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Article

Eriophyoid (Trombidiformes: Eriophyoidea) mite species associated with boxes worldwide with a new record of *Eriophyes canestrinii* (Nalepa, 1890) from Iran

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ABSTRACT

During survey for the pests of *Buxus* plants in Bandar Gaz, Golestan province, Iran, *Eriophyes canestrinii* (Nalepa, 1890) was collected on *Buxus sempervirens hyrcana* (Pojarkova) Tachtadzjan (Buxaceae) and recorded for the first time in Iran. High population of this mite species made damage on the host plant as buds and leaves deformation. Herein Iranian specimens of this mite species was presented and a key to the eriophyoid mite species collected on boxes worldwide and the information about their morphology, type host, type locality and habitus are provided.

KEY WORDS: Bud gall; *Buxus*; Damages; Eriophyidae; Pest.

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INTRODUCTION

The species of *Buxus* are monoic, evergreen shrubs or small trees. The *Buxus* species occupy a wide diversity of habitats worldwide. Most species inhabit tropical areas of America, Africa and Asia, and a few grow in extratropical regions of Europe and Asia. Its type species, the common box, *B. sempervirens* L., is widely present throughout southern and western and central Europe, North Africa and western Asia including Iran (Roselló *et al.* 2007).

With onset and expansion dieback disease on boxes, *B. sempervirens hyrcana* (Pojarkova) Tachtadzjan (Buxaceae) in Caspian coastal region (Iran), an investigation was carried out about range of disease incidence and the possible vectors of the related agents. During this survey one eriophyid species has been found in very high population (Fig. 2) as an important pest inhabiting boxes deformed buds and leaves (Figs. 2, 3). The aim of the current paper was to present Iranian specimens of *Eriophyes canestrinii* (Nalepa, 1890) and summarizing information about boxes associated eriophyoid mite species.

MATERIAL AND METHODS

During the investigation on damaged box plant samples collected from Cheshmeh Bolbol, Bander Gaz in Golestan province of Iran on March and July 2012, an eriophyid mite species was found. Mite specimens were separated from infested plants by direct examination, slide mounted using Hoyer's medium (Krantz and Walter 2009) and studied by means of a phase contrast microscope Olympus BX53. The terminology and the setal notation in the morphological description of the mite follow mainly Lindquist (1996). All morphological measurements were taken according to Amrine and Manson (1996) as modified by de Lillo *et al.* (2010), and are given in micrometers. Slight clarifications should be added as follows: ventral semiannuli were counted from the first entire annulus behind the prodorsal shield; coxigenital semiannuli were counted medially from the coxal region to the anterior margin of the external genitalia and were not included in the ventral semiannuli count. Measurements and means are rounded off to the nearest integer when required. Measurements refer to the length of the morphological trait unless otherwise specified. The measurements are range values (min.–max.) of the studied specimens. The mean values of all specimens are reported in the few cases in which the measurements of the studied species could not be taken, due to the slide mounting position of some specimens. Line drawings were hand-drawn through a *camera lucida* according to de Lillo *et al.* (2010) and the abbreviations labeling schematic drawings in Fig. 1 follow mainly Amrine *et al.* (2003). Host plant names and their synonymies are in accordance with "The Plant List on-line database" (2013).

Materials are deposited at the Acarology Laboratory, Department of Plant Protection, Faculty of Agriculture, Azarbaijan Shahid Madani University, Tabriz and at the Agricultural Research Zoology Department, Iranian Research Institute of Plant Protection, Tehran, Iran.

RESULTS

Eriophyoid mite species associated with boxes worldwide

Until now 10 eriophyoid species described from boxes, *Buxus* spp. (Buxaceae), worldwide including one *Aceria*, six *Eriophyes*, one *Calepitrimerus*, one *Epitrimerus* and one *Diptilomiopus* species (Canestrini 1892; Nalepa 1930; Keifer 1964; Petanović 2001; Song *et al.* 2008a, b). The information about their type host, type locality and habitus are provided in Table 1.

Table 1. Eriophyoid species collected on boxes (*Buxus* spp.) worldwide and their type host, type locality and habitus (according to Amrine and Stasny 1994 and further update literature). The list is sorted according to the key sequence.

