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# A new species of *Augeriflechtmannia* (Prostigmata: Tetranychidae) from *Haloxylon ammodendron* (Amaranthaceae) in Iran and a key to the world species

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**Original research**

**ABSTRACT**

A new species of the genus *Augeriflechtmannia* Koçak & Kemal, 2008 – formerly *Diplonychus* Auger & Flechtmann, 2003, namely *Augeriflechtmannia haloxyloni* **sp. nov.** is described and illustrated based on females and males collected from *Haloxylon ammodendron* (Amaranthaceae) in Iran. A key to the known species of the world is also provided.

**Keywords** spider mite; Tetranychoidea; Trombidiformes; Kerman
**Zoobank** http://zoobank.org/62B46D0D-4836-44A6-8C4C-4B2D58B8FDC5

## Introduction

*Augeriflechtmannia* was first described as *Diplonychus* Auger & Flechtmann in 2003. After that, Mahdavi *et al.* (2021) refined the genus diagnosis. It is a quite small genus of the tribe Tetranychini Reck, 1950 with only five species: *A. armeniaca* (Bagdasarian, 1951) collected from *Amaranthus hybridus* and *Salsola dendroides* (Amaranthaceae) in Armenia, *A. astragalus* Mahdavi, Asadi, Latifi & Seeman, 2021 collected from *Astragalus* sp. (Fabaceae) and *A. iraniensis* (Mahdavi & Ueckermann, 2013) collected from *Salsola* sp. (Amaranthaceae) (Mahdavi *et al*, 2013) both in Iran, *A. jeridi* (Auger & Flechtmann, 2003) collected from *Arthrophytum schmittianum* (Amaranthaceae) and *A. penisinuosus* (Auger & Flechtmann, 2003) collected from *Cornulaca monacantha* and *Salsola* sp. (Amaranthaceae) both in Tunisia.

In this paper, one more species of this genus, *Augeriflechtmannia haloxyloni* **sp. nov.** is described and illustrated based on females and males collected from *Haloxylon ammodendron* (Amaranthaceae) in Kerman Province, Iran. A key to the world species of *Augeriflechtmannia* is also provided.

## Material and methods

Leaves and twigs of *H. ammodendron* (Fig. 1) were collected in bags and brought to the laboratory. The twigs were cut layer by layer and washed in a solution of water and commercial detergent. The dipping-washing-filtering method (Boller 1984) was used to remove the mites

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**Figure 1** Photograph of Kerman sampling site of *Augeriflechtmannia haloxyloni* **sp. nov.** showing several *Haloxylon ammodendron.*

from plant material. The resulting solution was filtered through a sieve (400 Mesh), and the mites retained on the sieve were washed with 70% ethanol into a Petri dish, then collected individually under a stereomicroscope and mounted in Hoyer's medium. Mites were described with an Olympus® BX51 phase-contrast compound microscope. Measurements were done using an imaging system including DinoCapture® 2.0 software are given in micrometers (µm). The measurements of the holotype are given in parentheses after the range of measurements for the paratypes. The drawings were made using a drawing tube attached to a microscope with 1000x and 1600x magnifications. Final illustrations were drawn with Corel® draw x8 2016 and edited using Photoshop® CC 2017. The terminology and setal notations used for the description follow that of Lindquist (1985). Depositories are cited using the following abbreviations:

- **SBUK** —Collection of the Acarology Laboratory, Shahid Bahonar University of Kerman, Kerman, Iran.
- **CBGP** — Centre de Biologie pour la Gestion des Populations - Continental Arthropod Collection. https://doi.org/10.15454/D6XAKL.
- **QM** —Queensland Museum, South Brisbane, Australia.

## Family Tetranychidae Donnadieu, 1875

### Subfamily Tetranychinae Berlese, 1913

### Tribe Tetranychini Reck, 1950

### Genus *Augeriflechtmannia* Koçak & Kemal, 2008

*Diplonychus* Auger & Flechtmann, 2003: 75. (Preoccupied)

*Augeriflechtmannia* Koçak & Kemal, 2008: 4
*Augeriflechtmannia,* Mahdavi *et al.*, 2021: 703

Type-species: *Augeriflechtmannia jeridi* (Auger & Flechtmann, 2003).

## *Augeriflechtmannia haloxyloni* sp. nov.

Zoobank: DF1218EE-9273-42AA-AE46-56AFB8A6C01F

(Figs. 2–8)

### Type material

Male (holotype), 9 males, 11 females, two deutonymphs and two protonymphs paratypes ex. *Haloxylon ammodendron* (Amaranthaceae), Kerman-Kerman Province, Iran, 30°14′N 57°13′E, altitude 1835m a.s.l. and Rafsanjan-Kerman Province, Iran, 30°20′N 56°09′E, altitude 1616m a.s.l, on 15 October 2017 and 03 June 2021, respectively, coll. S. M. Mahdavi.

