

1-1-2010

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AKYOL, MUSTAFA and KOÇ, KAMİL (2010) "Contributions to the raphignathoid fauna of Turkey,with a description of a new species of Cryptognathus Kramer (Acari: Actinedida: Raphignathoidea)," *Turkish Journal of Zoology*. Vol. 34: No. 2, Article 4. <https://doi.org/10.3906/zoo-0811-5>
Available at: <https://journals.tubitak.gov.tr/zoology/vol34/iss2/4>

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Contributions to the raphignathoid fauna of Turkey, with a description of a new species of *Cryptognathus* Kramer (Acari: Actinedida: Raphignathoidea)*

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Received: 04.11.2008

Abstract: A new species, *Cryptognathus ayyildizi* sp. nov. is described and illustrated. *Raphignathus bathursti* Meyer and Ryke, 1960 (Raphignathidae), and *Cheyllostigmaeus californicus* Summers and Ehara, 1965 (Stigmaeidae) are redescribed, and are new records for the Turkish fauna. Their worldwide distribution is also given.

Key words: Acari, Actinedida, *Raphignathus*, *Cryptognathus*, *Cheyllostigmaeus*, new species, new records, Turkey

Türkiye'den *Cryptognathus* Kramer cinsine ait yeni bir türün tanımı ile rafignatoid akar (Acari: Actinedida; Raphignathoidea) faunasına katkılar

Özet: Bu çalışmada, bilim dünyası için yeni olan *Cryptognathus ayyildizi* sp. nov. türünün tanımı ile Türkiye faunası için yeni kayıt olarak tespit edilen *Raphignathus bathursti* Meyer ve Ryke, 1960 (Raphignathidae) ve *Cheyllostigmaeus californicus* Summers ve Ehara, 1965 (Stigmaeidae)'in yapısal özellikleri ve dünyadaki yayılışları verilmiştir.

Anahtar sözcükler: Acari, Actinedida, *Raphignathus*, *Cryptognathus*, *Cheyllostigmaeus*, yeni tür, yeni kayıtlar, Türkiye

Introduction

Raphignathoidea (Acari: Actinedida) is composed of several families of predatory and herbivorous mites that are very common in soil, and on moss and foliage. The Stigmaeidae are the most ecologically diverse, acting as predators in leaf litter and on trees, and as herbivores on moss. Cryptognathidae and Raphignathidae are frequently encountered in dry soil, but also occur in litter and soil, and on moss, lichens, tree bark, and plants (Meyer and Ueckermann, 1989).

Members of Cryptognathidae Oudemans are microphytophages (Swift, 1996; Swift and Goff, 2001). Their mouthparts are often highly extrudable, so that they may selectively feed on fungal spores (Luxton, 1973). These mites live in large numbers on moss and moss-covered substrates. To date, *Cryptognathus* Kramer comprises 18 species worldwide and 3 of these species are known from Turkey (*C. lagena* Kramer, *C. luteolus* Summers & Chaudhri, and *C. ozkani* Doğan & Ayyildiz) (Doğan, 2008).

* This paper is based partly on the PhD thesis of M. Akyol, supervised by K. Koç.

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Species of *Cheylostigmaeus* are fairly robust mites that are presumed to be effective predators (Koç, 2005). Currently, only 1 species of this genus is known from Turkey (*C. salmani* Koc) (Koç, 2005). Members of Raphignathidae are predaceous. They are found on tree barks, litter, and moss, and in soil, stored products, house dust, and bird's nests. Raphignathidae are represented by 16 species in Turkey (Doğan, 2008). Herein *Cryptognathus ayyildizi* sp. nov. is described and illustrated from Turkey. In addition, supplementary descriptions of 2 known species, which are new records for the Turkish fauna, are given and their distribution worldwide is given. In the descriptions that follow all measurements are given in micrometers (μm) and are displayed as follows: A (B-C) (A: holotype or drawn specimen; B: minimum and C: maximum of other specimens). Morphological terminology follows that of Kethley (1990) and Grandjean (1944).

