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Genus *Eryngiopus* Summers (Acari: Trombidiformes: Stigmaeidae) from Saudi Arabia; a new record and redescription of *E. discus* Meyer, with a key to the world species

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ABSTRACT

Eryngiopus discus Meyer, 1969 (Acari: Trombidiformes: Stigmaeidae), the first species of the genus *Eryngiopus* Summers recorded from Saudi Arabia, is re-described and illustrated. The specimens of this species were collected from foxtail grass *Cenchrus* sp. (Poaceae) and *Euryops arabicus* (Asteraceae). Also, the species of the genus *Eryngiopus* are categorized into two species groups, *bakeri* and *gracilis*, based on three and four pairs of prodorsal setae, respectively. A key to the world species of the genus *Eryngiopus* is provided too.

Keywords *bakeri*, *gracilis*, predatory mites, species groups, stigmaeids
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Introduction

The family Stigmaeidae (Acari: Trombidiformes: Prostigmata) contains 32 genera (Fan *et al.*, 2016, Rehman *et al.*, 2016) of which only five genera including *Agistemus* Summers, *Cheylostigmaeus* Willmann, *Eustigmaeus* Berlese, *Eryngiopus* Summers and *Ledermuelleriopsis* Willmann have been reported from Saudi Arabia so far (Alatawi, 2011a & b, Alatawi & Kamran, 2017).

The species of the genus *Eryngiopus* inhabit plant foliage, soil litter, lichens and mosses (Ueckermann & Meyer, 1987, Matioli *et al.*, 2002). Members of this genus are considered as predators of soft-bodied insects and mite pests (Fan & Zhang, 2005, Khanjani *et al.,* 2014) and known from different geographical regions of the world (Vacante & Gerson, 1988, Fan & Zhang, 2005).

Up to now, 31 valid species from the genus are known worldwide (Doğan *et al.*, 2015, Fan *et al.*, 2016). Previously, few regional keys have been made for the afrotropical species of the genus (Meyer, 1969, Ueckermann & Meyer, 1987, Van Dis & Ueckermann, 1993). A key to the all known *Eryngiopus* species was provided by Vacante & Gerson (1988).

The objectives of this study were to re-describe and illustrate *E. discus* Meyer, since the original description lacks complete details of the species (Meyer, 1969) which is the requirement of modern taxonomy, and to provide a key to the world species of *Eryngiopus*.

Materials and methods

Mite specimens were collected by shaking the plant foliage on a white paper with a fine tip camel hairbrush and preserved in 70% ethanol. Samples of soil and leaf debris were

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also collected from the field and were processed through Tullgren's funnels. The preserved specimens were then mounted on glass slides in Hoyer's medium under a stereomicroscope (SZX10, Olympus). The mounted specimens were dried in an oven at 40°C for one week. The specimens were identified under a phase contrast microscope (BX51, Olympus) with the help of literature and diagnostic keys. Different body parts were pictured using an Auto-Montage system (Syncroscopy, Cambridge) and illustrated with Adobe illustrator (Adobe Systems Incorporated). All measurements are given in micrometers (μm). Body width was measured at the broadest area and setae were measured from the setal base to the tip. Terminology and setal nomenclature follow those of Kethley (1990) and Grandjean (1944). All specimens have been deposited in the Acarology Research Laboratory, Department of Plant Protection, College of Food and Agriculture Science, King Saud University, Riyadh, Kingdom of Saudi Arabia.

Results and discussion

Family Stigmaeidae Oudemans

Genus: *Eryngiopus* Summers

Eryngiopus Summers, 1964: 186.
Type species: *Eryngiopus gracilis* Summers, 1964.

Diagnosis based on Fan & Zhang (2005).

In the present study, the species of genus *Eryngiopus* are categorized into two species groups based on the number of prodorsal setae (Table 1); 1) species group *bakeri* having three pairs of prodorsal setae (*vi, ve* and *sci*) including nine species reported from Turkey, Egypt, Yemen, Thailand, China, South Africa and USA; 2) species group *gracilis* having four pairs of prodorsal setae (*vi, ve, sci* and *sce*) comprising 22 species mostly reported from USA, New Zealand, Italy, South Africa, China, Russia, Uzbekistan, Iran, Pakistan and India (Doğan *et al.*, 2015, Fan *et al.*, 2016).