Species	Type host	Type locality	Habitus
<i>Diptilomiopus buxusis</i> Song, Xue & Hong, 2008	<i>Buxus</i> sp.	Danchang County, Gansu, China	Vagrant on lower leaf surface
<i>Aceria unguiculata</i> (Canestrini, 1891)	<i>B. sempervirens</i> L.	Veneto, Italy	Erineum galls on buds
<i>Eriophyes buxi</i> (Canestrini, 1891)	<i>B. sempervirens</i> L.	Ferrara, Emilia Romagna, Italy	Glabrous bud galls
<i>Eriophyes parabuxi</i> Keifer, 1964	<i>Buxus</i> sp.	Air Intercept, Seattle, Washington, USA, from England, Great Britain	Vagrant
<i>Eriophyes canestrinii</i> (Nalepa, 1890)	<i>B. sempervirens</i> L.	Halle am Saale, Sachsen, Germany	Gray hairy bud gall-making; leaf deformation and flower blasting; shortening of internodes
<i>Eriophyes crinites</i> Nalepa, 1930.	<i>B. sempervirens</i> L.	Avellino, Campania, Italy	Bud deformation
<i>Eriophyes hypophyllus</i> Nalepa, 1929.	<i>B. sempervirens</i> L.	Eisgrub (= Lendice), (Südmähren), Czech Republic	Leaf deformation
<i>Eriophyes tricheutes</i> Nalepa, 1930.	<i>B. sempervirens</i> L.	Not stated by the author; Austria is presumed	Small deformed buds
<i>Calepitrimerus buxi</i> Petanović, 2001	<i>B. sempervirens</i> L.	Radenkovic, North-Western Serbia, Yugoslavia	Vagrant on leaves and shoots
<i>Epitrimerus buxsinica</i> Song, Xue & Hong, 2008	<i>B. sinica</i> (Rehd. et Wils.) Cheng	Fuzhou City, Fujian Province, China	Vagrant on the undersurface of leaves, causing no apparent damage to the host plant

All species were well described except the *Eriophyes* ones reported by Nalepa (1929, 1930) and Canestrini (1892). It should be noted that Canestrini gave a quite good description based on the standard of that time.

Key to the eriophyoid mite species collected on boxes worldwide, proposed on the base of the most detailed published descriptions

1. Gnathosoma large in comparison to the body; chelicerae abruptly curved and bent down near their base; empodium divided; prodorsal shield reticulated composed of incomplete median and submedian lines, complete admedian lines; median, admedian and submedian lines connected; scapular setae and tubercles absent; empodium divided, each 8-rayed; female genitalia coverflap with granules Diptilomiopidae Keifer, 1944 *Diptilomiopus buxusis* Song *et al.*, 2008
- Gnathosoma small in comparison to the body; chelicerae straight or slightly curved down Eriophyidae Nalepa 1898 2
2. Body vermiform, opisthosoma with annuli subequal dorsoventrally, at least on anterior $\frac{1}{2}$ to $\frac{2}{3}$; prodorsal shield lacking a frontal lobe or if frontal lobe present, it is narrow, basally flexible, and combined with narrow annuli Eriophyinae Nalepa, 1898 3
- Body usually fusiform; prodorsal shield with a broad-based and rigid frontal lobe; opisthosoma typically with broad dorsal semiannuli and narrow microtuberculate ventral ones; tubercles *sc* usually well formed, often plicate and placed ahead of the rear margin of the prodorsal shield, directing setae *sc* forward, centrad..... Phyllocoptinae Nalepa, 1892 9
- Phyllocoptini Nalepa, 1892 9
3. Setae *sc* directed posteriorly; prodorsal shield smooth *Aceria unguiculata* (Canestrini, 1891)
- Setae *sc* directed upwards and centrad; frontal lobe absent or very short *Eriophyes* 4
4. Prodorsal shield design composed of continuous lines with short median line on anterior half and complete admedian and first submedian lines; opisthosoma with 70 annuli; empodium 4-rayed *Eriophyes buxi* (Canestrini, 1891)*
- Prodorsal shield mainly smooth with short admedian lines or with a pair of faint depression in rear part 5
5. Prodorsal shield design absent except for a pair of sinuate admedian lines on rear $\frac{1}{3}$ just inside the tubercles of setae *sc*..... *Eriophyes parabuxi* Keifer, 1964
- Prodorsal shield design faint without distinct lines 6
6. Prodorsal shield design with fine lines; setae *sc* 28; empodium 5-rayed; opisthosoma with 76 annuli; setae *d* about 56 long *Eriophyes hypophyllus* Nalepa, 1929**
- Prodorsal shield design unclear; empodium 6-rayed 7
7. Making bud galls with fleshy thickened internal parts, and with dry external parts without abnormal hairs; the thorns of the female buds thickened, with their upper ends inclined from each other, and enclosing a hollow space, which contains adult mites *Eriophyes canestrinii* (Nalepa, 1890)***
- Making bud galls with hairy surface 8
8. Body stretched, almost worm-shaped, 200 long and 37 wide; chelicerae 20 long; prodorsal shield 28 long, triangular, the median part bounded by slow lines that terminate over the *sc* tubercles, and traversed by five distinctly prominent, multiply broken lines, lateral part with shorter lines, partially parallel with the shield margin; dorsal semiannuli with coarse microtubercles; ventral setae strong; seta *d* 56 long; female genitalia 21 wide, coverflap ornamented with strong longitudinal striae; making almost spherical buds of 2–4 mm in diameter, covered with gray hairs, consisting of broadened, braked bracts; the mites live between the hairs on the inside of the bracts and in the central cavity enclosed by them *Eriophyes tricheutes* Nalepa, 1930**
- Body squat, roll-shaped, 200 long and 48 wide; chelicerae 18 long; prodorsal shield length similar to *E. tricheutes*, triangular, pattern unclear; dorsal semiannuli with coarser microtubercles

