

Two new species of the genus *Agistemus* Summers (Acari: Stigmaeidae) from Saudi Arabia

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Original research

ABSTRACT

Two new predatory mites of the genus *Agistemus* Summers (Acari: Prostigmata: Stigmaeidae) namely *A. neocollyerae* n. sp. and *A. arabensis* n. sp. are described and illustrated based on adult females. Additionally, two species namely *A. simplex* González-Rodríguez and *A. floridanus* González-Rodríguez are reported as new records for the stigmaeid mite fauna of Saudi Arabia. A regional key to reported species of the genus *Agistemus* is also provided.

Keywords description; *neocollyerae*; *simplex*; *floridanus*; new records

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Introduction

Stigmaeid mites (Acari: Trombidiformes: Stigmaeidae) are important predators of wide range of prey species and play potential role in the control of phytophagous mites after the family Phytoseiidae (Santos and Laing 1985). They are distributed worldwide and are found in variety of different habitats i.e. plant canopy, soil, leaf litter and crevices etc. (Gerson et al. 2003; Fan and Zhang 2005; Dönel and Doğan 2011).

The family Stigmaeidae includes 34 genera and more than 578 described species (Fan et al. 2016). The genus *Agistemus* Summers 1960, the third largest stigmaeid genus, includes 88 species worldwide (Bizarro et al. 2022). Many species of the genus *Agistemus* are economically important and are known as efficient egg predators of many phytophagous mite species (Gerson et al. 2003; Matioli et al. 2002; Fan and Flechtman 2015).

A total of five species of the genus *Agistemus* have been reported from Saudi Arabia so far viz. *A. aimogastaensis* Leiva, Fernandez, Theron & Rollard, *A. exsertus* González-Rodríguez, *A. fleschneri* Summers, *A. jawadi* Rehman et al., *A. macrommatus* González-Rodríguez and *A. vulgaris* nomen nudum Soliman & Gomaa (Alatawi and Kamran 2017; Rehman et al. 2018). The present study reports two new species; *A. neocollyerae* n. sp. and *A. arabensis* n. sp. described and illustrated based on adult females. Two new records (*A. simplex* González-Rodríguez and *A. floridanus* González-Rodríguez) were reported from Saudi Arabia in the current study. A regional key to reported species of the genus *Agistemus* is given.

Material and methods

The specimens were collected from the leaves of different host plants and preserved in 70% ethanol. The collected mite specimens were directly mounted on slides in Hoyer's medium under a stereomicroscope (SZX10, Olympus, Tokyo, Japan), and identified under a phase

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contrast microscope (DM2500, Lieca, Wetzlar, Germany). Different mite body parts were pictured using an auto-montage software system (Syncroscopy, Cambridge, UK) and then drawn with Adobe Illustrator (Adobe System Inc., San Jose, CA, USA). The nomenclature for gnathosomal and leg chaetotaxy followed that of Grandjean (1944) and for the idiosomal setae followed those of Kethley (1990). All measurements of the holotype and paratypes (as ranges in parenthesis) are given in micrometers (μm). All specimens of new species and new records have been deposited in KSMA (King Saud University Museum of Arthropods, Acarology section), Department of Plant Protection, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia.

Results

Family Stigmaeidae Oudemans

Genus *Agistemus* Summers

Type species: *Caligonus terminalis* Quayle, 1912, by original designation.

Agistemus terminalis (Quayle), Summers 1960: 234.

Diagnosis

As defined by Fan & Zhang (2005).

Species group *terminalis* Rehman et al. (2018)

Diagnosis (Based on female)

As defined by Rehman et al. 2018.

Two pairs of aggenital setae (ag_{1-2}) present.

Agistemus neocollyerae n. sp.

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Figures 1–3

Diagnosis

Dorsal shield reticulated, setae f_1 and h_1 longer than other dorsocentral setae, setae v_i shorter than the distance v_i-v_i , setae ve reaching the base of sce , two pairs of aggenital setae (ag_{1-2}), genital setae (g) long, extending pass the bases of anal setae ps_2 .

Description of female (n=8)

Idiosomal dorsum — (Figure 1a). Idiosoma broadly oval. Length of idiosomal dorsum excluding gnathosoma 260 (258–262); including gnathosoma from base to tips of chelicerae 340 (339–342), width of idiosoma at the level of setae c_2 180 (178–181). Prodorsal shield subtriangular with polygonal reticulations, with one pair of eyes 10 (8–10); post ocular bodies pob not clearly visible, and three pairs of setae (vi , ve and sce), humeral shields smooth, small and bearing setae c_2 . Median hysterosomal shield with polygonal reticulations, bearing five pairs of setae (c_1 , d_1 , d_2 , e_1 and e_2), intercalary shields smooth and with setae f_1 , suranal shield entire and smooth, with two pairs of setae, h_1 and h_2 . Dorsal setae barbed, shorter than the distance to the setae next in line.

