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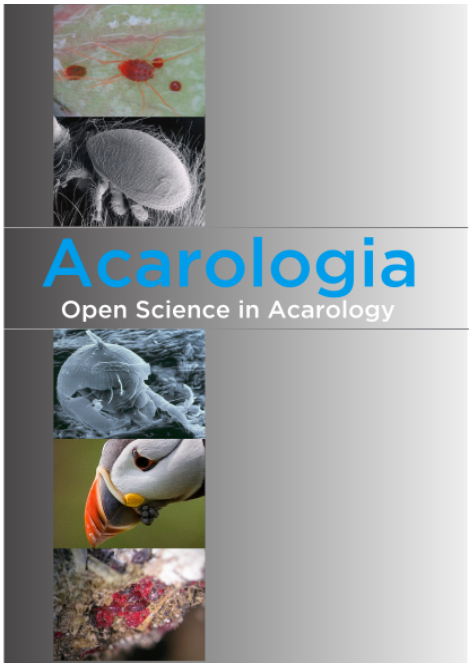

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Aceria species associated with Solanaceae worldwide with description of a new species

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Original research

ABSTRACT

During the study on the eriophyoid mite fauna of Ajabshir region in East Azerbaijan province (Iran), a new species was found on *Lycium ruthenicum* Murray (Solanaceae). It was described, named as *Aceria ajabshiriensis* **n. sp.** and compared with 18 other *Aceria* species associated with plants of the family Solanaceae. *Aceria ajabshiriensis* **n. sp.** strongly resembles *Aceria eucricotes* (Nalepa). *Aceria ajabshiriensis* **n. sp.** is the third eriophyoid species collected on *L. ruthenicum* in Iran. A list of *Aceria* species associated with Solanaceae plants worldwide, their type hosts, type localities, habitats and a key for identification are provided. In addition, a new combination was proposed: *Aceria dunaliae* (Boczek & Oleczek, 1988) **n. comb.**

Keywords Ajabshir; habitus; identification key; *Lycium ruthenicum*
Zoobank http://zoobank.org/5F62B54F-AC4C-40AD-BF42-B3647A44D239

Introduction

The family Solanaceae is one of the largest and economically important families of flowering plants, including fruit, spice, and drug plants representing 8,400 scientific plant names of species (2,678 species names are accepted) within 115 plant genera (The Plant List on-line database 2013). This family includes evolutionarily successful and advanced taxa and shows high level of diversity reflected by the variety of life forms of its members, ranging from ephemeral herbs to large trees. They are cosmopolitan plants found throughout tropical and temperate regions, but with more focus in Australia and Latin America (Majaz Ganaie *et al.* 2018).

Due to the high host specificity of the eriophyoid mites, it seems that a large number of these mites must be found on Solanaceae. However, about 46 eriophyoid species have been collected on this plant family until now and 18 of them belong to the genus *Aceria* (Amrine and de Lillo unpublished database; Table 1). Six eriophyoid mite species are reported in Iran from Solanaceae including *Aceria eucricotes* (Nalepa), *A. melongena* (Zaher & Abou-Awad), *A. paramacrodonis* Kuang, *Aculops lycopersici* (Tryon), *Tetra lycopersici* Xue & Hong and *Echinacrus ruthenicus* Lotfollahi, de Lillo & Haddad (Sepasgozarian 1973; Baradaran-Anaraki and Daneshvar 1992; Ramazani *et al.* 2006; Jalilian *et al.* 2010; Kamali 2011; Xue and Hong, 2005, Xue *et al.* 2011; Lotfollahi *et al.* 2014, 2017; Delfan *et al.* 2015; Honarmand and Sadeghi 2016).

The seventh species from Solanaceae was collected from *Lycium ruthenicum* Murray in Iran. It is described and illustrated herein and a key to the *Aceria* species associated with Solanaceae plant species is given in order to assist species identification.

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Table 1 *Aceria* species collected on Solanaceae plants, worldwide and their type host, type locality and habitus. The list is sorted according to the key sequence. The name of the host species is consistent with the current nomenclature available in The Plant List (2013).