### Type deposition

Holotype and all paratypes at SBUK, except one female and one male paratype at CBGP and one female paratype at QM.

### Diagnosis

*Male* – Empodia I-II with two clawlike structures and a strong dorsomedian spur; empodia III-IV deeply split into two clawlike structures, each with two pairs of dorsal appendant hairs without dorsal spurs. Aedeagus turned upwards, without knob, ending in a short sigmoid distal part; axis of the proximal part of sigmoid end forming an acute to a slightly acute angle with the shaft axis. Female. Dorsal striae without lobes; setation of tibiae and tarsi I–IV tibiae 8+(1$\omega$)-7-5-5, tarsi 13+(1$\omega$)+2 dupl.-11+(1$\omega$)+1 dupl.-9+(1$\omega$)-9+(1$\omega$).

### Description

**Male (Holotype)** — (n=9; Figs. 2–4).

*Dorsum* – Color in living specimens light-yellow to orange with red eyes. Dorsal striae without lobes. Dorsal body setae slender and longer than distances between consecutive setae. Lengths of setae $v_2$ 41–55 (41), $sc_1$ 80–84 (84), $sc_2$ 46–49 (46), $c_1$ 59–68 (59), $c_2$ 64–72 (64), $c_3$ 55–64 (64), $d_1$ 62–64 (64), $d_2$ 66–68 (66), $e_1$ 60–63 (63), $e_2$ 62–65 (65), $f_1$ 53–57 (52), $f_2$ 41–44 (41), $h_2$ 23–30 (30).

*Venter* – Ventral striae without lobes. Lengths of setae: $ps_1$ 9 (9), $ps_2$ 9 (9), $g_1$ 11 (11), $g_2$ 11 (11), *ag* 20–25 (20), $h_3$ 18–20 (20).

*Gnathosoma* – Peritreme straight distally ending in a small bulb (Fig. 2e). Palp setation typical, spinneret (*su*$\zeta$) about 2.5 times as long as broad, 4 long, 1.5 wide, solenidion ($\omega$) length 4 (Fig. 2f).

*Legs* – (Fig. 2a–b). Setation of legs I–IV: coxae 2-2-1-1, trochanters 1-1-1-1, femora 10-6-4-4, genua 5-5-4-4, tibiae 8+(4$\omega$)-7-5-5, tarsi 13+(3$\omega$)+2 dupl.-11+(1$\omega$)+1 dupl.-9+(1$\omega$)-9+(1$\omega$); Empodia I–II with two clawlike structures and a strong dorsomedian spur (Fig. 2c); empodia III-IV deeply split into two clawlike structures, each with two dorsal appendant hairs without dorsal spurs (Fig. 2d). Tarsus I with four tactile setae (*l′1*, *l″1*, *v′2*, *v″1*) and two solenidia ($\omega$*′1,* $\omega$*″2*) well proximal to a proximal set of duplex setae, one solenidion ($\omega$*″1*) and one tactile seta (*v′1*) at the level of proximal duplex setae (Fig. 2a). Tarsus II with one tactile seta (*v′2*) and one solenidion ($\omega$*″1*) well proximal to duplex setae, two tactile setae (*v′1, pv″*) near to proximal duplex setae (Fig. 2b). Lengths of legs (from trochanter): I 168–170 (168), II 135–137 (135), III 137–140 (137), IV 153–160 (153).

*Aedeagus* – Holotype, (Figs. 3a–4). Aedeagus turned upwards, without knob, ending in a short sigmoid distal part, the axis of proximal part of sigmoid end forming an acute to slightly