- than *E. tricheutes*; ventral setae very fine; Seta *d* 48 long; female genitalia a little wider than *E. tricheutes*; genitalia coverflap ornamentation similar to *E. Tricheutes*; making closed, large, stout, rarely rounded bud galls of 3–12 mm in diameter, green, spatter greenish yellow to reddish; the surface with short hairs, with numerous irregular internal hollow, whose inner wall is filled with bumps, between which mites live in large numbers *E. crinites* Nalepa, 1930**
9. Central ridge ending in a broad furrow before termination of lateral ridges; prodorsal shield design without median line and with short admedian lines connected to the middle of complete first submedian lines; empodium 6-rayed; coxae without ornamentation; opisthosoma with 44 dorsal semiannuli; female genitalia coverflap with 13 striae *Calepitrimerus buxi* Petanović, 2001
- Central ridge fading simultaneously with lateral ridges, the shallow subdorsal furrows often causing ridges to be weak; prodorsal shield design with incomplete median, admedian and submedian lines, median line only occupies posterior $\frac{1}{3}$; empodium 5-rayed; coxae ornamented with short lines; opisthosoma with 34 (34–36) dorsal semiannuli; female genitalia coverflap with 10 striae *Epitrimerus buxsinica* Song et al., 2008

Canestrini (1891) described *Eriophyes buxi* (*) with prodorsal shield design composed of continuous lines of short median and complete admedian, first submedian and lateral lines, while Farkas (1965) have drawn its prodorsal shield smooth. Also, in the description published by Cho and Lee (2013), *E. buxi* (*) prodorsal shield described smooth or with obscure longitudinal lines. It seems that they confused the species and their specimens belong to *E. canestrinii*. Canestrini (1892) described both *Eriophyes* species, *E. canestrinii* and *E. buxi* at the end of 19th century and they were distinct species for him. So *E. buxi* is valid and should be found and redescribed.