Species	Type host	Type locality	Ecological class/plant symptoms
A. eucricotes (Nalepa, 1892)	*Lycium europaeum* L.	South Europe, and Algiers, Algeria	Blister galls in leaves
A. pallida Keifer, 1964	*Lycium pallidum* Miers	11,3 km E. Tombstone, Arizona, USA	Blister galls in leaves
A. kendalli Baker *et al.*, 1996	*Lycium barbarum* L.	Arnold Arboretum, Forest Hills, Norfolk Co., Massachusetts, USA	Leaf pustules; infesting also young twigs, petioles, floral leaves, stamens, and ovaries
A. kuko (Kishida, 1927)	*Lycium chinense* Mill.	Japan	Leaf galls
A. parawagnoni (Kuang, 1983)	*Lycium* sp.	Yinchuan City, Ningxia Hui Autonomous Region, China	Blister galls in leaves
A. paramacrodonis Kuang, 1988	*Lycium* sp.	Zhongning County, Ningxia Hui Autonomus Region, China	Pockets galls on leaf undersurface
A. bicornis (Trotter, 1900)	*Solanum elaeagnifolium* Cav.	La Plata, Argentina	Leaf galls
A. sodomaei (Keifer, 1976)	*Solanum sodomaeum* Drege in DC	The Ark, Aberdare National Park, Kenya	Collected in bud hairs but no specific symptoms were recorded
A. melongena (Zaher & Abou-Awad, 1979)	*Solanum melongena* L.	Alexandria, Egypt	Vagrant
A. daturae (Soliman & Abou-Awad, 1978)	*Datura stramonium* L.	Gyza, Egypt	Vagrant
A. baliotes (Nalepa, 1921)	*Solanum indicum* L.	Bandoeng, Java, Indonesia	Yellow spots on leaf undersurface
A. lycopersici (Wolffenstein, 1879)	*Lycopersicon lycopersicum* (L.) H.Karst.	Southern Spain	Leaf and stem erinea, curling and shrinkage
A. acnistii Keifer, 1953	*Acnistus arborescens* (L.) Schltdl.	Ouro Preto, Minas Gerais, Brazil	Conspicuous blister galls in leaves
A. dunaliae (Boczek & Oleczek, 1988) **n. comb.**	*Acnistus arborescens* (L.) Schltdl.	Pueblo Hondo, Venezuela	Small galls on the leaves
A. annui (Keifer, 1977)	*Capsicum annuum* L.	Guarne, Antioquia, Columbia	Erinea on buds, stems and leaves
A. wagnoni (Keifer, 1977)	*Lycium cooperi* A. Gray	Valecito Creek box canyon, NW of Vallecito, Laguna Mts., San Diego Co., California, USA	Large, central, blister galls with lower surface, spout-like openings
A. macrodonis Keifer, 1965	*Lycium macrodon* A. Gray	Along highway in Kit Peak District, South of Tucson, Arizona, USA	Blister galls in leaves
A. caulicecis (Keifer, 1972)	*Lycium andersonii* A. Gray	San Felipe, San Diego Co., California, USA	Irregular hollow galls along stems and on spines, especially at the leaf bases

Material and Methods

Plant samples of Russian Box Thorn, *L. ruthenicum*, were collected in Ajabshir region of East Azerbaijan province (Iran), on July 2016. Eriophyoid mites were recovered from the plant samples by means of a modified washing method developed by Monfreda *et al.* (2007). The mites were slide mounted according to Baker *et al.* (1996) with some changes: specimens were directly placed in modified Hoyer's medium without previous clearing and fibers were interposed between slide and coverslip. Mounted specimens were cleared at 90°C for a few minutes. Then, the slides were dried for about four weeks in an oven at 47°C. The terminology and the setal notation in the morphological description of the mite follow mainly Lindquist (1996) and terminology of the internal female genital apparatus follows Chetverikov (2014) and Chetverikov *et al.* (2014). All morphological measurements were taken by means of a phase contrast microscope Olympus BX53, at 1,000 magnification (oil immersion), 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: dorsal semiannuli were counted from the first semiannulus behind the rear margin of the prodorsal shield; ventral semiannuli were counted from the first complete annulus after coxae II; 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 except of the minute characters. Measurements refer to the length of the morphological trait unless otherwise specified and are given in micrometers. In the female description, the holotype measurements are followed by range values, in parentheses, of the studied population (*i.e.* holotype and paratypes) and for males only the range values are given. The mean values of the paratypes are reported in the cases in which the measurements of the holotype could not be taken, due to the slide mounting position of the specimens and were marked by an asterisk (*) in the description. Line drawings were hand-drawn with a *camera lucida* according to de Lillo *et al.* (2010) and the abbreviations labelling schematic drawings follow mainly Amrine *et al.* (2003). The genus classification follows Amrine *et al.* (2003) but new genera described after 2003 were also considered. Host plant names and their synonymies are in accordance with *"The Plant List on-line database"* (2013).