Length of dorsal setae: vi 16 (15–17), ve 24 (22–25), sce 30 (27–32), c_1 21 (20–22), c_2 30 (29–33), d_1 26 (24–28), d_2 25 (22–26), e_1 31 (28–32), e_2 24 (22–25), f_1 35 (33–36), h_1 35 (34–36), h_2 34 (33–35).

Distances between dorsal idiosomal setae: $vi-vi$ 33 (30–34), $ve-ve$ 62 (61–64), $vi-ve$ 23 (20–24), $ve-sce$ 28 (27–29), $sce-sce$ 99 (97–98), c_1-c_1 32 (31–33), c_1-d_1 44 (41–44), c_1-d_2

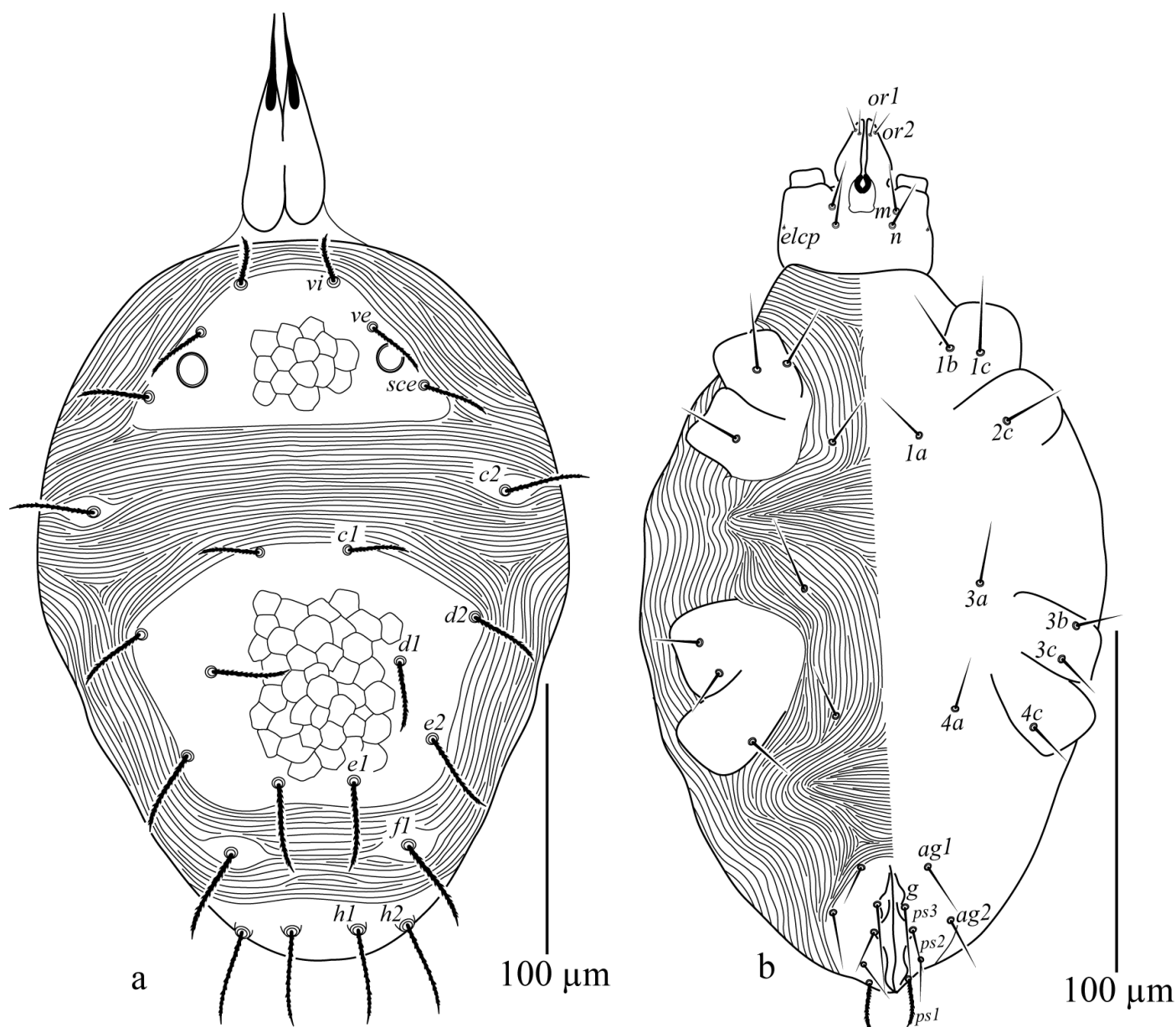


Figure 1 *Agistemus neocollyerae* n. sp., female, a – dorsum; b – venter.