Materials and methods

Litter and soil samples collected from under *Astragalus* sp., *Populus* sp., *Juniperus oxicedrus*, *Juniperus* sp., *Quercus* sp., *Prunus* sp., *Cerasus vulgaris*, *Pinus brutia*, and *Phragmites australis*, and samples collected from moss on rocks and soil in a mole's nest in Afyonkarahisar province were brought to the laboratory in plastic bags. The mites were extracted in Berlese funnels and preserved in 75% ethanol. The mites were removed from the samples under a stereomicroscope and mounted on slides in Hoyer's medium.

Type materials and all other specimens are deposited in the Zoological Museum of Celal Bayar University, Manisa, Turkey.

Results and discussion

Taxonomy

Cryptognathus Kramer, 1879

Type species: *Cryptognathus lagena* Kramer, 1879.

This genus is characterized by a transparent, crescent-shaped prosternal apron anterior of the ventral plate and 3 pairs of aggenital setae.

Cryptognathus ayyildizi sp. nov.

Female (Figure 1)

Body length (including gnathosoma) (minimum and maximum measurements in parentheses) 296 (291-312), width 182 (182-187) ($n = 10$).

Gnathosoma

Gnathosoma extrudable from under the hood. Length of palp 91 (88-104), length of chelicerae 91 (83-104). Subcapitulum with a pair of long setae ($m = 16$) and 2 pairs of pilose adoral setae (ad_{1-2}). Palp setal formula (from femur to tarsus): 3-2-3+1 claw, 4+1 ω +4 eupathidia.

Dorsum

Anterior margin of the hood is 6 notched with two groups. Length of hood 44 (44-52), 5 dimples in each longitudinal row, dorsal shield with 11 pairs of simple setae, 1 pair of simple eyes and 1 pair of postocular bodies laterally between setae *sci* and *sce*. Dorsal shield porous, reticulate, without striate ornamentation. Polygonal cells mostly longer than wide; 19-27 pores are present in the center of each foveolum. Dorsal and ventral shields with different ornamentation. Dimensions of dorsal setae are as follow: $vi = 18$, $sci = ve = sce = d_1 = e_2 = 26$, $c_1 = e_1 = f_1 = h_1 = 23$, $h_2 = 21$; distances between setae: $vi-vi = 34$, $vi-ve = 13$, $sci-sci = 60$, $sci-c_1 = 31$, $ve-sci = 13$, $ve-ve = 42$, $sce-sce = 104$, $sce-c_1 = 26$, $c_1-c_1 = 68$, $c_1-d_1 = 39$, $d_1-d_1 = 91$, $d_1-e_1 = 52$, $e_1-e_1 = 68$, $e_1-e_2 = 18$, $e_2-e_2 = 96$, $e_1-f_1 = 52$, $f_1-f_1 = 36$, $f_1-h_1 = 29$, $h_1-h_1 = 21$, $h_1-h_2 = 23$, $h_2-h_2 = 60$.

Venter

The venter is not reticulated, but is completely covered with pores. Sternocoxal area with faint longitudinal striation. Prosternal apron hyaline, front margin deeply concave. There are 6 pairs of setae (*1a*, *3a*, *4a*, *4c*, *ag₁*, and *ag₂*); 3 pairs of genital setae (*g₁₋₃*) set adjacent to the genital valves; 2 pairs of aggenital setae (*ag₁₋₂*); anal opening terminal, with 3 pairs of pseudanal setae (*ps₁₋₃*).

Legs

Length of legs I-IV (from base of femur to tip of tarsal claw): 182, 135, 135, 172, respectively. Setal formulae of legs I-IV: coxae 2-1-2-1, trochanters 1-1-2-1, femora 4-3-2-2, genua 5(+*k*)-4(+*k*)-2-3, tibiae 5(+ $\phi\rho$, + ω)-5(+ $\phi\rho$)-4(+ $\phi\rho$)-3, tarsi 13(+ $\phi\rho$, + ω)-11(+ $\phi\rho$, + ω)-9(+ ω)- 9(+ ω). Setae *tc* on tarsi II dissimilar.