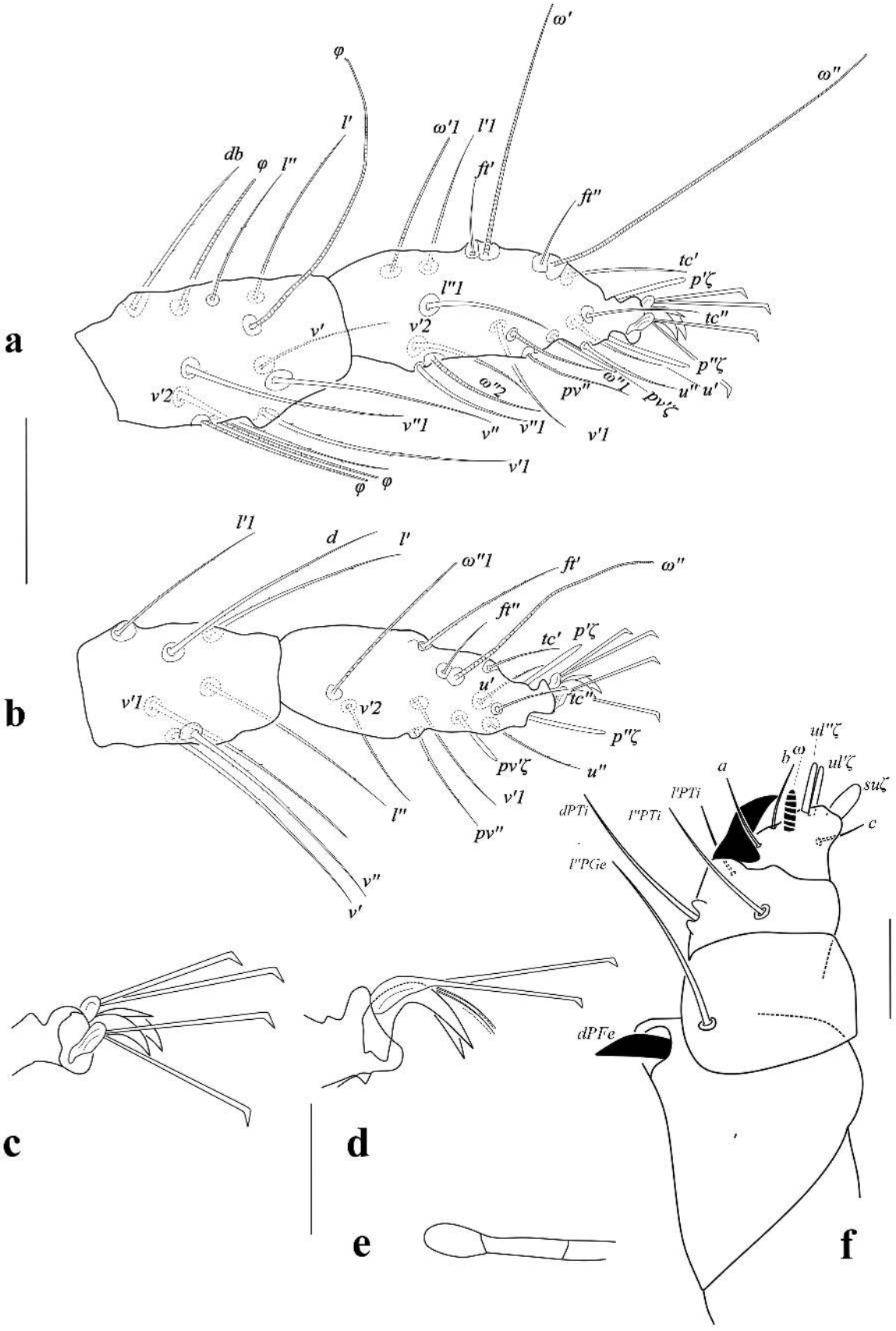



**Figure 2** *Augeriflechtmannia haloxyloni* **sp. nov.** (Male). (a) Tarsus and tibia I; (b) Tarsus and tibia II; (c) Empodia I–II; (d) Empodia III–IV; (e) End of peritreme; (f) Palp; Scale bars = 20 µm (a, b), 10 µm (c–f).