49 (47–51), d_1-d_1 67 (66–67), d_1-d_2 32 (31–33), d_1-e_1 46 (44–46), d_1-e_2 31 (31–33), d_2-d_2 116 (110–115), d_2-e_2 44 (42–45), e_1-e_1 29 (27–29), e_1-e_2 32 (30–33), e_2-e_2 88 (87–88), f_1-f_1 64 (64–66), h_1-h_1 21 (20–24), h_1-h_2 10 (10–11).

Ratios: $vi/vi-vi$ 0.5 (0.4–0.5), $ve/ve-sce$ 0.8 (0.7–0.9), c_1/c_1-c_1 0.65 (0.6–0.7), d_1/d_1-d_1 0.4 (0.38–0.42), e_1/e_1-e_1 0.96 (0.9–1), f_1/f_1-f_1 0.54 (0.5–0.57), h_1/h_1-h_1 1.6 (1.6–1.8), c_1-c_1/d_1-d_1 0.5 (0.5–0.6), c_1-c_1/e_1-e_1 1 = d_1-d_1/e_1-e_1 2.3 (1.5–2.7), h_1/h_2 1 (0.9–1.1).

Idiosomal venter — (Figure 1b). Ventral surface ornamented with simple striations; bearing three pairs of simple sub equal setae ($1a$, $3a$ and $4a$), length of setae as follows: $1a$ 14 (13–14), $1b$ 21 (20–23), $1c$ 18 (17–21), $2c$ 22 (20–24), $3a$ 20 (20–21), $3b$ 16 (15–17), $3c$ 12 (10–12), $4a$ 20 (19–22), $4c$ 12 (10–12); aggenital plate each side with two setae, ag_1 13 (10–13), ag_2 19 (18–20), anogenital covers with one pair of genital setae, g 21 (20–24) and three pairs of pseudoanal setae, ps_1 14 (13–14), ps_2 15 (14–15), ps_3 17 (15–16); distances between setae:

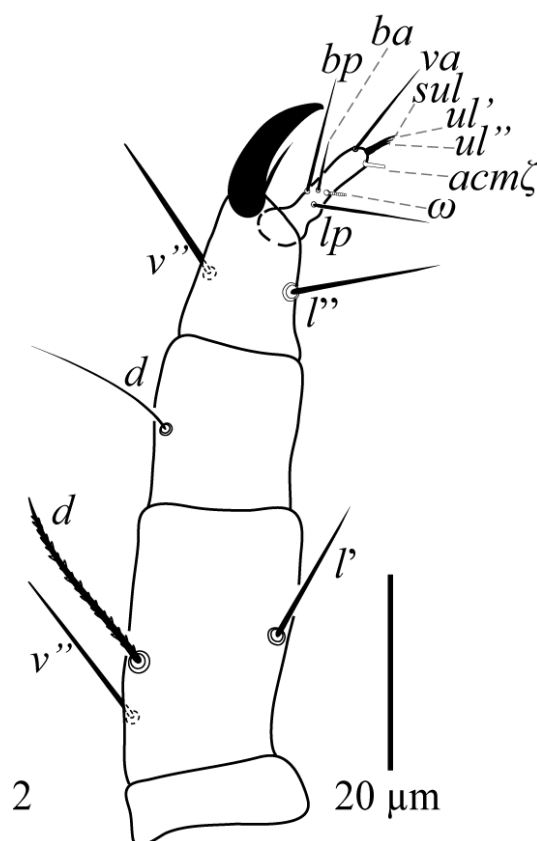


Figure 2 *Agistemus neocollyerae* n. sp., female, palp.

g-g 9 (8–10), *ps₁-ps₁* 14 (13–15), *ps₂-ps₂* 20 (20–21), *ps₃-ps₃* 13 (12–14), *ps₁-ps₂* 10 (8–9), *ps₂-ps₃* 11 (10–12).

Gnathosoma — (Figure 2). Subcapitulum bearing subcapitular setae *m* 17 (16–17), *n* 21 (20–21), adoral setae *or₁* 10 (10–12) and *or₂* 12 (9–12). Distance *m-m* 24 (21–25), *n-n* 21 (21–23), *m-n* 11 (10–11), *or₁-or₁* 5 (4–5), *or₂-or₂* 10 (8–9), *or₁-or₂* 4 (3–4) *elcp* 1.6(1–2) (Figure 1b). Palp five-segmented, palp trochanter without setae; palp femur with two smooth setae (*l'*, *v''*) and one barbed seta (*d*); palp genu with one smooth seta (*d*); palp tibia with two simple setae (*v''*, *l''*), one well-developed claw, one seta associated with claw (*l'T*); palptarsus with four simple setae (*ba*, *bp*, *va* and *lp*), one solenidion (*ω*), subapical eupathidium (*acmζ*) and three eupathidia (*sulζ*, *ul'ζ*, *ul''ζ*), fused at basis, trifold distally (Figure 2).