Type materials are deposited at the Acarology Laboratory, Department of Plant Protection, Faculty of Agriculture, Azarbaijan Shahid Madani University, Tabriz (Iran).

Family Eriophyidae

Subfamily Eriophyinae

Tribe Acerini

Aceria ajabshiriensis n. sp.

Zoobank: 714B12BB-BC8E-43DA-BA85-BB6E61A48939

Description — FEMALE (Figure 1; measured specimens n = 10).

Body vermiform, 190 (173–205, excluding gnathosoma), 53* (52–54) thick, 55 (50–58) wide.

Gnathosoma projecting obliquely downwards, chelicerae 26 (26–30), palp 28 (26–35), palp coxal setae *ep* 3.5* (3–3.5), dorsal palp genual setae *d* 8 (7–10), unbranched.

Prodorsal shield 35 (24–35) including frontal lobe, 43* (40–45) wide, sub-circular; with a short flexible distally acuminate frontal lobe, 7 (5–7), over gnathosomal base, completely smooth. Tubercles of scapular setae *sc* on rear shield margin, 29 (27–29) apart, setae *sc* 30 (26–35), directed backward divergently.

Legs with all usual segments and setae. Leg I 31 (26–33), trochanter 6 (6–7), femur 8 (8–10), genu 6 (5–6), tibia 8 (6–9), tarsus 9 (7–9), tarsal solenidion ω6 (6–8) distally enlarged and tapered, empodium simple, 7.5 (6.5–9), 6-rayed; femoral setae *bv* 14* (12–16), genual setae *l''* 29 (25–33), paraxial tibial setae *l'* 8 (6–10), located in basal third of tibia, paraxial fastigial