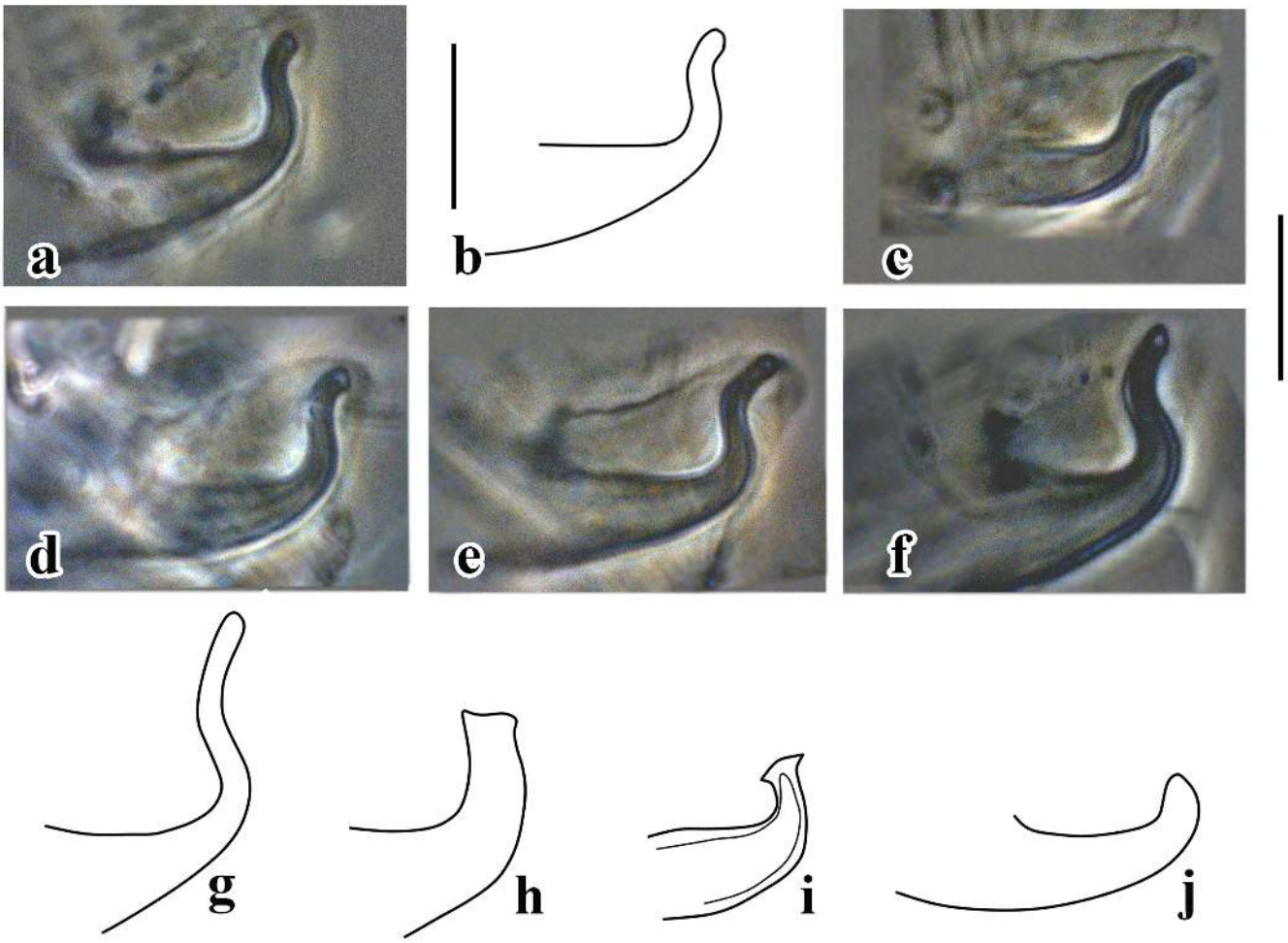



**Figure 3** Shape of aedeagus of different species of *Augeriflechtmannia*: (a–f) variations in the aedeagus of *Augeriflechtmannia haloxyloni* **sp. nov.**, (a) Holotype, (a–c) males collected in Kerman, (d–f) males collected in Rafsanjan; (g) *A. penisinuosus* (Auger & Flechtmann, 2003); (h) *A. jeridi* (reproduced from Auger & Flechtmann, 2003) (i) *A. astragalus* (reproduced from Mahdavi *et al.* 2021); (j) *A. iraniensis* (reproduced from Mahdavi *et al.* 2013). Scale bars = 10 µm (a–j).

acute angle with the shaft axis. Aedeagus with some obvious variations in the length of sigmoid distal part (Fig. 3a–f; Fig. 4 and Table 1).

**Female** — (n=11; Figs. 5–8).

**Table 1** Angle variations and length of sigmoid distal part found in the aedeagus of *Augeriflechtmannia haloxyloni* **sp. nov.** (Refer to Fig. 3a–f to see the measured aedeagi and to Fig. 4 for explanations on measurements).

| Location | Aedeagus | a (degrees) | b (degrees) | c (Length) | d (Length) |
|---|---|---|---|---|---|
| Kerman | a | 42 | 83 | 3 | 2 |
| Kerman | b | 43 | 88 | 3 | 2 |
| Kerman | c | 36 | 100 | 5 | 3 |
| Rafsanjan | d | 33 | 85 | 3 | 2 |
| Rafsanjan | e | 40 | 75 | 4 | 3 |
| Rafsanjan | f | 38 | 70 | 4 | 3 |

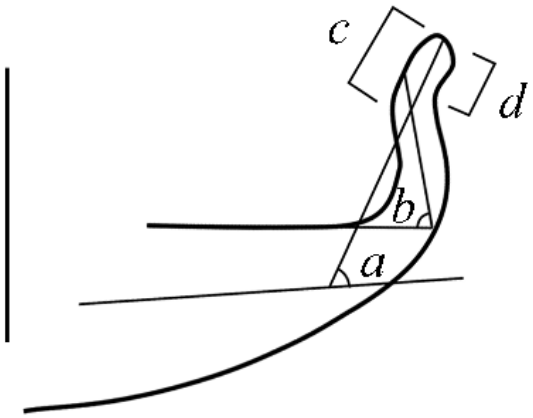



**Figure 4** *Augeriflechtmannia haloxyloni* **sp. nov.** (Male). explanations on measurements of aedeagus. The angle of the proximal upturned part of the aedeagus, "b", is measured from the shaft dorsal margin, that of the upturned distal part, "a", is measured from the shaft axis. The letter "c" represents the longest length of the distal part and "d" the shortest. Scale bars = 10 µm.