Legs — (Figures 3a–d). Length of legs I–IV from trochanter to tip of empodium: 144 (141–144), 140 (140–142), 145 (143–146), and 147 (147–149), respectively; dorsal seta on leg femur (*dF*) I–IV and dorsal seta on leg genu I (*dGI*) barbed; tibiae and tarsi on leg IV lack solenidion. Number of setae on leg segments as follows (specialized setae are in parentheses): coxae 2–1–2–1, trochanter 1–1–1–1, femora 4–4–2–2, genua 2(+1κ)–0–0–0, tibiae 5(+1φ)–5(+1φ)–5(+1φ)–4, tarsi 11(+1ω)–9(+1ω)–7(+1ω)–7. Length of specialized setae on legs: κI 5 (4–5), φI 8.8 (8–9), φII 4.4 (3–4), φIII 3.2 (3–4), ωI 8 (6–8), ωII 8 (7–8), ωIII 4 (3–5).

Etymology

The specific epithet (*neocollyerae*) is derived from the closely related species *A. collyerae*.

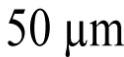


Figure 3 *Agistemus neocollyrae* n. sp., female, a – Leg I; b – Leg II; c – Leg III; d – Leg IV.

Type materials

Holotype female, one paratype female, weeds, Wadi Shora, Al-Bahah 19.49351°N, 41.46529°E, October 28, 2019, coll. M. Kamran & H.M.S. Mushtaq; two paratype females, from *Conocarpus* (Combretaceae), Bani Kabir, Al-Bahah 19.59252°N, 41.31964°E, September 12, 2021, coll. E.M. Khan & N. A. Elgoni; one paratype female, from *Convolvulus* spp. (Convolvulaceae), Buljershi, Al-Bahah, 19.53752°N, 41.34423°E, September 12, 2021, coll. E.M. Khan & N. A. Elgoni; one paratype female, from *Acacia* (Fabaceae), Ghora, Asir, 19.13116°N, 42.04608°E, October 29, 2019, coll. M. Kamran & H.M.S. Mushtaq; one paratype female, from grasses, Ghora, Asir, 18.37286°N, 42.16217°E, October 29, 2019, coll. M. Kamran & H.M.S. Mushtaq; one paratype female, from Olive, *Olea europaea* (Oleaceae), Sakaka, Al-Jouf, 29.57251°N,

40.0548°E, June 21, 2021, coll. J. H. Mirza.

Remarks

The new species *A. neocollyerae* n. sp. is close to three species; *A. aimogastaensis* Leiva et al., *A. collyerae* González-Rodríguez and *A. manjilicus* Khanjani based on the following set of characteristics; tibia IV with four setae, genu I with two setae (excluding solenidion) and dorsal shields entirely reticulated. The new species differs from *A. aimogastaensis* by the number of setae on coxae IV (1 vs 2), distance of *ve/ve-sce* (*ve* reaching base of setae *sce* vs *ve* half as long as *ve-sce*). The new species differs from *A. manjilicus* based on the length of genital setae (*g* extending beyond the bases of *ps₁* vs *g* reaching the base of *ps₂*), *vi/vi-ve* = 0.6 vs *vi/vi-ve* = 0.9–1.08, setae *ag₂* long, *h₁/h₁-h₁* 1.6 in new species vs *h₁/h₁-h₁* 2.33 in *A. manjilicus*. The new species differs from *A. collyerae* by the length and position of setae; *vi*<*vi-vi* vs. *vi*=*vi/vi*, setae *ve* not reaching the base of *sce* vs. *ve* extending well beyond the base of setae *sce*, *c₁* reaching less than half the distance *c₁-d₁* vs. *c₁* longer than the distance *c₁-d₁*, setae *f₁* and *h₁* equally long vs. *f₁* the longest dorsal setae.

Agistemus arabensis n. sp.

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Figures 4–6

Diagnosis: All dorsal shields with weak longitudinal irregular striations, dorsal setae not set on tubercles, femur I with four setae and femur IV with one seta, all dorsal body setae reaching or longer than distance between the setae next in line,

Description of female (n=5)

Idiosomal dorsum — (Figure 4a). Idiosoma broadly oval. Length of idiosomal dorsum excluding gnathosoma 320 (315–325); including gnathosoma from base to tips of chelicerae 410 (400–418), width of idiosoma at level of setae *c₂* 210 (208–217). Prodorsal shield subtriangular without reticulations and with weak irregular longitudinal striae, with one pair of eyes 8 (7–8); post ocular bodies *pob* present 12 (11–12) and three pairs of setae (*vi*, *ve* and *sce*), humeral shields smooth, small and bearing setae *c₂*. Median hysterosomal shield with fine longitudinal striations, bearing five pairs of setae (*c₁*, *d₁*, *d₂*, *e₁* and *e₂*), intercalary shields smooth and with setae *f₁*, suranal shield entire and smooth, with two pairs of setae, *h₁* and *h₂*. Dorsal setae barbed, longer than distance to setae next in line.