Number of prodorsal setae, either 3 pairs (*vi, ve, sci*) or four pairs (*vi, ve, sci, sce*) (Table 1), is strong and constant morphological character to categorize the species of *Eryngiopus* into two species groups. Vacante & Gerson (1988) used number of prodorsal setae (three/four) pairs as an important and basic character to develop a key to 17 world species of *Eryngiopus*. Also, Van Dis & Ueckermann (1993) separated the Afrotropical *Eryngiopus* species and used number of prodorsal setae (three/four) pairs as the first couplet in the key.

Species group *bakeri*

Eryngiopus discus Meyer

Eryngiopus discus Meyer, 1969: 232.

Re-description of adult female (n= 8) (Figures 1-4)

Idiosoma oval — Length of body (excluding gnathosoma) 370 – 378; length of gnathosoma 75 – 80; width of idiosoma 170 – 175 at the level of setae *c2*.

Gnathosoma (Figures 1C, 3) — Chelicerae separated; palp five segmented; palptibial claw subequal to palptarsus; palptarsus with tridentate terminal eupathidion distally, one solenidion, one eupathidion and four simple setae; palptibia with one well developed claw and one seta-like accessory claw, and two simple setae; palpgenua with one serrate seta; palpfemur with one simple and 2 serrated setae. Subcapitulum with 2 pairs of subcapitular setae (*m*, *n*) and two pairs of adoral setae (*or1*, *or2*). Length of subcapitular setae as follows: *m* 55 – 57, *n* 29 – 31, *or1* 12 – 14, *or2* 14 – 17; distances: *or1-or1* 6 – 8, *or2 -or2* 10 – 12, *or1-or2* 5 – 7, *m-m* 25 – 27, *n-n* 30 – 32, *or1-m* 37 – 40, *or2-n* 40 – 44, *or1-m* 35 – 38, *m-n* 6 – 7.

Table 1 Some morphological diagnostic characters of the species of the genus *Eryngiopus*.