*Length* – ($v_2$–$h_2$) 270–281; width ($c_3$–$c_3$) 205–216.

*Dorsum* – Color in living specimens light-yellow to orange with red eyes. Dorsohysterosomal striae transverse between all dorsocentral setae (Fig. 5), without lobes (Fig. 6b). Dorsal body setae slender and longer than distances between consecutive setae and reach second seta behind. Lengths of setae: $v_2$ 56–60, $sc_1$ 101–117, $sc_2$ 54–74, $c_1$ 87–89, $c_2$ 87–89, $c_3$ 74–86, $d_1$ 84–89, $d_2$ 88–94, $e_1$ 81–83, $e_2$ 77–88, $f_1$ 77–82, $f_2$ 69–73, $h_2$ 33–51. Distances between dorsal setae: $v_2$–$v_2$ 53–63, $sc_1$–$sc_1$ 65–77, $sc_2$–$sc_2$ 159–170, $c_1$–$c_1$ 63–64, $c_2$–$c_2$ 125–132, $c_3$–$c_3$ 205–216, $d_1$–$d_1$ 61–63, $d_2$–$d_2$ 140–142, $e_1$–$e_1$ 42–49, $e_2$–$e_2$ 139–145, $f_1$–$f_1$ 32–33, $f_2$–$f_2$ 81, $h_2$–$h_2$ 20–22.

*Venter* – Ventral striae without lobes; pregenital striae with irregular hourglass pattern (Fig. 8). Lengths of setae: *1a* 35–40, *3a* 32–39, *4a* 38–45, *ag* 42–47, $g_1$ 26–28, $g_2$ 28–29, $ps_1$ 14–15, $ps_2$ 13–15, $h_3$ 25–30; distances between setae *1a–1a* 31–33, *3a–3a* 54–63, *4a–4a* 39–42, *ag* 64–72. Spermatheca (Fig. 7d) ending in a small bulb.

*Gnathosoma* – Peritreme straight, distally ending in the small bulb (Figs. 5a, 7c); palp setation typical, spinneret ($su\zeta$) about 2 times as long as broad, 3–4 long, 1.5–2 wide, solenidion ($\omega$) length 3 (Fig. 7f). Stylophore rounded, longer than wide.

*Legs* – (Fig. 7a, b). Setation of legs I–IV: coxae 2-2-1-1, trochanters 1-1-1-1, femora 10-6-4-4, genua 5-5-4-4, tibiae 8+(1$\omega$)-7-5-5, tarsi 13+(1$\omega$)+2 dupl.-11+(1$\omega$)+1 dupl.-9+(1$\omega$)-9+(1$\omega$); empodia I–IV deeply split into two clawlike structures each with two pairs of dorsal appendant hairs without dorsal spurs (Fig. 7e). Tarsus I with four tactile setae (*l'1*, *l''1*, *v'2*, *v''1*) well proximal to proximal set of duplex setae, and one solenidion ($\omega$*''1*) two tactile setae (*v'1, pv''*) at the level of proximal duplex setae (Fig. 7a). Tarsus II with one tactile seta (*v'2*) and one solenidion ($\omega$*''1*) well proximal to duplex setae and two tactile setae (*v'1, pv''*) at the level of proximal duplex setae (Fig. 7b). Lengths of legs: I 180–199, II 155–161, III 177–181, IV 180–185.

## Etymology

The specific epithet "*haloxyloni*" is derived from the specific name of the host plant *Haloxylon ammodendron* (Amaranthaceae).

