: ag, 9 (8–9), ag, 9 (8–9), ag, 9 (8–9), ag, 10 (9–10), g, 8 (7–9), g, 9 (7–10), ps, 24 (23–25), ps, 21 (19–23), ps, 11 (11–11).

**Legs** (Figs 3C–F). Lengths: leg I 136 (133–142), leg II 100 (97–105), leg III 103 (102–106), leg IV 125 (118–132). Counts of setae on legs I–IV: coxae 2-2-2-2, trochanters 1-1-2-1, femora 4-4-3-2, genua 5(+1κ)-3-0-1, tibiae 5(+1φ+1φρ)-5(+1φρ)-5(+1φρ)-5(+1φρ), tarsi 13(+1ω)-8(+1ω)-7(+1ω)-7(+1ω). Lengths of solenidia: Iω 12, IIω 7, IIIω 4, IVω 3.

**Deutonymph** (DN) (Figs 4–5) (n=1)


**Gnathosoma**. Lengths: gnathosoma 60, chelicerae 69, palp 68. Number of setae on palp segments as in female. Dimensions and distance between subcapitular setae: m 12, n 15, m–m 18, n–n 23, m–n 10.

**Dorsum** (Fig. 4A). As in female except suranal shields with two pairs of setae. Lengths and distances of dorsal idiosomal setae as follows: vi 13, ve 36, sc 16, sce 33, c_{1}, 13, c, 41, d, 13, d, 21, e, 14, e, 14, f, 26, h, 7, h, 20, vi–vi 26, ve–ve 29, vi–ve 17, sci–sci 39, ve–sci 31, sce–sce 96, sci–sce 29, c_{1}–c_{1} 27, c_{1}–c_{1} 130, c_{1}–c_{1} 52, d_{1}–d_{1} 99, c_{1}–c_{1} 37, c_{1}–d_{1} 41, d_{1}–d_{1} 23, d_{1}–d_{1} 42, e_{1}–e_{1} 94, d_{1}–e_{1} 55, d_{1}–e_{1} 41, d_{1}–e_{1} 52, e_{1}–e_{1} 30, e_{1}–e_{1} 42, f_{1}–f_{1} 23, e_{1}–f_{1} 37, f_{1}–h_{1} 34, f_{1}–h_{1} 29, h_{1}–h_{1} 19, h_{1}–h_{1} 41, h_{1}–h_{1} 11.

**Venter** (Fig. 4B). Ventral view similar to that of female but genital shield and its setae absent, aggenital shields bearing three pairs of aggenital setae (ag_{1,2}). Lengths of ventral setae as follows: 1a 10, 3a 14, 4a 10, 1a–1a 20, 3a–3a 33, 4a–4a 33, ag, 7, ag, 7, ag, 7, ps, 18, ps, 16, ps, 12.

**Legs** (Figs 4C–F). Lengths: leg I 122, leg II 94, leg III 105, leg IV 115. Counts of setae on legs I–IV: coxae 2-2-2-2, trochanters 0-1-2-0, femora 4-4-3-2, genua 5(+1κ)-2-0-0, tibiae 5(+1φ+1φρ)-5(+1φρ)-5(+1φρ)-5(+1φρ), tarsi 13(+1ω)-8(+1ω)-7(+1ω)-7(+1ω). Lengths of solenidia: Iω 12, IIω 7, IIIω 4, IVω 3.

**Male and immature stages**

Unknown.

**Distribution**

Iran (Bagheri & Zarei 2012; Hajizadeh et al. 2013; Beyzavi et al. 2013; Navaei-Bonab et al. 2015; Rahmati et al. 2015).

**Remarks**

*Stigmaeus miandoabiensis* was described from Iran by Bagheri & Zarei (2012). Hajizadeh et al. (2013) and Beyzavi et al. (2013) compiled checklists of Iranian prostigmatic mites, which equally included *S. miandoabiensis*. Later, Navaei-Bonab et al. (2015) and Rahmati et al. (2015) also mentioned this species briefly.

*Stigmaeus miandoabiensis* is very close to *S. planus* Kuznetzov, 1978, but it can be distinguished from the latter by *e*, situated on minute platelets (on striate integument in *S. planus*), ag_{1,2}–ag_{1,2} on the same shield (ag_{1,2}–ag_{1,2} on another shield in *S. planus*), and longer ve.
This species is a new record for Turkish fauna, and its deutonymph was identified for the first time in this study. Generally, the Turkish specimens are similar to the type specimens except for the fact that the anterior and posterior regions of the propodosomal shield are covered with tubercles.

**Discussion**

The superfamily Raphignathoidea belongs to the suborder Prostigmata. They are worldwide in distribution, abundant in most geographical regions, and are even found in the Antarctic region (Fan & Zhang 2005). Most raphignathoid mites are known from the drier edaphic microhabitats such as litter, soil, bark and moss (Doğan et al. 2014). Raphignathoidea comprises 11 families, eight of which have been recorded from Turkey: Barbutiidae, Caligonellidae, Camerobiidae, Cryptognathidae, Eupalopsellidae, Homocaligidae, Raphignathidae and Stigmaeidae (Doğan 2007; Erman et al. 2007; Doğan et al. 2014). Until now, 192 raphignathoid mite species (including the two species in this paper) in 25 genera have been found in Turkey (Table 2).
Stigmaeidae, a family within the superfamily Raphignathoidea, is a large cosmopolitan group of genera distinguished by the position of the dorsal shields, number of subcapitular setae, size of the palptibial claw, shape of the terminal eupathidia on the palptarsus, cheliceral base fused or free, and presence of coxisternal shields (Dönel & Doğan 2011). Currently, it consists of 33 genera (excluding Erynglpusopsis Tseng, 1982 accepted as synonym of Eryngiopus Summers, 1964 by Doğan et al. [2015b]) and more than 575 species (Fan 2005; Dönel & Doğan 2011; Zhang et al. 2011; Fan & Flechtmann 2015; Doğan et al. 2015a, 2015c; Fan & Ueckermann 2016; Fan et al. 2016). The genus Stigmaeus is one of the oldest and most diverse genera in the Stigmaeidae (Fan & Zhang 2005) with 133 valid species (Fan & Zhang 2005; Doğan et al. 2015a, 2016; Dilkaraoğlu et al. 2016a, 2016b, Fan et al. 2016). To date, 36 species of the genus Stigmaeus have been reported from Turkey (Özkan et al. 1988, 1994; Erman et al. 2007; Doğan 2007; Doğan et al. 2015a, 2016; Dilkaraoğlu et al. 2016a, 2016b). In this paper, we described one new species and reported a new record of Stigmaeus from Turkey. This raises the total number of Stigmaeus species for Turkey to 38.

Some variations and asymmetric morphological abnormalities in the species are noted. In both Stigmaeus species, the shape of some dorsal body setae vary. Some setae are slightly serrated, whereas others are smooth (Figs 2A, 5A). Among the paratypes of Stigmaeus bifurcus sp. nov., in one specimen the left seta c1 is about two times as long as the right (Fig. 1C). Seta h3 is absent on right suranal shield in another paratype of the new species (Fig. 1D).

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