Species	AG	TPS	PDS	Coxae	Troch	Femur	Genu	Tibiae	tarsus	*1a*	*3a*	*4a*	References
Species group *bakeri* (Three pairs of prodorsal setae; *vi, ve, sci*)													
anatolicus	3	-	U	2-1-2-1	1-1-1-1	6-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	22	24	17	Dogan *et al.,* 2015
bakeri	3	F	D	2-1-2-2	1-1-1-1	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-7	24	24	20	Vacante & Gerson, 1988
custodis	2	Tr	S	2-1-2-2	1-1-1-1	4-4-2-1	2-0-0-0	6-6-6-6	11-9-7-6	19	19	19	Van Dis & Ueckermann, 1993
discus	3	Tr	D	2-1-2-2	1-1-1-1	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	80	21	20	Meyer, 1969; Ueckermann & Meyer, 1987; present study
jiangxiensis	3	Sp	U	2-1-2-1	1-1-1-1	4-4-2-2	3-1-0-0	6-6-6-6	14-10-8-8	82	95	88	Hu & Chen, 1992
nanchangensis	3	-	U	2-1-2-1	1-1-1-1	4-4-2-2	3-1-0-0	6-6-6-6	14-9-8-7	80	60	17	Hu & Chen, 1994
woodi	3	F	D	2-1-2-2	1-1-1-1	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	103	37	30	Gomaa & El-Enany, 1985
yasumatsui	3	F	D	-	-	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	-	-	-	Ehara & Wongsiri, 1984
yemenensis	3	S	S	2-1-2-2	1-1-1-1	5-4-2-2	4-1-0-0	6-6-6-6	13-9-7-7	L	L	L	Van Dis & Ueckermann, 1993
Species group *gracilis* (Four pairs of prodorsal setae; *vi, ve, sci, sce*)													
affinis	3	Tr	U	2-1-2-1	1-1-1-1	6-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	25	28	21	Jafari *et al.,* 2014
arboreus	2	S	D	2-1-2-1	1-1-1-0	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	36	42	34	Vacante & Gerson, 1988; Fan & Zhang, 2005
audreae	3	S	D	2-1-2-1	1-1-1-0	4-4-2-2	3-1-0-0	6-6-6-6	14-9-7-7	59	62	17	Maake *et al.,* 2015
bidens	2	F	D	2-1-2-1	1-1-1-0	4-4-2-2	3-1-0-0	6-6-6-6	14-10-8-8	L	L	L	Meyer, 1969; Vacante & Gerson, 1988
bifidus	2	F	U	2-1-2-1	1-1-1-0	4-4-2-2	4-0-0-0	6-6-6-6	14-10-8-8	85	40	65	Vacante & Gerson, 1988; Fan & Zhang, 2005
cirrus	3	Tr	U	2-2-2-1	1-1-1-1	4-4-2-2	3-2-0-0	6-5-5-6	14-9-8-8	L	S	S	Chaudhri, 1979
coimbatorensis	3	S	D	-	-	3-3-2-2	1-1-1-1	-	-	-	-	-	Gupta & David, 1990
dicrotrichus	3	F	D	2-1-2-1	1-1-1-0	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	69	67	15	Fan *et al.,* 2000
gracilis	3	S	U	2-1-2-1	1-1-1-1	4-4-2-2	4-0-0-0	6-6-6-4	14-9-7-7	20	34	27	Summers, 1964; Vacante & Gerson, 1988
hamedanicus	3	S	D	2-1-2-1	1-1-1-1	6-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	28	28	22	Khanjani *et al.,* 2014
hortus	3	-	S	2-2-2-2	1-1-1-1	4-4-2-2	3-1-0-0	5-6-5-5	11-8-7-7	L	S	S	Chaudhri, 1979
langroudiensis	3	S	S	2-1-2-1	1-1-1-1	3-3-2-2	3-0-0-0	6-6-6-6	12-10-8-8	60	44	40	Khanjani *et al.,* 2014
lindei	3	F	D	2-1-2-1	-	4-4-2-2	3-1-0-0	6-6-6-6	14-10-8-8	L	L	L	Meyer, 1969; Vacante & Gerson, 1988
microsetus	2	S	D	2-1-2-1	1-1-1-0	4-4-2-2	4-0-0-0	6-6-6-6	14-10-8-8	72	40	45	Summers, 1964; Vacante & Gerson, 1988
nelsonensis	3	S	U	2-1-2-1	1-1-1-1	5-4-2-2	4-2-0-0	6-6-6-6	14-9-7-7	18	37	18	Vacante & Gerson, 1988; Fan & Zhang, 2005
parsimilis	2	F	S	2-1-2-1	1-1-1-0	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	25	25	32	Ueckermann & Smith-Meyer, 1987
placidus	3	F	D	2-1-2-1	1-1-1-0	4-4-2-2	4-0-0-0	6-6-6-6	14-10-8-8	70	60	40	Kuznetzov, 1977
siculus	3	F	D	2-1-2-1	1-1-1-0	4-4-2-2	4-0-0-0	6-6-6-6	14-10-8-8	86	80	45	Vacante & Gerson, 1988
similis	2	F	D	2-1-2-1	1-1-1-0	4-4-2-2	4-1-0-0	6-6-6-6	14-10-8-8	24	24	30	Vacante & Gerson, 1988; Fan & Zhang, 2005
summersi	3	F	U	2-1-2-1	1-1-1-1	4-4-2-2	4-1-0-0	6-6-6-6	14-9-8-8	75	70	80	Vacante & Gerson, 1988
tauricus	3	S	D	1-1-2-1	1-1-1-1	4-4-2-2	4-1-0-0	6-6-6-6	14-9-8-8	28	30	25	Vacante & Gerson, 1988; Kuznetzov, 1978
vagantis	3	S	U	1-1-2-1	1-1-1-1	5-4-3-2	4-1-0-0	6-6-6-6	14-9-8-8	30	80	64	Summers, 1964; Vacante & Gerson, 1988

AG, Aggenital setae; TPS, shape of terminal palpal sensillum either F (forked), S (simple), Tr (tri dentate) or Sp (spine like); PDS, Propodosomal dorsal shields either D (divided), U (undivided) or S (striated); PRS, Propodosoma with either three or four pairs of setae. Setal count on leg segments includes solenidia and micro setae.