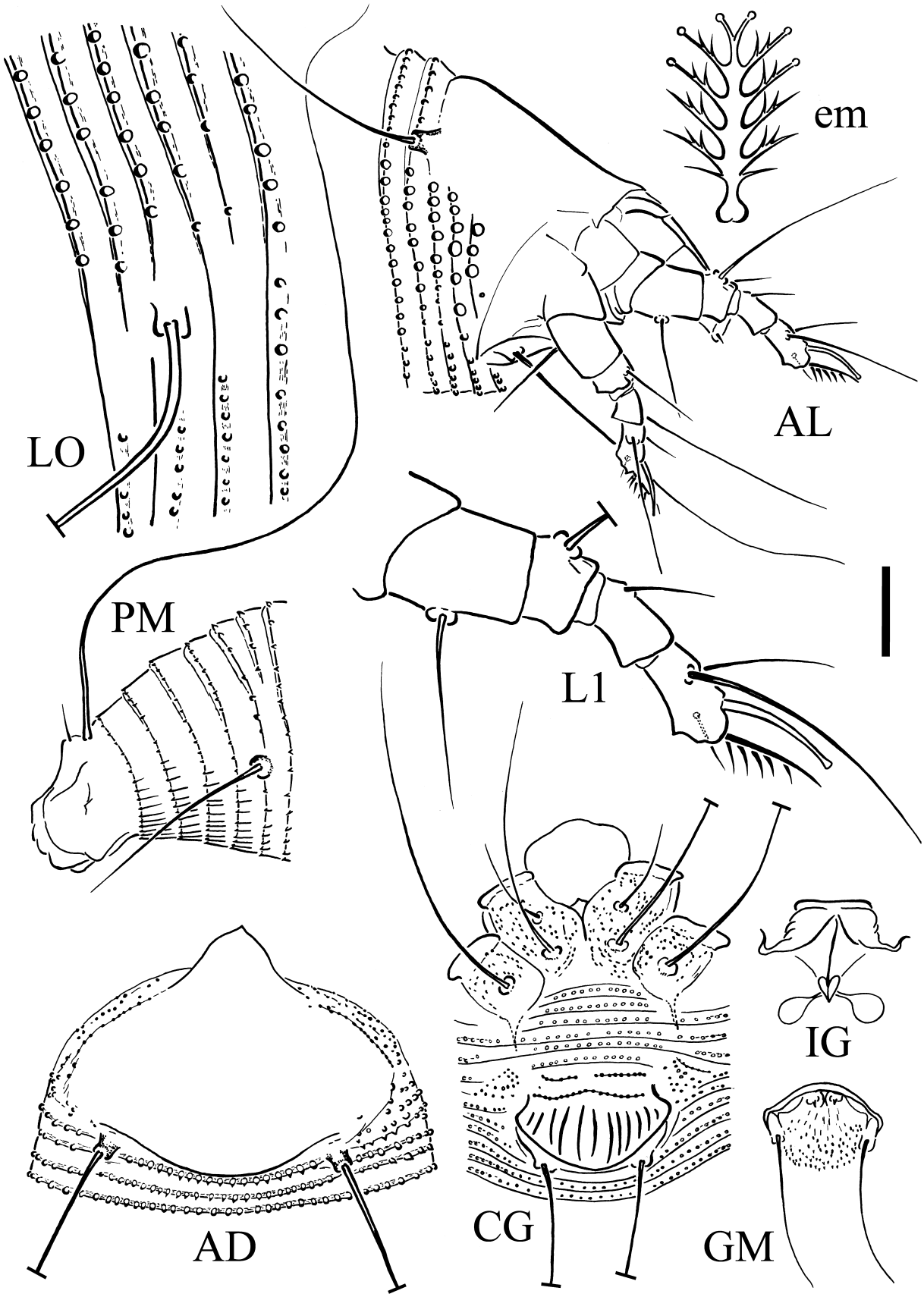

Figure 1 Schematic drawings of *Aceria ajabshiriensis* **n. sp.**: AD – Prodorsal shield; AL – Lateral view of anterior body region; CG – Female coxigenital region; em – Empodium; GM – Male genital region; IG – Internal female genitalia; LO – Lateral view of annuli; L1 – Leg I; PM – Lateral view of posterior opisthosoma. Scale bar: 10 μm for AD, AL, CG, GM, IG, PM; 5 μm for LO, L1; 2.5 μm for em.

tarsal setae *ft*' 15 (10–19), antaxial fastigial tarsal setae *ft''* 26 (23–30), paraxial unguinal tarsal setae *u'* 4 (3–4.5). Leg II 31 (26–33), trochanter 5 (5–7), femur 10 (9–10), genu 5 (4–5), tibia 7 (5–8), tarsus 7 (7–8), tarsal solenidion ω8 (7–8.5) distally tapered, empodium simple, 6 (5.5–8), 6-rayed; femoral setae *bv* 12 (12–15), genual setae *l''* 11 (9–15), paraxial fastigial tarsal setae *ft'* 6 (6–9), antaxial fastigial tarsal setae *ft''* 24 (21–27), paraxial unguinal tarsal setae *u'* 4.5 (3.5–5.5).

Coxisternal region. Prosternal apodeme 5 (5–6.5), anterior setae on coxisternum I *1b* 12* (10–19), 11 (9–11) apart; proximal setae on coxisternum I *1a* 34 (27–41), 10 (7–10) apart; proximal setae on coxisternum II *2a* 48 (44–54), 23 (18–23) apart; 7 (6–8) microtuberculate semiannuli between coxae and genital coverflap plus 3 (2–3) transversal rows of lined granules at the base of the coverflap. Coxae ornamented with numerous dots and dashes.

External genitalia 11 (10–15), 21 (21–22) wide, coverflap with 9 (9–10) longitudinal striae; setae *3a* 22 (20–27), 14 (11–14) apart.

Internal genitalia: spermathecae ovoid, oriented posterolaterad; spermathecal tubes relatively short; transverse genital apodeme trapezoidal, distally folded.

Opisthosoma dorsally arched, with 48 (39–53) dorsal semiannuli, 64 (46–64) ventral semiannuli.

Microtubercles: subelliptical, on posterior margin of dorsal semiannuli, bigger on last 17–20th dorsal semiannuli and minute spiny on last 3 (no variation) dorsal semiannuli; circular, on posterior margin of ventral semiannuli, elongated and linear on last 5 (5–7) ventral semiannuli.