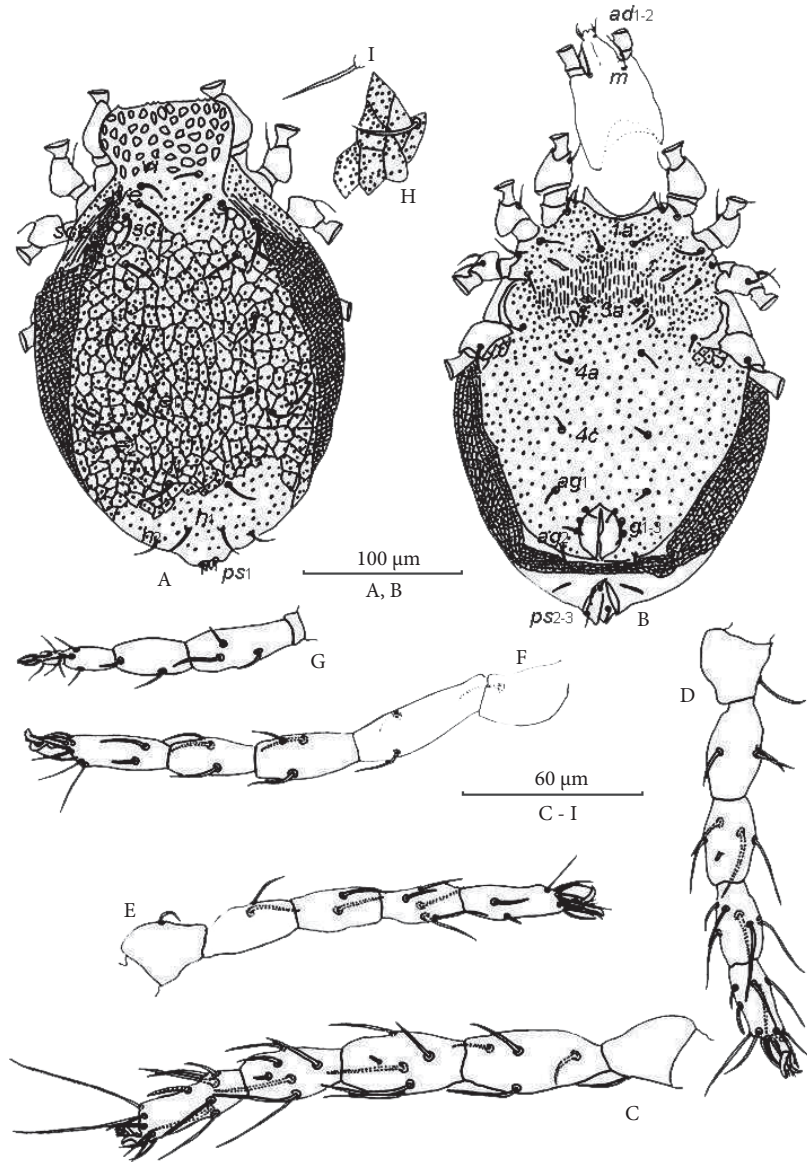


Figure 1. *Cryptognathus ayyildizi* sp. nov. (female). (A) Dorsal view, (B) ventral view, (C) leg I, (D) leg II, (E) leg III, (F) leg IV, (G) palpus, (H) Dorsal ornamentation and seta e_1 , and (I) seta c_1 .

Material examined

One ♀ from litter under *Quercus* sp., Afyonkarahisar, Çakırköy town, Kestanelik, 1150 m, 21.09.2004; 2 ♀♀ from litter under *Populus* sp., Sultandağ district, Taşköprü, 970 m, 16.11.2004; 1 ♀ from litter under *Astragalus* sp., Bolvadin district, B. Karabağ town, Kayadanağıl, 1150 m, 14.03.2005; 2 ♀♀ from litter under *Astragalus* sp., Çay district, Çayderesi, Sultandağ mountains, 1100 m, 15.03.2005; 1 ♀ from litter under *Astragalus* sp.,

Bolvadin district, B. Karabağ town, Çeşme, Emirdağı mountains, 1280 m, 24.04.2005; 1 ♀ from litter under *Quercus* sp., Dinar district, border of Denizli province, Akdağ mountains, 850 m, 19.05.2005; 1 ♀ from litter under *Juniperus* sp., Hocalar district, Devlethan village, 1080 m, 22.04.2006; 1 ♀ from litter under *Astragalus* sp., Bolvadin district, B. Karabağ town, Kocataş, Emirdağı mountains, 1400 m, 23.04.2006; Afyonkarahisar, Turkey, coll. M. Akyol.