Length of dorsal setae: *vi* 31 (30–32), *ve* 60 (58–61), *sce* 48 (47–49), *c₁* 47 (45–49), *c₂* 43 (43–44), *d₁* 50 (49–51), *d₂* 44 (43–45), *e₁* 49 (47–51), *e₂* 49 (47–49), *f₁* 47 (44–46), *h₁* 41 (41–43), *h₂* 35 (34–36).

Distances between dorsal idiosomal setae: *vi-vi* 15 (12–14), *ve-ve* 46 (44–46), *vi-ve* 20 (20–21), *ve-sce* 32 (31–33), *sce-sce* 89 (90–92), *c₁-c₁* 53 (51–54), *c₁-d₁* 58 (56–60), *c₁-d₂* 62 (61–62), *d₁-d₁* 82 (80–83), *d₁-d₂* 24 (21–25), *d₁-e₁* 52 (50–55), *d₁-e₂* 37 (36–38), *d₂-d₂* 123 (120–125), *d₂-e₂* 41 (40–43), *e₁-e₁* 40 (38–41), *e₁-e₂* 33 (31–33), *e₂-e₂* 100 (97–101), *f₁-f₁* 69 (67–71), *h₁-h₁* 21 (20–21), *h₁-h₂* 67 (66–68).

Ratios: *vi/vi-vi* 2 (2.2–2.8), *ve/ve-sce* 2 (1.8–2.1), *c₁/c₁-c₁* 0.8 (0.7–1), *d₁/d₁-d₁* 0.6 (0.5–0.8), *e₁/e₁-e₁* 1.2 (1.1–1.4), *f₁/f₁-f₁* 0.7 (0.6–0.9), *h₁/h₁-h₁* 1.9 (1.7–2), *c₁-c₁/d₁-d₁* 0.5 (0.5–0.6), *c₁-c₁/e₁-e₁* 1.3 (0.9–1.6), *d₁-d₁/e₁-e₁* 2 (1.9–2.3), *h₁/h₂* 1.2 (1–1.5).

Idiosomal venter — (Figure 4b). Ventral surface ornamented with simple striations; bearing three pairs of simple setae (*1a*, *3a* and *4a*), length of setae as follows: *1a* 36 (35–36), *1b* 28 (27–29), *1c* 33 (30–33), *2c* 32 (31–32), *3a* 28 (27–29), *3b* 25 (21–24), *3c* 20 (18–22), *4a* 25 (23–26), *4b* 26 (24–26), *4c* 21 (18–20); aggenital plate each side with two pair of setae, *ag₁* 17 (16–17), *ag₂* 29 (27–29), anogenital covers with one pair of genital setae, *g* 29 (27–30) and three pairs of pseudoanal setae, *ps₁* 17 (15–16), *ps₂* 17 (16–17), *ps₃* 16 (15–16); distances between setae: *g-g* 8 (8–9), *ps₁-ps₁* 15 (14–15), *ps₂-ps₂* 22 (21–22), *ps₃-ps₃* 16 (14–15), *ps₁-ps₂* 14 (13–14), *ps₂-ps₃* 10 (8–9).