Dorsum (Figures 1A, 2A-B) — Prodorsal shield divided medially by striations, bearing three pairs of setae (*vi, ve*, *sci*), setae *sce* absent, eyes present, 8 – 11 μm, post ocular bodies (*pob*) absent; hysterosomal striations with micro tubercles (Fig.1B), longitudinal between setae *c1* and *e1*, and transverse posterior to *e1*. Setae *f1* situated on small platelets. Suranal shield divided into three feebly developed plates bearing setae *h1* and *h2*; setae *h1* share larger median plate; setae *h2* on smaller lateral plates. Hysterosoma bears eight pairs of setae. Dorsal idiosomal setae slender, slightly barbed and tapering towards end. Length of dorsal setae as follows: *vi* 20 – 23, *ve* 28 – 32, *sci* 18 – 21, *c1* 12 – 14, *c2* 23 – 25, *d1* 11 – 14, *d2* 12 – 14, *e1* 17 – 20, *e2* 14 – 17, *f1* 19 – 22, *h1* 27 – 31, *h2* 31 – 35. Distances between dorsal setae: *vi-vi* 25 – 27, *ve-ve* 48-53, *vi-ve* 19 – 21, *sci-sci* 77 – 83, *ve-sci* 31 – 34, *c1-c1* 62 – 66, *c1-c2* 68 – 71, *c2-c2* 124 – 127, *c1-d1* 73 – 75, *d1-d1* 93 – 97, *d1-d2* 41 – 43, *d1-e1* 44 – 48, *d1-e2* 26 – 30, *d2-e2* 50 – 55, *d2-d2* 133 – 138, *e1-e1* 41 – 44, *e2-e2* 51 – 55, *e1-e2* 45 – 48, *e1-f1* 35 – 38, *f1-f1* 76 – 81, *f-h1* 41 – 46, *h1-h1* 31 – 25, *f1-h2* 42 – 45, *h2-h2* 75 – 80, *h1-h2* 29 – 32; ratios: *vi/vi-vi* 0.76, *c1/c1-c1* 0.2, *d1/d1-d1* 0.12, *e1/e1-e1* 0.41, *f1/f1-f1* 0.26, *h1/h1-h1* 1.27, *h2/h2-h2* 1.10, *h1/h2* 0.88.

Venter (Figure 1C, 2C) — The first pair of intercoxal setae *1a* ultra long and reaches to the bases of subcapitular setae *m*. The latter intercoxal setae *3a* and *4a* much shorter than first pair of intercoxals. Lengths of setae; *1a* 80 – 86, *1b* 16 – 18, *1c* 13 – 14, *2c* 15 – 17, *3a* 21 – 23,