Distinguishing between *E. canestrinii*, *E. crinites*, *E. hypophyllus* and *E. tricheutes* is not easy. Nalepa (1891) and Canestrini (1892) described and have drawn *E. canestrinii* (***) with smooth prodorsal shield. While Nalepa described that as *E. canestrinii* (typicus) (Nalepa) with prodorsal shield pattern of faint lines (Nalepa 1930). The most complete description about this species was made by Keifer (Baker et al. 1996). According to his summarized drawings, *E. canestrinii* has smooth prodorsal shield. In the current study the Iranian specimens of *E. canestrinii* has smooth prodorsal shield with a pair of faint depression on its rear part (Fig. 1). Nalepa (1929, 1930) described *E. crinites*, *E. hypophyllus* and *E. tricheutes* (**) as three subspecies of *E. canestrinii*. He provided very short description for them with no figures. In Table 2, the summarized information about them based on Nalepa (1930) is provided. According to Nalepa description *E. hypophyllus* can be distinguished easily with its 5-rayed empodium and its prodorsal shield pattern. This species has special symptom on the host plant. The epidermis of the underside of the leaf more or less detached and stretched over a cavity inhabited by a great number of mites. The remaining three *Eriophyes* species have no certain character for distinguishing. The more certain is about their habitus on boxes that indicated in the key. They need redescription. Here we give data on Iranian specimens of *E. canestrinii*.

Eriophyes canestrinii (Nalepa, 1890) (Fig. 1)

Description

Female (n = 10) – **Body** wormlike, 182–205 (excluding gnathosoma), 36–39 thick, 34–38 wide. **Gnathosoma** 20–25 projecting obliquely downwards, chelicerae 19–23, palp coxal setae *ep* 3 (no variation), palp genual setae *d* 4–5, unbranched. **Prodorsal shield** smooth with a pair of faint depression in rear part, 25–28, 27–32 wide, sub-circular, with lateral ocellar-like structures 7 diameter; without a frontal lobe. Tubercles of *sc* setae 5–7 ahead of rear shield margin, 15–16 apart, setae *sc* 10–15, directed divergently anterior. **Leg I** 20–26, femur 7–9, genu 4–5, tibia 4–5, tarsus 5–7, ω 4–5 distally rounded, empodium simple, 6–7, 6-rayed; femoral setae *bv* 7–9, genual setae *l*"

15–21, tibial setae *l'* 6–9, tarsal setae *ft'* 11–14, *ft''* 14–18, *u'* 3–4. **Leg II** 20–26, femur 8–9, genu 4–5, tibia 4–5, tarsus 5–7, *ω* 5–6 distally rounded, empodium simple, 5–7, 6-rayed; femoral setae *bv* 7–8, genual setae *l''* 9–13, tarsal setae *ft'* 6–9, *ft''* 15–20, *u'* 3–3.5. **Coxae** mainly smooth with few dashes on coxae I; setae *1b* 7–9, tubercles *1b* 9–10 apart, setae *1a* 15–21, tubercles *1a* 6–8 apart, setae *2a* 24–29, tubercles *2a* 20–21 apart. Prosternal apodeme 7–8. **Opisthosoma** with 65–71 dorsal semiannuli, 60–63 ventral semiannuli (counted from first complete annulus after coxae II); 3–5 semiannuli between coxae and genital coverflap plus 2–3 transversal rows of lined granules at the base of the coverflap. **Microtubercles:** circular on posterior part of dorsal and ventral semiannuli; spiny on the rear margin of the last 3 dorsal semiannuli and elongated and linear on last 5 ventral semiannuli. Setae *c2* 26–28 on ventral semiannulus 7–9, setae *d* 30–40 on ventral semiannulus 17–21; setae *e* 10–18 on ventral semiannulus 30–36; setae *f* 13–17 on ventral semiannulus 55–58; 5 annuli posterior to setae *f*. Setae *h2* 36–44 apically very fine, *h1* absent. Genital coverflap 10–13, 18–20 wide, ornamented with 11–12 striae; setae *3a* 11–14, 13–14 apart.

Male (n = 3) – Similar in shape and prodorsal shield arrangement to female. Body 168–190, 50–52 wide, 49 thick; palp genual setae *d* 3–4; prodorsal shield 27, 36–37 wide, lateral ocellar-like structures 6 diameter; setae *sc* 7–10, 19–20 apart. Opisthosoma with 64–69 dorsal semiannuli and 57–60 ventral semiannuli (counted from first complete annulus after coxae II); 4 semiannuli between coxae and genitalia. Setae: *1b* 6–7, *1a* 16–21, *2a* 24–30, *c2* 19–20, *d* 31–33, *e* 10–11, *f* 14–16, *h2* 35–48). Male genitalia 17–21 wide, setae *3a* 8–12, 17 apart.