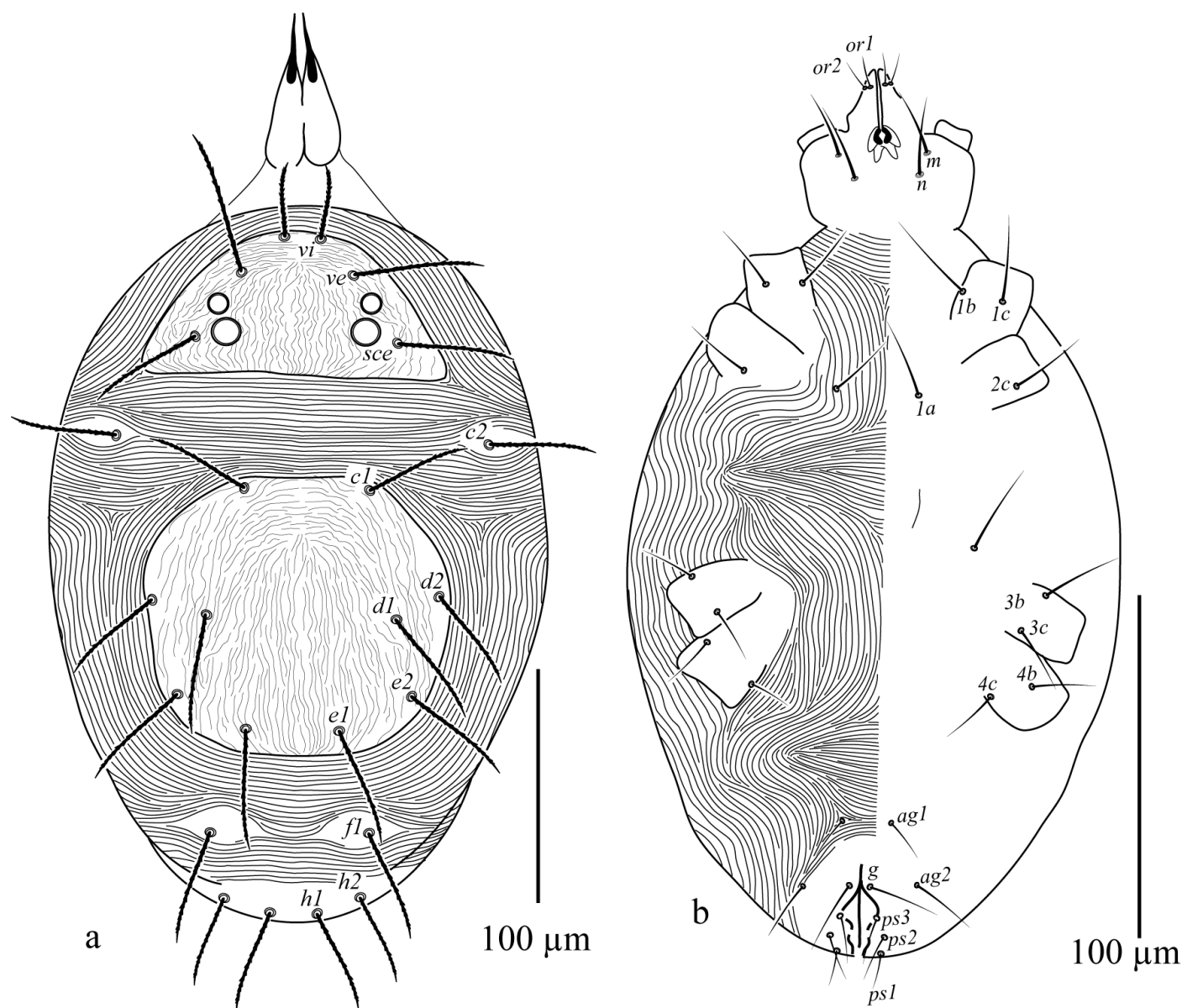


Figure 4 *Agistemus arabensis* n. sp., female, a – dorsum; b – venter.

Gnathosoma — (Figure 5). Subcapitulum bearing subcapitular setae *m* 22 (21–22), *n* 33 (30–32), adoral setae *or*₁ 12 (11–12) and *or*₂ 12 (10–11). Distances *m*–*m* 36 (34–35), *n*–*n* 28 (26–29), *m*–*n* 11 (9–10), *or*₁–*or*₁ 5 (4–6), *or*₂–*or*₂ 7 (6–8), *or*₁–*or*₂ 4 (3–4) (Figure 4b). Palp five-segmented, palp trochanter without setae; palp femur with two smooth setae (*l*″, *v*″) and one barbed seta (*d*); palp genu with one smooth seta (*d*); palp tibia with two simple setae (*v*″, *l*″), one well-developed claw, one seta associated with claw (*l*′*T*); palptarsus with four simple setae (*ba*, *bp*, *va* and *lp*), one solenidion (*ω*), subapical eupathidium (*acm*ζ) and three eupathidia (*sul*ζ, *ul*′ζ, *ul*» ζ), fused at basis, trifid distally (Figure 5).

Legs — (Figures 6a–d). Length of legs I–IV from trochanter to tip of empodium: 200 (197–201), 180 (178–182), 185 (182–187), and 215 (209–216), respectively; dorsal seta on leg femur (*dF*) I–IV and dorsal seta on leg genu I (*dGI*) barbed; tarsi on leg IV lack solenidion. Number of setae on leg segments as follows (specialized setae are in parentheses): coxae 2–1–2–2, trochanters 1–1–1–1, femora 4–4–2–1, genua 3(+1κ)–1–0–0, tibiae 5(+1φ)–5(+1φ)–

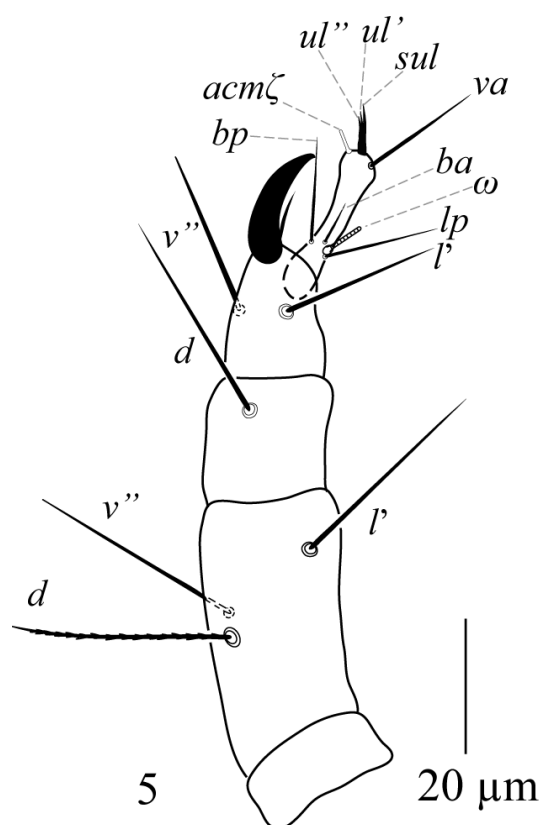


Figure 5 *Agistemus arabensis* n. sp., female, palp.