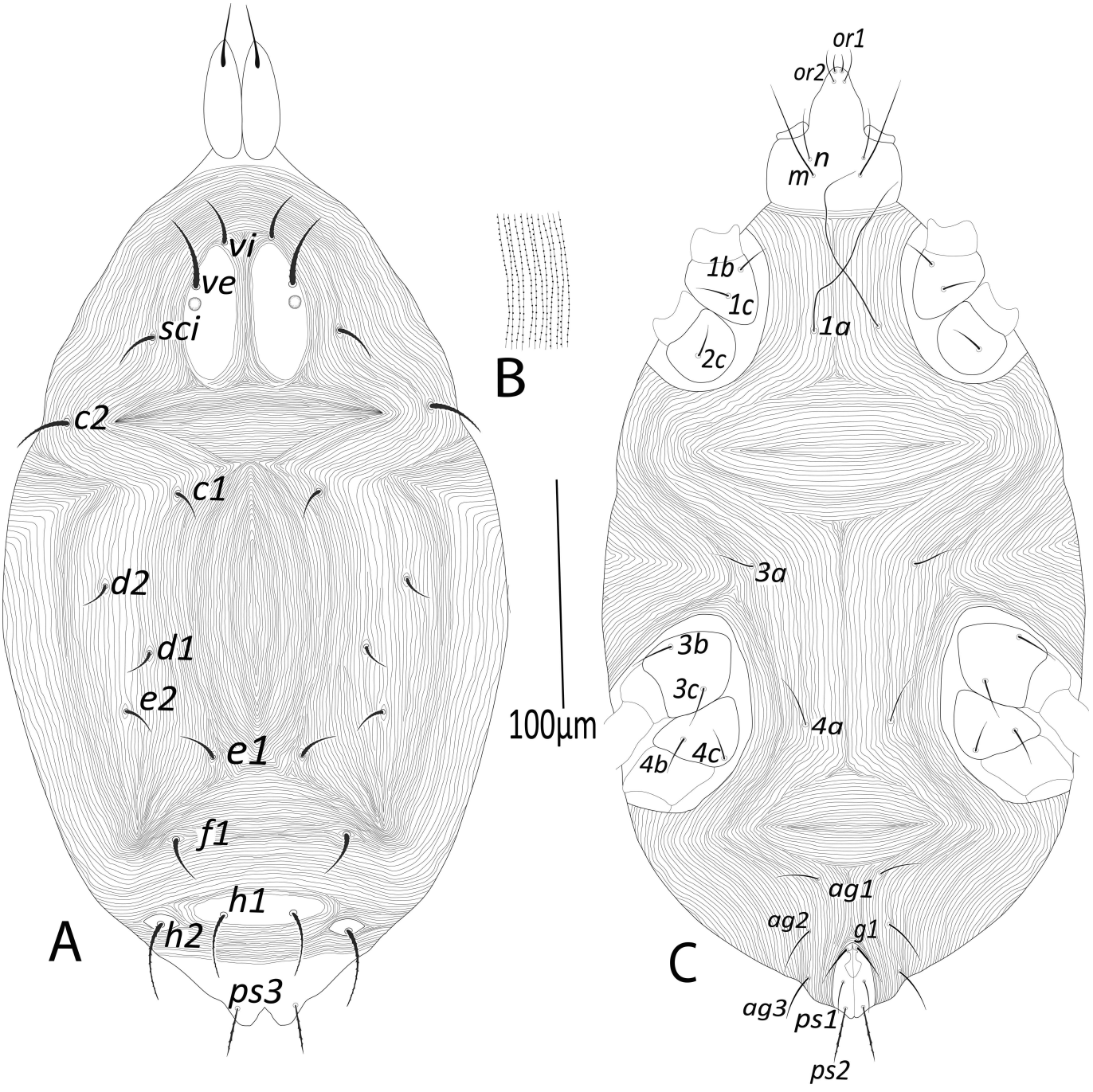


Figure 1 *Eryngiopus discus* Meyer, adult female: A – Dorsal view of idiosoma; B – Micro tubercles on dorsal striations; C – Ventral view of idiosoma.