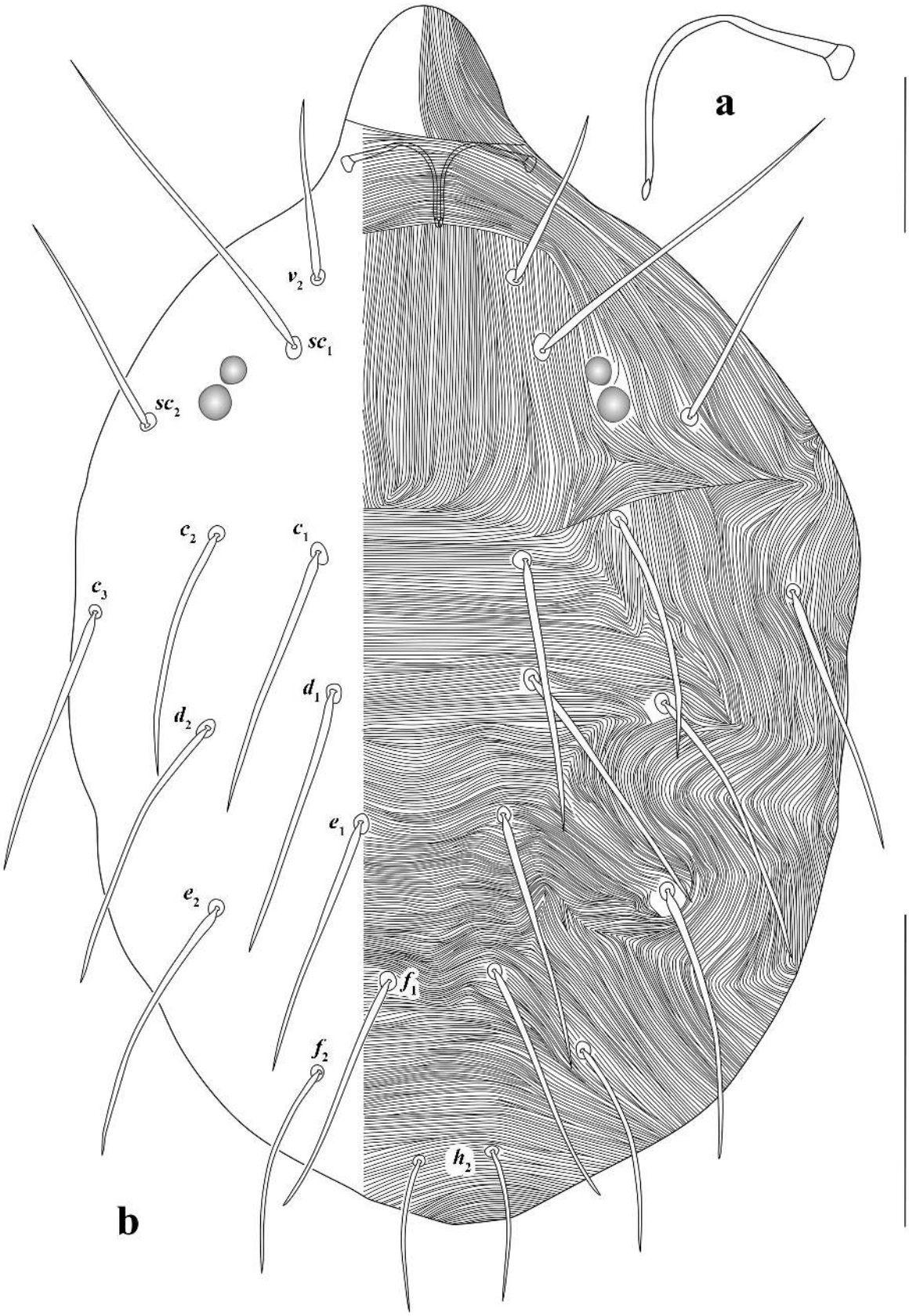



**Figure 5** *Augeriflechtmannia haloxyloni* **sp. nov.** (Female). (a) Peritreme; (b) Dorsum. Scale bars = 25 µm (a), 100 µm (b).

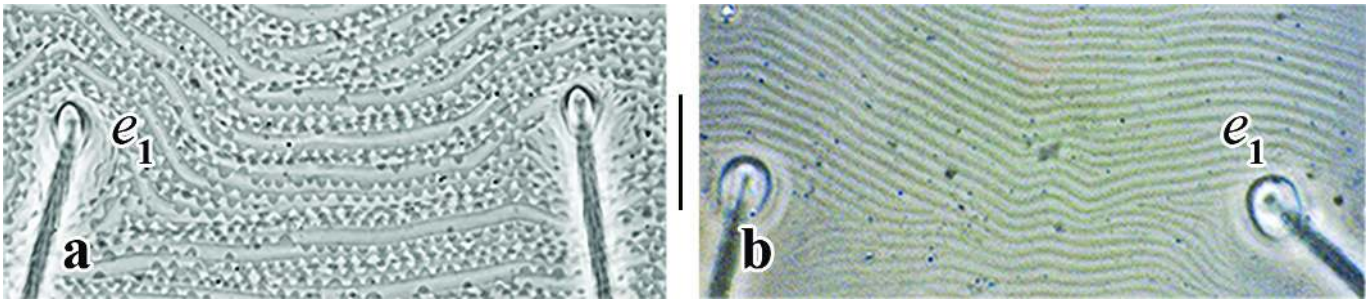



**Figure 6** Dorsal striation aspect: (a) with lobes in *A. penisinuosus* (Auger & Flechtmann, 2003); (b) without lobes in *Augeriflechtmannia haloxyloni* **sp. nov.** Scale bars = 10 µm (a–b).