5(+1 φ)–5(+1 φ), tarsi 12(+1 ω)–9(+1 ω)–7(+1 ω)–7. Length of specialized setae on legs: κ I 5 (4–5), φ I 10 (9–10), φ II 12 (11–12), φ III 9 (7–8), φ IV 9 (8–9), ω I 16 (15–16), ω II 16 (14–15), ω III 10 (9–10).

Type materials

Holotype female, two paratype females, from *Convolvulus* spp. (Convolvulaceae), Bashayer, Asir, 19.36194°N, 42.53823°E, October 29, 2019, coll. M. Kamran & H.M.S. Mushtaq; Two paratype females, from *Cordia* spp. (Boraginaceae), Zarq Valley, Al-Baha, 20.11329°N, 41.17463°E, September 10, 2020, coll. J.H. Mirza, H.M.S. Mushtaq & H.M.S. Ali.

Etymology

The specific epithet (*arabensis*) is derived from the type region, Saudi Arabia.

Remarks

The new species *Agistemus arabensis* n. sp. closely resembles *A. iburiensis* Ehara 1985, based on the number of setae on femur I and IV (4 and 1), dorsal setae not set on tubercles, setae c_2 on humeral plate and dorsal shield without reticulations. However, the new species differs from the later based on a very distinct morphological character; length of dorsal setae (all setae longer than distances to their bases vs. distinctly shorter, far behind the bases of next consecutive setae), ratio $vi/vi-vi = 2$ vs $vi/vi-vi = 0.6$; $ve/ve-sce = 2$ vs $ve/ve-sce = 0.8$ in *A. iburiensis*.