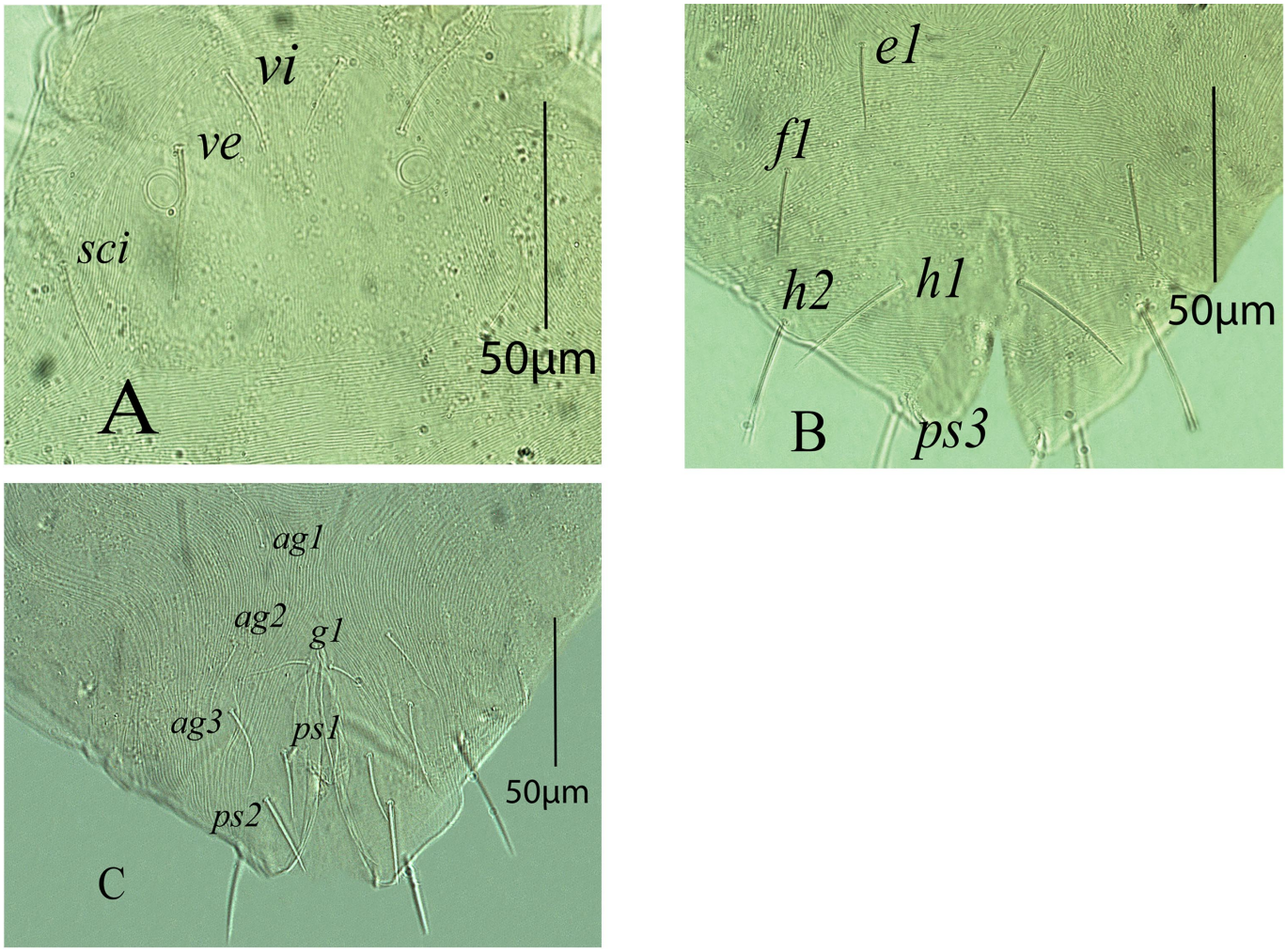


Figure 2 *Eryngiopus discus* Meyer, adult female: A – Prodorsum; B – Opisthosoma; C – Genital region.

3b 20 – 22, *3c* 17 – 20, *4a* 20 – 23, *4b* 17 – 20 and *4c* 15 – 17, aggenital setae three pairs: *ag1* 16 – 17, *ag2* 23 – 25, *ag3* 19 – 20, ano-genital area with one genital setae, *g* and three pairs of pseudanal setae (*ps1-3*): *g* 16 – 18, *ps1* 19 – 22, *ps2* 23 – 25, ps_3 24 – 27. Distances between setae: *1a-1a* 26 – 28, *3a-3a* 56 – 58, *4a- 4a* 35 – 37, *ag1-ag1* 26 – 28, *ag2-ag2* 38 – 40, *ag3-ag3* 49 – 52, *ag1-ag2* 20 – 21, *ag2-ag3* 20 – 21, *ps1-ps1* 32 – 34, *ps2-ps2* 35 – 38, *ps3-ps3* 20 – 21; *g1-g1* 6 – 7.

Legs (Figure 4) — Length of legs I-IV, (tarsal claws to coxal bases): 188-192, 154 – 159, 148 – 155, 153 – 159 respectively. Empodial shaft branches up into 2 pairs of tenent hairs before pass beyond tips of claws. Number of setae on leg segments as fellows: coxae 2-1-2-2; trochanters 1-1-1-1; femora 4-4-2-2; genua 3+1κ-1-0-0; tibiae 5+1φ-5+1φ-5+1φ-5+1φ; tarsi 13+1ω-9+1ω-7+1ω-7+1ω.

Male and immature stages — unknown

Material examined — Five females, *Euryops arabicus* (Asteraceae), Taif, 21.19385°N, 040.25704°E, October 11, 2016, coll. M. Ur Rehman, Muhammad Kamran; three females, foxtail grass *Cenchrus* sp. (Poaceae), Makkah to Taif road, Taif, 21.36528°N, 040.15897°E, 2015, coll. J.H. Mirza, M. Kamran.

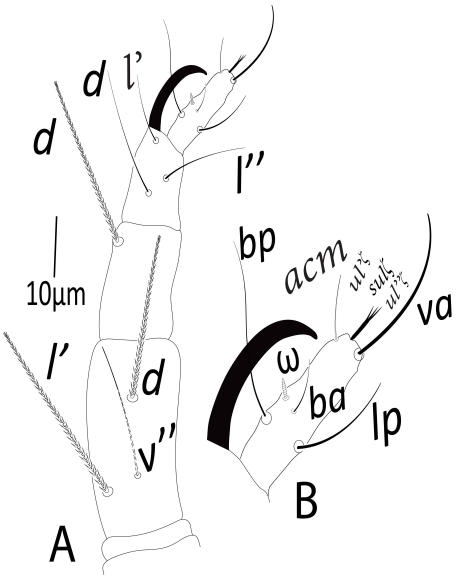


Figure 3 *Eryngiopus discus* Meyer, adult female: A – Palp; B – Palptibial claw & palptarsus (not scaled).