Remarks

Cryptognathus ayyildizi resembles *C. summersi* Robaux, but in the new species trochanter III has 2 setae, femur I has 4 setae, tibiae III has 5 setae, and tarsi II has 11 (+φρ, +ω) setae; all tarsi have a solenidion (ω) and no reticulation on the venter. In *Cryptognathus summersi*, trochanter III has 1 setae, femur I has 3 setae, tibiae III has 4 setae, and tarsi II has 9 (+φρ, +ω) setae; tarsi I and II have a solenidion (ω), partly reticulate on the venter (Robaux, 1975). Body size of *C. summersi* (length/width) is 230/145 (Robaux, 1975), while the Turkish specimens of the new species are larger 296 (291-312)/182 (182-187).

***Raphignathus* Dugés, 1834**

Type species: *Raphignathus ruberrimus* Dugés, 1834.

Cheliceral bases fused to form a conical stylophore; peritremes arising from mid-basal part of the stylophore, projecting to the anterior margin of the idiosoma. Palptibial claw small, subcapitulum with 2 pairs of setae and 2 pairs of adoral setae, podosoma with 3 shields, opisthosoma with a large shield, dorsum with 11-12 pairs of setae, 1 pair of eyes on the lateral podosomal shields, and 2 pairs of aggenital setae. Genital and anal shields each with 3 pairs of setae.

***Raphignathus bathursti* Meyer & Ryke, 1960**

Female (Figure 2)

Body length (including gnathosoma) (minimum and maximum measurements in parentheses) 442 (442-504), width 234 (234-296) (n = 8).

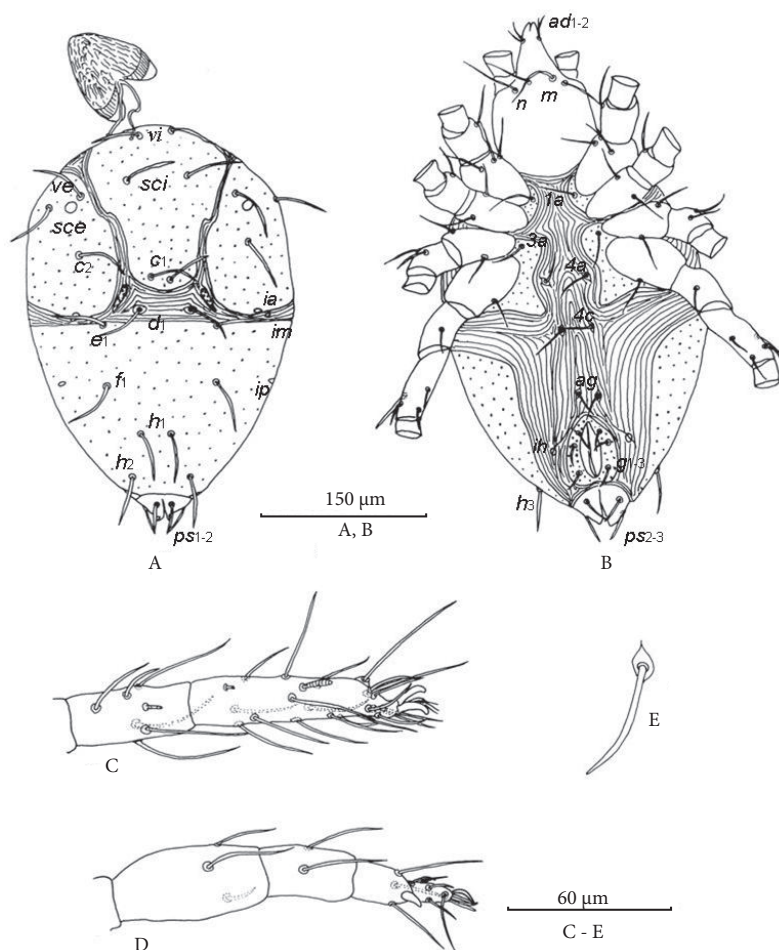


Figure 2. *Raphignathus bathursti* (female). (A) Dorsal view, (B) ventral view, (C) leg I tibia and tarsus, (D) palpus, and (E) seta d_1 .