Setae *c2* 55 (37–57) on ventral semiannulus 11 (9–11), setae *d* 69 (69–86) on ventral semiannulus 23 (18–23); setae *e* 53 (47–72) on ventral semiannulus 40 (27–40); setae *f* 33 (28–36) on ventral semiannulus 59 (42–59); 5 (4–5) annuli posterior to setae *f*. Setae *h2* 110 (87–115) apically very fine, *h1* 3 (3–5).

MALE (measured specimens n = 3). Similar in shape and prodorsal shield arrangement to female. Body smaller than female, 125–150, 47–52 wide, 42 thick; palp genual setae *d* 7–8; prodorsal shield 24–32, 40–42 wide; setae *sc* 25–26, 20–25 apart. Opisthosoma with 35–41 dorsal semiannuli and 53–50 ventral semiannuli; 8 semiannuli between coxae and genitalia, with microtubercles similar to those of female. Setae: *1b* 8.5–9, *1a* 20–27, *2a* 32–43, *c2* 37–47, *d* 42–44, *e* 33–41, *f* 22–29, *h1* 3, *h2* 55–67). Male genitalia 15–20 wide, setae *3a* 15–21, 12 apart.

Type host plant — *Lycium ruthenicum* Murray (Solanaceae), Russian Box Thorn.

Type locality — Rahmanloo village, Ajabshir region, East Azerbaijan province, Iran (37°18'39.8''N, 45°28'50.3"E), 1,290 m above sea level, coll. S. Tajaddod, late July 2016.

Type material — Holotype: single female on a microscope slide (LR-IEA-RO16T-1). Paratypes: 5 females and 3 males mounted singly on separate microscope slides (LR-IEA-RO16T-2–8).

Other material — Mites preserved in a vial (LR-IEA-RO16T) of Oudemans' fluid (Walter and Krantz, 2009) as extracted from the same sample as the type specimens.

Relation to the host plant — Vagrant; no apparent symptom was observed.

Etymology — This species is named after Ajabshir, the region where it was collected.

Differential diagnosis — The new species was compared with 18 *Aceria* species associated with the plants of family Solanaceae known to date. The new species closely resembles *Aceria eucricotes* (Nalepa) collected on *Lycium europaeum* L. from Algeria and, previously, also on *L. ruthenicum* from Iran (Lotfollahi *et al.* 2017). Both species have completely smooth prodorsal shields, similar number of empodial rays and body setal length. But these two species differ in number of dorsal semiannuli (39–53 in the new species *versus* 51–73 in *A. eucricotes*), number of semiannuli between coxae and genital coverflap (6–8 in the new species *versus* 3–5 in *A. eucricotes*). In addition, *A. ajabshiriensis* **n. sp.** has a short flexible distally acuminate frontal lobe, while *A. eucricotes* doesn't have a frontal lobe. Finally, the female genital coverflap of the new species is ornamented with 9–10 longitudinal striae, whereas *A. eucricotes* has a smooth coverflap.

Remarks — This is the third eriophyoid species collected on *L. ruthenicum* and all three species were collected from this host plant in Iran (Lotfollahi *et al.* 2014, 2017).

Key of the *Aceria* species associated to the Solanaceae plants

A key of the *Aceria* mite species collected on Solanaceae worldwide is proposed on the base of the most detailed published descriptions:

1. Female genitalia coverflap smooth 2
— Female genitalia coverflap with ornamentations 7

2. Empodium 6-rayed 3
— Empodium 5-rayed 4

3. Prodorsal shield completely smooth . . . . . ***A. eucricotes*** (Figure 2A) (from Lotfollahi *et al.* 2017)
— Prodorsal shield with design almost absent, with very short median and admedian lines near rear prodorsal shield margin as short curved lines converging posteriorly, and surrounded outwardly by some granules . . . . . ***A. pallida*** (Figure 2B) (from Keifer 1964)

4. Prodorsal shield without distinct lines 5
— Prodorsal shield with distinct design posteromedially 6

5. Prodorsal shield very small, triangular, smooth or with obscure design . . . . . ***A. kendalli*** (no Figure available) (from Kendall 1929)
— Prodorsal shield with granules between setae *sc* tubercles near rear margin . . . . . ***A. kuko*** (Figure 2D) (from Ripka and Sanchez 2017)