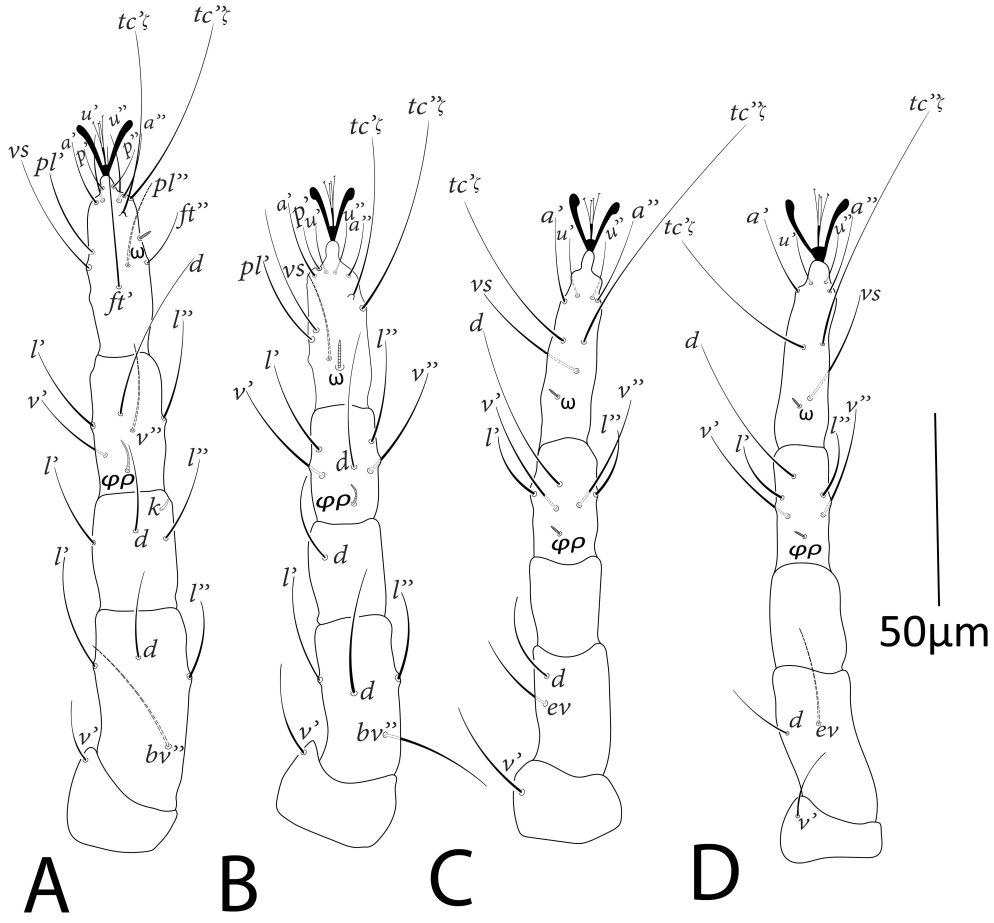


Figure 4 *Eryngiopus discus* Meyer, adult female: A – Leg I; B – Leg II; C – Leg III; D – Leg IV.

Ecological note — The mite color was red-orange when collected. The species *Eryngiopus discus* was collected from foxtail grass *Cenchrus* sp. in association with date palm mite *Oligonychus afrasiaticus* (McGregor).

Key to the world species of the genus *Eryngiopus* Summers After Vacante & Gerson (1988)

Note — This key is based on the descriptions available in literature and few assumptions depending upon quality of illustrations.

1. Propodosoma with three pairs of setae (*vi,ve, sci*), prodorsal setae *sce* absent ..... species group *bakeri* 2
— Propodosoma with four pairs of setae (*vi, ve, sci, sce*), prodorsal setae *sce* present ..... species group *gracilis* 10

2. Aggenital setae two pairs ..... *E. custodis* van Dis & Ueckermann
— Aggenital setae three pairs 3

3. Genu I with three setae 4
— Genu I with four setae 5

4. Tarsi II with 10 setae, ventral setae *3a* long = 88 ..... *E. jiangxiensis* Hu & Chen
— Tarsi II with 9 setae, ventral setae *3a* short = 17 ..... *E. nanchangensis* Hu & Chen

5. Femur I with five or six setae 6
— Femur I with four setae 7

6. Coxae IV with one seta, tarsi I with 14 setae ..... *E. anatolicus* Doğan, Dilkaraoğlu & Fan
— Coxae IV with two setae, tarsi I with 14 setae ..... *E. yemenensis* van Dis & Ueckermann