Gnathosoma

Length of gnathosoma 83. Subcapitulum with 2 pairs of long setae ($n = m = 52$) and 2 pairs of pilose adoral setae ($ad_{1,2}$). Dorsum of stylophore striate. Palp setal formula (from femur to tarsus): 3-2-3 + 1 claw, 4 + 1ω + 4 eupathidia.

Dorsum

Propodosoma with 1 median and 2 lateral shields separated by striae; propodosoma with 1 pair of small shields behind the median propodosomal shield. Opisthosoma with a large shield; the latter shield and platelets with remnants of the groove *dsj*. One pair of setae (d_1) located on small plates and 1 pair of lyrifissures (*im*) located on the interscutal membrane. Dorsal body setae linear-lanceolate and smooth; median shield bearing 3 pairs of setae (*vi*, *sci*, c_1). Each lateral shield ovoid with 3 pairs of setae (*ve*, *sce*, c_2), 1 pair of eyes, and 1 pair of lyrifissures (*ia*). There are 5 pairs of setae (e_1, f_1, h_1, h_2, h_3) and 1 pair of lyrifissures (*ip*) on the opisthosomal shield. Setae e_1 on anterior margin of opisthosomal shield; setae h_3 situated on ventral extension of opisthosomal shield. Lyrifissure (*ip*) lateral or anterolateral of f_1 . All dorsal shields punctuated, but not striated; body surface striated between the propodosomal and opisthosomal shields. Dimensions of dorsal setae are as follows: $vi = 44$, $sci = 49$, $ve = 44$, $sce = 44$, $c_1 = 42$, $c_2 = 44$, $d_1 = 42$, $e_1 = 44$, $f_1 = 47$, $h_1 = 39$, $h_2 = 39$, $h_3 = 31$; distances between setae: $vi-vi = 27$, $vi-sci = 42$, $sci-sci = 60$, $ve-sci = 42$, $ve-ve = 140$, $ve-sce = 31$, $sce-sce = 177$, $sce-c_1 = 109$, $c_1-c_1 = 13$, $c_1-c_2 = 78$, $c_2-c_2 = 164$, $c_2-d_1 = 83$, $c_1-d_1 = 37$, $d_1-d_1 = 39$, $d_1-e_1 = 39$, $e_1-e_1 = 104$, $e_1-f_1 = 55$, $f_1-f_1 = 104$, $f_1-h_1 = 49$, $h_1-h_1 = 26$, $h_1-h_2 = 26$, $h_2-h_2 = 52$, $h_3-h_3 = 83$.

Venter

Setae $1a = 39$ near coxa I. Coxae III and IV flanked by coxisternal shields with setae $3a = 31$. Venter striated and with 3 pairs of setae. Setae $4a = 31$ set on membrane between coxae IV. Setae $4c = 26$ set on membrane between setae $4a$ and *ag*. Anogenital area with 1 pair of aggenital setae ($ag = 26$) and 3 pairs of genital setae ($g_1 = g_2 = g_3 = 23$). One pair of lyrifissures (*ih*) located lateral to genital shield. Anal shield with 3 pairs of setae ($ps_1 = ps_2 = ps_3 = 26$). All ventral shields punctuated.

Legs

Length of legs I-IV (from base of femur to tip of tarsal claw): 218, 187, 192, 234, respectively. Setal formulae of legs I-IV: coxae 2(3)-2-2-1, trochanters 1-1-2-1, femora 6-6-4-4, genua 6(*k*)-6(*k*)-4-4, tibiae 7($\varphi\rho$, ω)-6($\varphi\rho$)-6($\varphi\rho$)-5($\varphi\rho$), and tarsi 21($\varphi\rho$, ω)-16(ω)-14(ω)-14(ω).

Material examined

Eight ♀♀ from moss samples on rock, Iscehisar district, Çatalağıl village, 1350 m, 19.05.2006; Afyonkarahisar, Turkey, coll. M. Akyol.