6. Median line very short near rear prodorsal shield margin . . . . . ***A. parawagnoni*** (Figure 2E) (from Kuang 1983)
— Prodorsal shield with very short admedian lines and without median lines . . . . . ***A. paramacrodonis***(Figure 2F) (from Kuang 1988)

7. With two long horn-shaped projections anteriorly on prodorsal shield . . . . . ***A. bicornis*** (Figure 2C) (from Trotter 1900)
— Without the projections; frontal lobe normal if present 8

8. Prodorsal shield completely smooth . . . . . ***A. ajabshiriensis*** **n. sp.** (Figure 1AD)
— Prodorsal shield with ornamentations 9

9. Empodium 4-rayed 10
— Empodium with more than 4 rays 14

10. Setae *e* 4 and setae *3a* 6 . . . . . ***A. sodomaei*** (Figure 2G) (from Keifer 1976)
— Without this combination for setae *e* and length 11

11. With more than 70 dorsal semiannuli 12
— With less than 70 dorsal semiannuli 13

12. Prodorsal shield with complete median line and first submedian lines in the middle of shield, quite close to admedian lines . . . . . ***A. melongena*** (Figure 2H) (from Zaher and Abou-Awad 1979)
— Prodorsal shield with incomplete median line (on posterior 2/3 of shield) and without first