7. Suranal shield entire (undivided) 8
— Suranal shield divided in to three feebly developed plates 9

8. Ventral setae *1a* very short (24), tarsi IV with seven setae ..... *E. bakeri* (McGregor)
— Ventral setae *1a* ultra long (103), tarsi IV with eight setae .... *E. woodi* Gomaa & El-Enany

9. Setae *d1* less widely spaced *d1*¬-*d1* = 80, dorsal striations simple, aggenital setae (*ag2*) shorter 14 ..... *E. yasumatsui* Ehara & Wongsiri
— Setae *d1* more widely spaced *d1*¬-*d1* = 94-97, dorsal striations with micro tubercles, aggenital setae (*ag2*) longer 23 ..... *E. discus* Meyer

10. Aggenital setae two pairs 11
— Aggenital setae three pairs 16

11. Genu I with three setae ..... *E. bidens* Meyer
— Genu I with four setae 12

12. Genu II without setae, intercoxal setae *1a* ≥ 70 13
— Genu II with one setae, intercoxal setae *1a* < 40 14

13. Prodorsal shield entire, terminal sensillum on palptarsus forked ..... *E. bifidus* Wood
— Prodorsal shield divided, terminal sensillum on palptarsus simple .. *E. microsetus* Summers

14. Prodorsal shield completely striated . . . . . *E. parsimilis* Ueckermann & Meyer
— Prodorsal shield divided medially 15

15. Ventral setae *3a* long = 42, terminal sensillum on palptarsus simple . . . . *E. arboreus* Wood
— Ventral setae *3a* short = 24, terminal sensillum on palptarsus forked . . . . . *E. similis* Wood

16. Femur I with 5 or 6 setae 17
— Femur I with 3 or 4 setae 20

17. Genu II with one seta, tarsi III and IV each with 8 setae 18
— Genu II with 2 setae, tarsi III and IV each with 7 setae . . . . . *E. nelsonensis* Wood

18. Coxae I with one seta, femur III with 3 setae . . . . . *E. vagantis* Summers
— Coxae I with 2 setae, femur III with 2 setae 19

19. Terminal sensillum on palptarsus simple, prodorsal shield divided medially . . . . . *E. hamedanicus* Khanjani, Mohammadi & Nazari
— Terminal palpal sensillum tridentate, prodorsal shield entire . . . . . *E. affinis* Barilo

20. Femur I with 3 setae 21
— Femur I with 4 setae 22

21. Genu setal formula 1-1-1-1, ratio *vi/vi-vi* = 0.18 . . . . . *E. coimbatorensis* Gupta & David
— Genu setal formula 3-0-0-0, ratio *vi/vi-vi* = 1.3 . . . . . *E. langroudiensis* Khanjani, Hazjizadeh & Ueckermann

22. Genu I with 3 setae 23
— Genu I with 4 setae 26

23. Coxae II with 2 setae 24
— Coxae II with 1 seta 25

24. Coxae IV with 2 setae, tarsi I with 11 setae . . . . . *E. hortus* (Chaudhri)
— Coxae IV with one seta, tarsi I with 14 setae . . . . . *E. cirrus* (Chaudhri)

25. Tarsi II with 9 setae, terminal palpal sensillum simple, first pair of intercoxal setae *1a* large (>60) . . . . . *E. audreae* Maake, Ueckermann & Childers
— Tarsi II with 10 setae, terminal palpal sensillum forked, first pair of intercoxal setae *1a* shorter . . . . . *E. lindei* Meyer

26. Trochanter IV with one seta 27
— Trochanter IV without setae 29

27. Coxae I with one seta, prodorsal shield divided medially . . . . . *E. tauricus* Kuznetsov
— Coxae I with 2 setae, prodorsal shield entire 28

28. Tibia IV with 4 setae, tarsi III and IV with 7 setae . . . . . *E. gracilis* Summers
— Tibia IV with 6 setae, tarsi III and IV with 8 setae . . . . . *E. summersi* Vacante & Gerson

29. Genu II with one seta . . . . . *E. dicrotrichus* Fan, Zhang & Liu
— Genu II without setae 30

30. Suranal shield bearing two pairs of setae (*h1, h2*), propodosomal striations divergent beyond shields ..... *E. placidus* Kuznetsov
— Suranal shield with one pair of setae (*h1*), Propodosomal striations convergent beyond shields ..... *E. siculus* Vacante & Gerson

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