### Remarks

*Augeriflechtmannia haloxyloni* **sp. nov.** is similar to *A. penisinuosus* (Auger & Flechtmann, 2003) in global shape of the aedeagus and leg chaetotaxy, but it can be distinguished from the latter by three features: In males, 1) the aedeagus bear a long sigmoid distal part in *A. penisinuosus* (Fig. 3g) *vs.* short in *A. haloxyloni* sp. nov. (Fig. 3a–f); 2) empodia I-II are different in *A. penisinuosus vs*. empodia I–II are similar among all the specimens of *A. haloxyloni* we observed. In females: 3) the dorsal striae bear lobes in *A. penisinuosus* (Fig. 6a) *vs*. dorsal striae without lobes in *A. haloxyloni*.

As we found adults and juveniles together during sampling, indicating that the mite is active as reproduction takes place, the absence of lobes on the integument of female dorsal striations is a morphological feature specific to the new species that do not result from diapause-inducing environmental conditions experienced by the specimens. Indeed, despite the mite were collected in two sampling events, in June and October, all the specimens examined are are devoid of lobes on the dorsal integument.

Despite some obvious variations in the aedeagus length, we assumed that all the specimens belong to the same species. In our opinion, there are three lines of evidence to consider these variations as intraspecific: First, similar variations are found among specimens collected in the same host in both localities: Kerman and Rafsanjan (Figs. 3a–f and Table 1). Second, there are some intermediate forms between aedeagi with a longer and aedeagi with a shorter sigmoid distal end. Third, it is not possible to link variations in the morphology of the aedeagus to variations in other morphological characters or biological characteristics.

## Key to the world species of *Augeriflechtmannia*

1. Male: tibiae I–IV with 8+(4$\omega$)-7-5-5 setae . . . . . 2
— Male: tibiae setal formula not as above . . . . . 3

2. Female: dorsal striae without lobes. Male: empodia I-II similar (Fig. 2c) . . . . . *A. haloxyloni* **sp. nov.**
— Female: dorsal striae with lobes. Male: empodia I-II not similar . . . . . *A. penisinuosus*

3. Male: tibiae I–IV with 9+(3$\omega$)-7-6-6 setae; knob of aedeagus with a slight angle to that of the shaft, the dorsal margin of knob curved, posterior projection about 1.6 times as long as anterior projection; knob twice as long as neck (Fig. 3i) . . . . . *A. astragalus*
— Male: tibiae setal formula not as above . . . . . 4

4. Male: tibiae I–IV with 10+(3$\omega$)-7-6-7 setae; end of aedeagus almost rounded without indentation, bend dorsally at an angle of 90 degrees (Fig. 3j) . . . . . *A. iraniensis*