Nymph (n = 3) – Body wormlike, 149–154 (excluding gnathosoma), 36–37 wide, 43 thick; palp genual setae *d* 2; prodorsal shield 23–28, 30 wide; setae *sc* 6–7, 17 apart. Opisthosoma with 51–59 dorsal semiannuli, 48–51 ventral semiannuli (counted from first complete annulus after coxae II). Setae: *1b* 4–7, *1a* 13–15, *2a* 17–20, *c2* 10–15, *d* 19–24, *e* 6–8, *f* 9–12, *h2* 22–25). Setae *3a* 3.5–7, 7 apart on semiannulus 10 after coxae.

Type data

Buxus sempervirens L. (Buxaceae); Halle am Saale, Sachsen, Germany.

Relation to the host plant

Leaf deformation, flower blasting; hairy bud gall-making (2–4 mm diameter); shortening of internodes (Nalepa 1930; Baker *et al.* 1996; Soika and Labanowski 1999).

Localities and host plant

30 females, 5 males and 7 nymphs collected during March and July from *Buxus sempervirens hyrcana* (Pojarck.) Takht. (Buxaceae) in Cheshmeh Bolbol, Bander Gaz, Golestan province, Iran.

Previous provincial records for Iran

This is the first report of this mite from Iran.

Remarks

Iranian female characters largely matches the short original description and summarized drawings made by Keifer (Baker *et al.* 1996). However, the Iranian specimens are longer [182–205 versus 170 in Baker *et al.* (1996)] and their coxae are mainly smooth with few dashes on coxae I, while according to Baker *et al.* (1996) coxae ornamented with few curved lines, lines, dashes and lines of granules. In addition the Iranian specimens have shorter seta *d* (30–40) than Nalepa described specimens with 56 long setae *d*.

Table 2. Comparison between the more closed *Eriophyes* species described on *Buxus* plants, based on Nalepa descriptions (Nalepa 1930).

Characters	<i>E. canestrinii</i> (Nalepa, 1890)	<i>E. tricheutes</i> Nalepa, 1930	<i>E. crinites</i> Nalepa, 1930	<i>E. hypophyllus</i> Nalepa, 1929
In Nalepa (1930)	<i>E. canestrinii</i> (typicus) (Nal.)	<i>E. canestrinii tricheutes</i> Nal.	<i>E. canestrinii crinites</i> Nal.	<i>E. canestrinii hypophyllus</i> Nal.
Body shape	Stretched, almost worm-shaped	Similar to <i>typicus</i>	Squat, roll-shaped	Elongated, cylindrical
Body length × width	200 × 37	Similar to <i>typicus</i>	200 × 48	190 × 30
Chelicerae length	20	Similar to <i>typicus</i>	18	Similar to <i>typicus</i>
Prodorsal shield length	28	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	32
Prodorsal shield shape and pattern	Triangular; The median part bounded by slow lines that terminate over the <i>sc</i> tubercles, and traversed by five distinctly prominent, multiply broken lines, lateral part with shorter lines, partially parallel with the shield margin	Similar to <i>typicus</i>	Triangular, pattern unclear	Triangular, with fine lines
Seta <i>sc</i> length	23	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	28
Leg I length	24	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	Similar to <i>typicus</i>
Leg II length	21	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	Similar to <i>typicus</i>
Empodium rays number	6	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	5
Rings number	72	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	76
Dorsal microtubercles	Strong and tight	Coarser than <i>typicus</i>	Coarser than <i>tricheutes</i>	Very coarse
Ventral setae thickness	Fine	Stronger than <i>typicus</i>	Very fine	Very fine
Seta <i>c2</i> length	23	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	28
Seta <i>d</i> length	56	Similar to <i>typicus</i>	48	56
Seta <i>e</i> length	22	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	23
Seta <i>f</i> length	26	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	26
Seta <i>h1</i>	Very short, usually seeable	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	Similar to <i>typicus</i>
Genitalia width	21	Similar to <i>typicus</i>	A little wider than <i>tricheutes</i>	21
Genitalia coverflap ornamentation	With strong longitudinal striae	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	Similar to <i>typicus</i>
Seta <i>3a</i> length	19	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	Similar to <i>typicus</i>
Setae <i>3a</i> distance	17	Similar to <i>typicus</i>	Similar to <i>tricheutes</i>	Similar to <i>typicus</i>