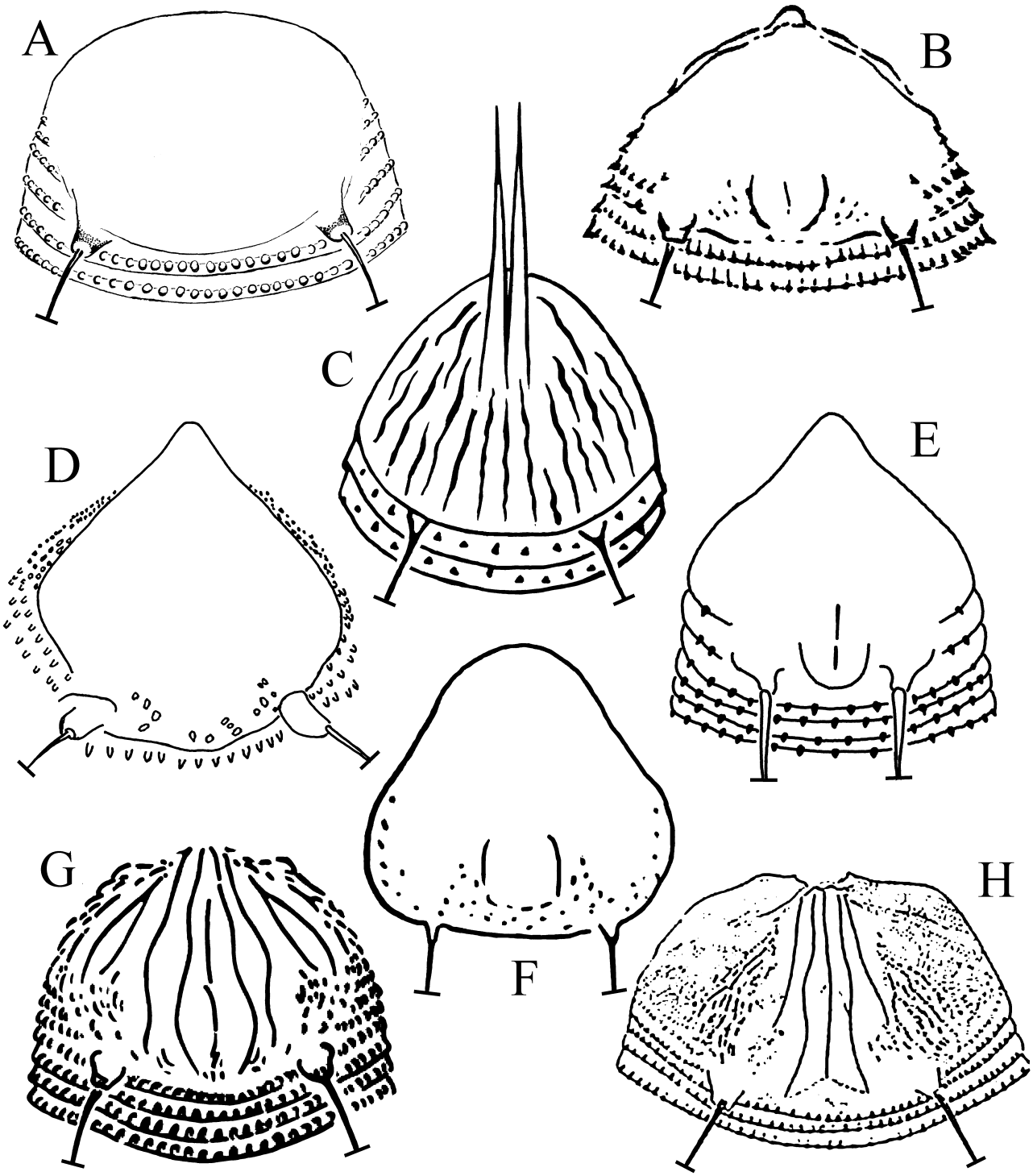

Figure 2 Schematic drawings of the prodorsal shield of: A – *A. eucricotes* (Nalepa, 1892) (from Lotfollahi *et al.* 2017); B – *A. pallida* Keifer, 1964 (redrawn from Keifer 1964); C – *A. bicornis* (Trotter, 1900) (redrawn from Trotter 1900); D – *A. kuko* (Kishida, 1927) (from Ripka and Sanchez 2017); E – *A. parawagnoni* (Kuang, 1983) (redrawn from Kuang 1983); F – *A. paramacrodonis* Kuang, 1988 (from Kuang 1988); G – *A. sodomaei* (Keifer, 1976) (redrawn from Keifer 1976); H – *A. melongena* (Zaher & Abou-Awad, 1979) (from Zaher and Abou-Awad 1979).

submedian lines . . . . . ***A. daturae*** (Figure 3A) (from Soliman and Abou-Awad 1978)

13. Opisthosoma with about 58 annuli and *sc* setae almost one and half the prodorsal shield length . . . . . ***A. baliotes*** (no Figure available) (from Nalepa 1921)
— Opisthosoma with about 70 annuli and *sc* setae almost twice the prodorsal shield length . . . . . ***A. lycopersici*** (Figure 3B) (from Farkas 1965)

14. Empodium 5-rayed 15
— Empodium with more than 5 rays 16

15. Prodorsal shield with numerous short dashes, obscuring the shield design . . . . . ***A. acnistii*** (Figure 3C) (from Keifer 1953)
— Prodorsal shield mostly smooth, with just a few dotted transverse lines near rear margin . . . .***Aceria dunaliae*** (Boczek & Oleczek, 1988) **n. comb.** (Figure 3D) (from Boczek and Oloczek 1988)

Note Boczek and Oleczek (1988) assigned this species to the genus *Paraphytoptus*. According to Amrine *et al.* (2003), members of this genus are characterized by wider annuli on the posterior opisthosoma. But in this species annuli of posterior opistosoma are continuous and subequal dorsoventrally and this species morphologically fits the diagnosis of the genus *Aceria*, and therefore we propose a new combination, ***Aceria dunaliae*** (Boczek and Oleczek, 1988) **n. comb.**

16. Prodorsal shield with submedian lines connected to admedian lines . . . . . ***A. annui*** (Figure 3E) (from Keifer 1977)
— Prodorsal shield without submedian lines 17

17. Median and admedian lines very short near rear prodorsal shield margin; spiny microtubercles . . . . . ***A. wagnoni*** (Figure 3F) (from Keifer 1977)
— Without median lines, only short admedian lines present near rear prodorsal margin 18

18. Prodorsal shield design close to the rear margin, consisting of short admedian lines subparallel, outwardly convex, surrounded laterally and posteriorly with granules; opisthosoma with about 70 annuli . . . . . ***A. macrodonis*** (Figure 3G) (from Keifer 1965)
— Prodorsal shield design weak and close to the rear margin, admedian lines represented by short centrally curved lines on rear 1/4; opisthosoma with 60 rings . . . . . ***A. caulicecis*** (Figure 3H) (from Keifer 1972)