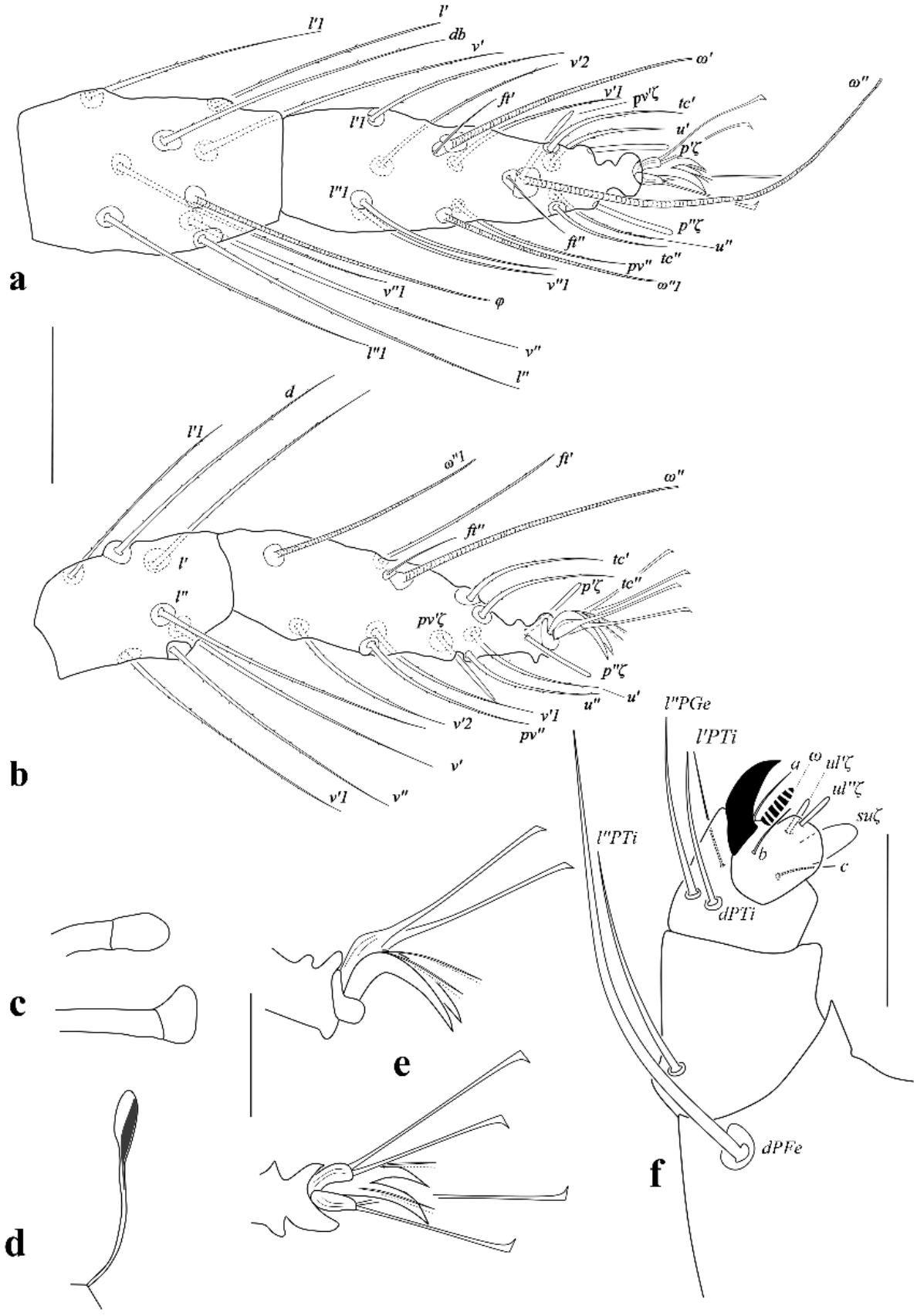



**Figure 7** *Augeriflechtmannia haloxyloni* **sp. nov.** (Female). (a) Tarsus and tibia I; (b) Tarsus and tibia II; (c) End of peritreme; (d) Spermatheca; (e) Empodia I–IV (dorsal (bottom) and lateral (top))); (f) Palp. Scale bars = 20 µm (a, b), 10 µm (c–f).

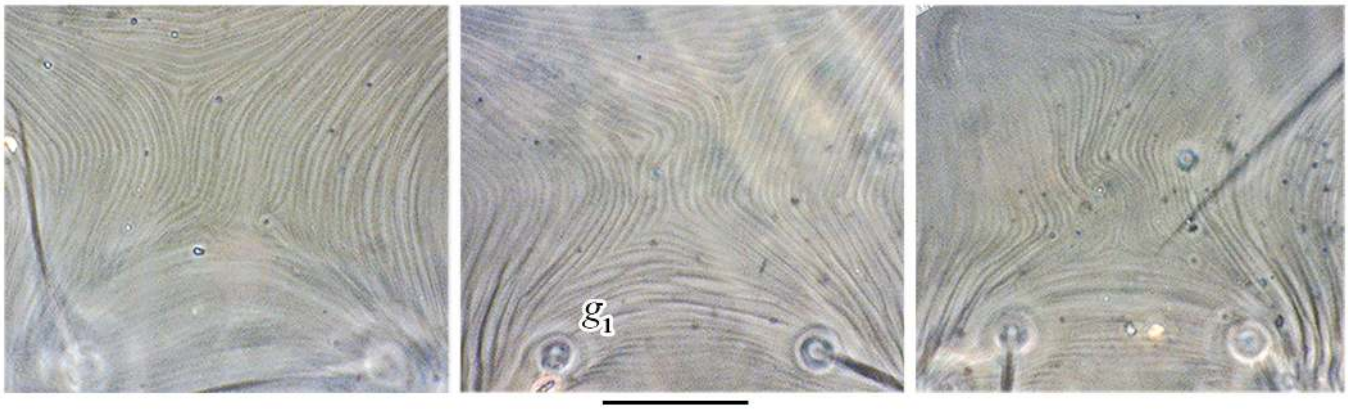



**Figure 8** *Augeriflechtmannia haloxyloni* **sp. nov**. (Female). Pregenital area (variations in hourglass striation pattern). Scale bar = 10 µm.

— Male: tibiae I–IV with 9+(5$\omega$)-7-6-7 setae; aedeagus bent dorsally at a right angle, with a small acute anterior projection pointing upwards and a small posterior angulate projection (Fig. 3h) . . . . . *A. jeridi*

### Note

As the male of *A. armeniaca* is unknown, this species is indistinguishable from other species of *Augeriflechtmannia* (Mahdavi *et al.* 2021). For this reason, it was not included in the key.

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