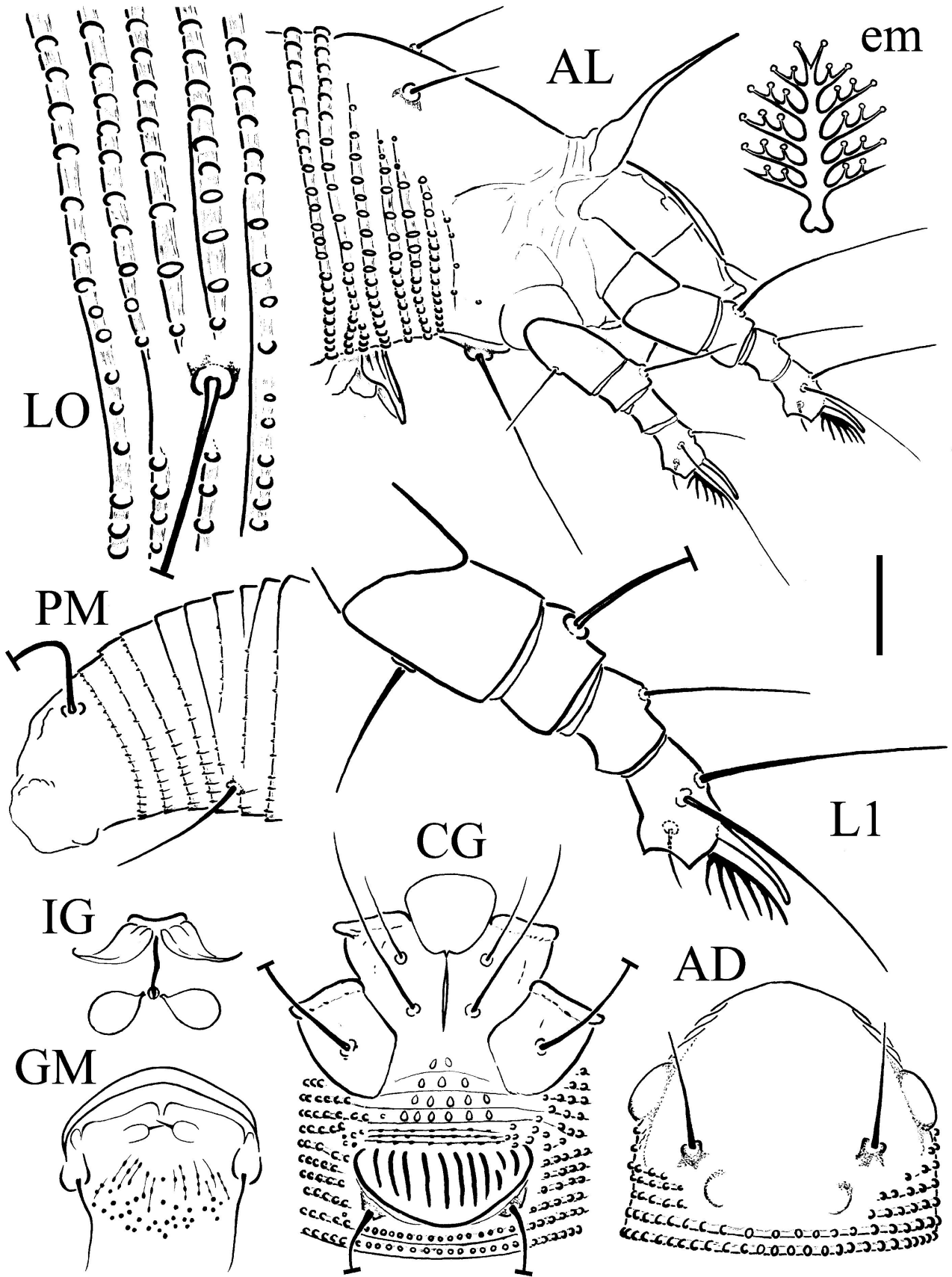


Figure 1. Schematic drawings of *Eriophyes canestrinii* (Nalepa, 1890) – AD. Prodorsal shield; AL. Lateral view of anterior body region; CG. Female coxigenital region; em. Empodium; GM. Genital region, Male; IG. Internal female genitalia; LO. Lateral view of annuli; L1. Leg I; PM. Lateral view of posterior opisthosoma. Scale bar: 10 μ m for AD, AL, CG, GM, IG, PM; 5 μ m for LO, L1; 2.5 μ m for em.

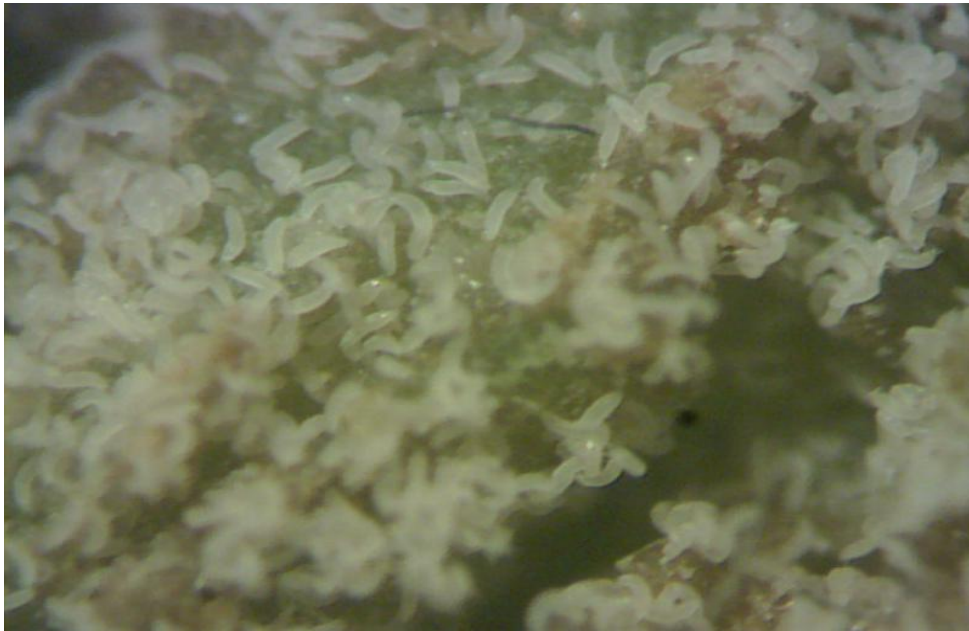


Figure 2. High population of *Eriophyes canestrinii* collected on *Buxus sempervirens hyrcana* ($\times 100$).




Figure 3. Deformation on *Buxus sempervirens hyrcana* bud caused by *Eriophyes canestrinii*.

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گونه‌های اریوفیوئید (Trombidiformes: Eriophyoidea) مرتبط با شمشادها در جهان همراه با گزارش *Eriophyes canestrinii* (Nalepa, 1890) برای نخستین بار از ایران

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چکیده

طی مطالعه آفات گیاهان شمشاد در بندر گز استان گلستان، گونه *Eriophyes canestrinii* (Nalepa, 1890) از روی *Buxus sempervirens* *hyrcana* (Pojarkova) Tachtadzjan (Buxaceae) جمع‌آوری و برای نخستین بار در ایران گزارش شد. جمعیت زیاد این گونه کنه خسارتی را به صورت بدشکلی‌هایی در برگ‌ها و جوانه‌ها وارد کرده بود. در اینجا نمونه‌های ایرانی این گونه کنه معرفی و کلیدی برای گونه های اریوفیوئید جمع‌آوری شده از روی شمشادها در جهان همراه با اطلاعاتی در مورد ریخت‌شناسی، گیاه میزبان و محل جمع‌آوری هولوتیپ گونه و ارتباط آن‌ها با گیاهان میزبان آورده شده است.

واژگان کلیدی: گال جوانه؛ *Buxus*؛ خسارت؛ Eriophyidae؛ آفت.

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