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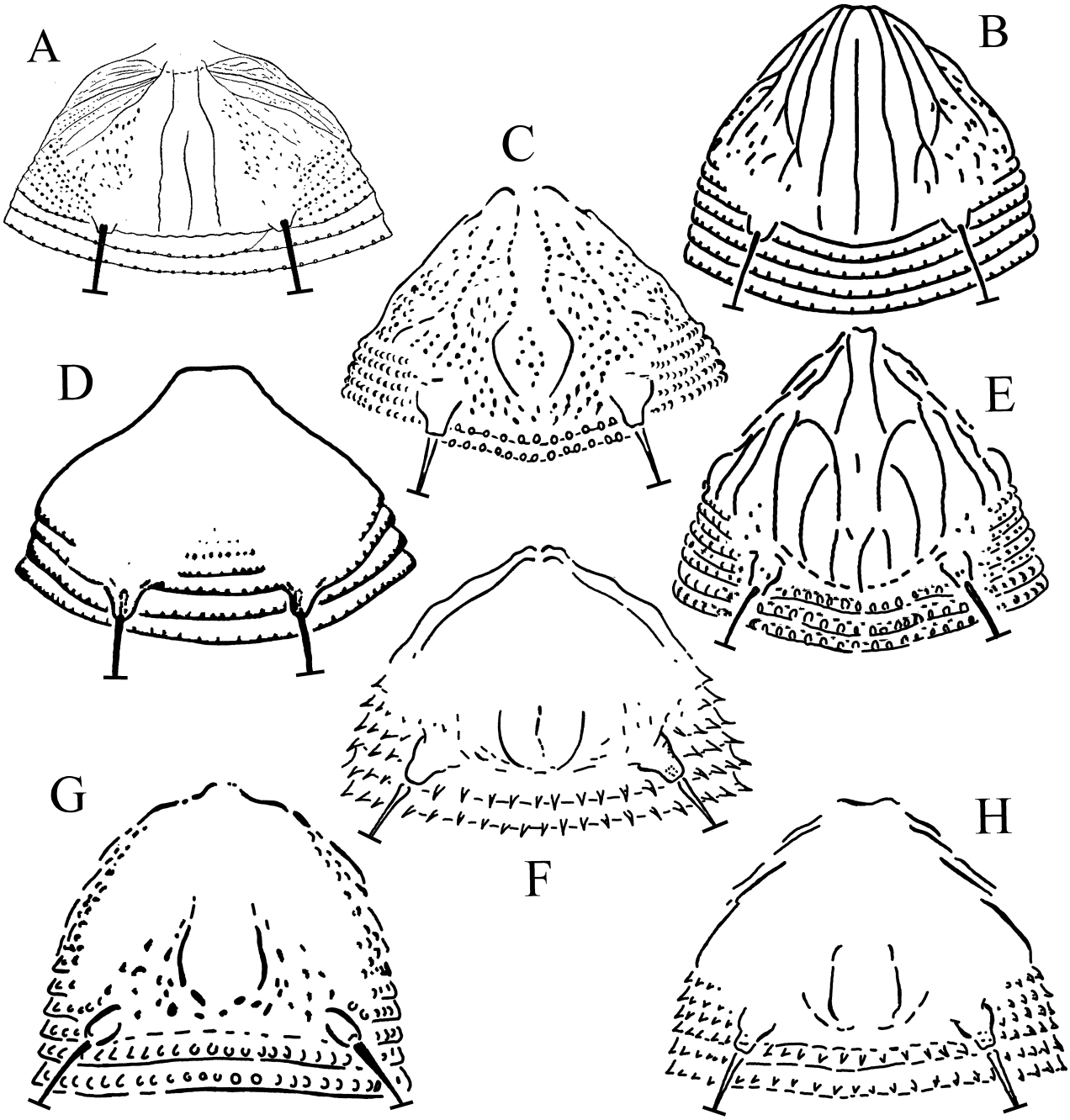

Figure 3 Schematic drawings of the prodorsal shield of: A – *A. daturae* (Soliman & Abou-Awad, 1978) (from Soliman and Abou-Awad 1978); B – *A. lycopersici* (Wolffenstein, 1879) (redrawn from Farkas 1965); C – *A. acnistii* Keifer, 1953 (redrawn from Keifer 1953); D – *A. dunaliae* (Boczek & Oleczek, 1988) (redrawn from Boczek and Oleczek 1988); E – *A. annui* (Keifer, 1977) (redrawn from Keifer 1977); F – *A. wagnoni* (Keifer, 1977) (redrawn from Keifer 1977); G – *A. macrodonis* Keifer, 1965 (redrawn from Keifer 1965); H – *A. caulicecis* (Keifer, 1972) (redrawn from Keifer 1972).

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