Remarks

Type species with 1 pair of small oval shields behind the median propodosomal shield; dorsal setae e_1 do not reach anterior margin of opisthosomal shield in type species (Meyer and Ryke, 1960). Turkish specimens with long and narrow small shields behind the median propodosomal shield; dorsal setae e_1 reach the anterior margin of the opisthosomal shield. In Turkish specimens, 1 female with 3 setae on right coxa I.

Distribution: Bathurst, Cape Province, South Africa (Meyer and Ryke, 1960).

Cheylostigmaeus Willmann, 1951

Type species: *Cheylostigmaeus grandiceps* Willmann, 1951.

Dorsum of idiosoma mainly covered with 2 large shields (prodorsal and opisthosomal). Chelicerae basally fused. Suranal shield ventro-terminal; dorsal shields have 13 pairs of setae.

Cheylostigmaeus californicus Summers & Ehara, 1965

Female (Figure 3)

Body length (including gnathosoma) (minimum and maximum measurements in parentheses) 504 (416-510), width 276 (250-296) ($n = 13$).

Gnathosoma

Length of gnathosoma 114 (78-114). Subcapitulum with 2 pairs of long setae $n = 26$ (18-31) and $m = 31$ (18-36), and 2 pairs of pilose adoral setae ($ad_{1,2}$). Anterior subcapitular setae m inserted on rostrum near baseline of ridge. Length of

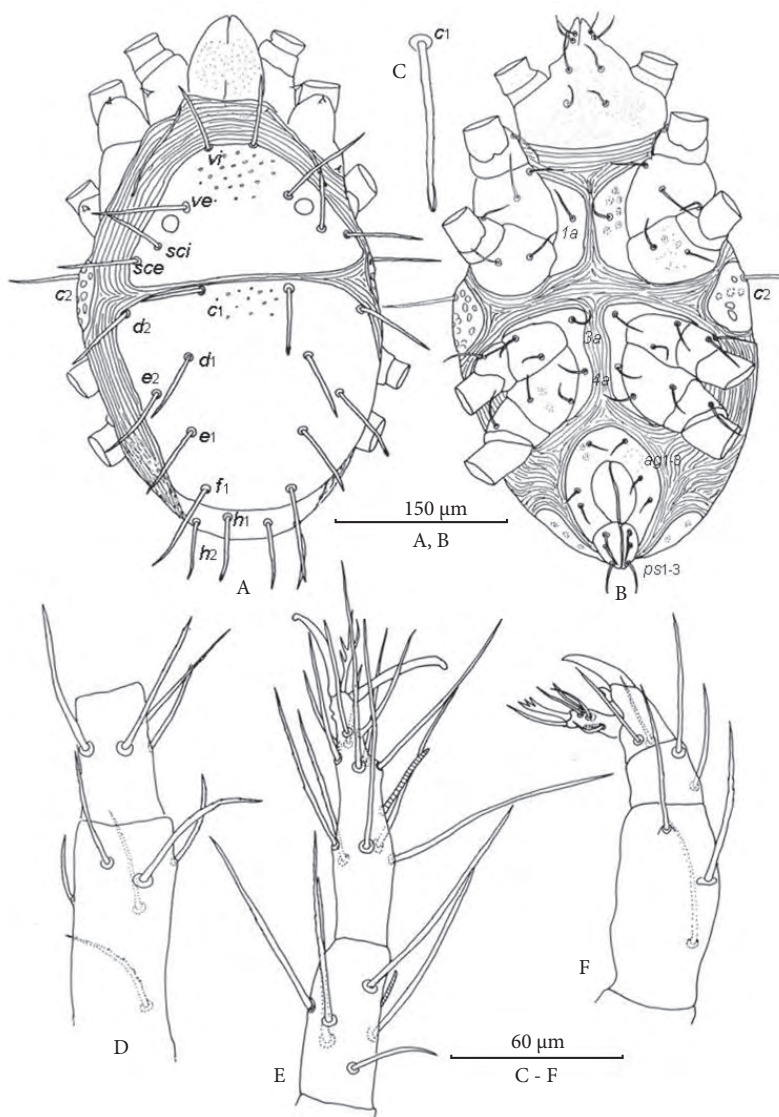


Figure 3. *Cheylostigmaeus californicus* (female). (A) Dorsal view, (B) ventral view, (C) seta c_1 , (D) leg I femur and genu, (E) leg I tibia and tarsus, and (F) palpus.

chelicerae 42, length of palp 99. Palp setal formula (from femur to tarsus): 3-2-2 + 1 claw + 1 accessory claw - 5 + 1 ω + 1 tridentate eupathidium.