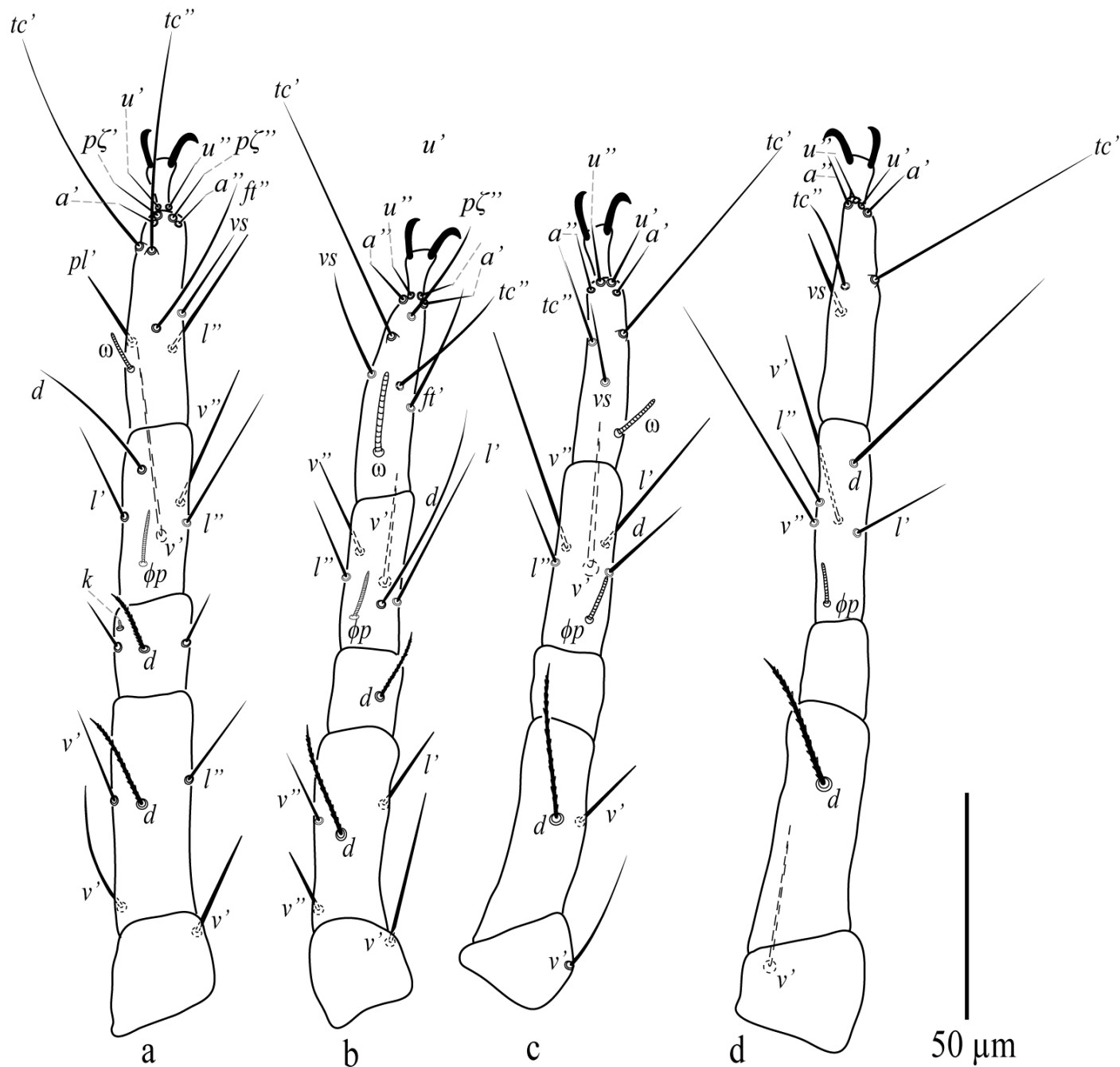


Figure 6 *Agistemus arabensis* n. sp., female, a – Leg I; b – Leg II; c – Leg III; d – Leg IV.

New Records

Agistemus simplex González-Rodríguez

Agistemus simplex González-Rodríguez 1965:33

Material Examined

Two females, fig, *Ficus carica* (Moraceae), Hijra, Al-Bahah 20.14154°N, 41.08445°E, September 11, 2020, coll. J. H. Mirza, H.M.S. Mushtaq & H. M. S. Ali; two females, grasses (Poaceae),

Thamod, Al-Madinah 24.542751°N, 39.00928°E, March 28, 2021, coll. M. Kamran & H.M.S. Mushtaq; one female, grasses, Al-Bahra, Al-Madinah, 24.35897°N, 39.23875°E, August 25, 2020, coll. F.J. Alatawi, J. H. Mirza & E.M. Khan. one female, *Zaleya* spp. (Aizoaceae), Dil Khansa, Al-Madinah, 24.54639°N, 39.00000°E, March 28, 2021, coll. M. Kamran & H.M.S. Mushtaq.

Distribution

Mexico (González-Rodríguez 1965).

Agistemus floridanus González-Rodríguez

Agistemus floridanus González-Rodríguez 1965:42; Matioli, Ueckermann and Oliveira 2002: 103.

Material Examined

One female, Brinjal, *Solanum melongena* (Solanaceae), Al-Amaria, Riyadh 24.47405°N, 46.25324°E, March 21, 2016, coll. H.M.S. Mushtaq; one female, *Acacia* (Fabaceae), Unyza, Al-Qasim 26.23618°N, 44.13713°E, May 03, 2018, coll. M. Kamran & J. H. Mirza.

Distribution

Florida (USA) (Matioli *et al.* 2002), Mexico (González-Rodríguez 1965)

Key to Saudi Arabian species of the genus *Agistemus* Summers

The following corrections should be made to the key to world species of the genus *Agistemus* published by Rehman *et al.* (2018). The number '31' at the couplet 15 should be replaced by '33'. The number '67' at the couplet 57 should be replaced by '68'.

The species *A. manjilicus* Khanjani *et al.* at the couplet 25 and the species *A. collyerae* González-Rodríguez at the couplet 26 should replace each other.

1. One pair of aggenital setae (*ag*) species group *fleschneri*; median hysterosomal shield reticulated, ratio c_1/c_1-c_1 1.0, setae e_1 crossing the bases of h_1 and reaching almost half length of h_1 , $e_1/e_1-e_1 = 1.8$: *fleschneri* Summers
— Two pairs of aggenital setae (ag_{1-2}) species group *terminalis* — 2
2. Median hysterosomal shield reticulated 3
— Median hysterosomal shield without reticulations 5
3. Ratio $vi/vi-vi \geq 2.1$ *jawadi* Rehman *et al.*
Ratio $vi/vi-vi \leq 1.6$ 4
4. Setae e_1 extending to or crossing the bases of h_1 , genital setae (*g*) very small (17), not reaching to the bases of ps_3 *aimogastaensis* Leiva *et al.*
— Setae e_1 about half of the distance e_1-h_1 , genital setae (*g*) very long, extending to the bases of ps_1 *neocollyerae* n. sp.
5. Dorsal idiosomal setae not set on tubercles 6
— Dorsal idiosomal setae set on tubercles 7
6. Femur I with four setae, femur IV with one setae *arabensis* n. sp.
— Femur I with five setae, femur IV with two setae *simplex* González-Rodríguez

7. Ratio $vi/vi-vi \geq 2.1$ *exsertus* González-Rodríguez
 — Ratio $vi/vi-vi \leq 1.7$ 8
8. Setae e_l at least reaching to the bases of f_l *floridanus* González-Rodríguez
 — Setae e_l at least reaching to the bases of h_l *macromatus* González-Rodríguez

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