Dorsum

Dorsal shields punctated. Prodorsal shield bears 4 pairs of setae (vi , ve , sci , sce) and 1 pair of eyes between setae ve and sci . Six pairs of setae (c_1 , d_1 , d_2 , e_1 , e_2 , f_1) occur on the opisthosomal shield and 2 pairs of setae (h_1 , h_2) on the suranal shield. Humeral shield ventro-laterally and with 1 pair of setae (c_2). All dorsal

body setae similar in form, each with minute spinules and a hyaline sheath that does not extend distally beyond the apex of the setal shaft (Figure 3C). Dimensions of dorsal setae are as follows: vi = 60 (55-60), ve = 88 (75-91), sci = 55 (52-62), sce = 70 (62-73), c_1 = 60 (52-60), c_2 = 65 (60-65), d_1 = 65 (57-65), d_2 = 65 (62-70), e_1 = 68 (57-68), e_2 = 70 (62-70), f_1 = 81 (73-83), h_1 = 55 (55-62), h_2 = 52 (52-57); distances between setae: $vi-vi$ = 39 (39), $vi-ve$ = 52 (52-60), $ve-ve$ = 91 (91-99), $ve-sci$ = 39 (27-39), $sci-sci$ = 146 (144-156), $sci-sce$ = 23 (21-26), $sce-sce$ = 190 (190-208), $sce-c_1$ =

62 (60-62), $c_1-c_1 = 78$ (78-88), $c_1-d_1 = 60$ (60-65), $c_2-c_2 = 265$ (265-278), $d_1-d_1 = 107$ (107-120), $d_1-d_2 = 65$ (57-65), $d_2-d_2 = 208$ (208-242), $d_1-e_1 = 68$ (65-73), $e_1-e_1 = 101$ (101-109), $e_1-e_2 = 44$ (44-52), $e_1-f_1 = 52$ (52-57), $f_1-f_1 = 78$ (78-81), $h_1-h_1 = 36$ (36-44), $h_1-h_2 = 26$ (21-26), $h_2-h_2 = 91$ (91).

Venter

Coxisternal shields divided, bearing *1a*, *3a* and *4a*; dimensions of these setae: $1a = 27$, $3a = 34$, $4a = 31$. Aggenital shield and anogenital covers with 3 pairs of setae ($ag_1 = ag_2 = ag_3 = 21$), ($ps_3 = ps_2 = 21$, $ps_1 = 26$). Setae ps_1 slightly longer than the other 2 pairs.

Legs

Length of legs I-IV (from base of femur to tip of tarsal claw): 312 (286-338), 239 (218-239), 218 (208-239), 260 (260-281), respectively. Setal formulae of legs I-IV: coxae 2-2-2-2, trochanters 1-1-2-1, femora 6-5-3-2, genua 4(+*k*)-3(+*k*)-1-1, tibiae 5(+ $\varphi\rho$, + ω)-5(+ $\varphi\rho$)-5(+ $\varphi\rho$)-5(+ $\varphi\rho$), tarsi 13(+ ω)-9(+ ω)-7(+ ω)-7(+ ω).

Male (Figure 4)

Body length (including gnathosoma) 374, width 208 (n = 1).

Gnathosoma

Length of gnathosoma 88. Subcapitulum with 2 pairs of long setae $n = 18$, $m = 18$, and 2 pairs of pilose adoral setae (ad_{1-2}). Length of chelicerae 52, length of palp 161. Palp setal formula (from femur to tarsus): 3-2-2 + 1 claw + 1 accessory claw - 5 + 1ω + 1 tridentate eupathidium.

Dorsum

Dorsal shields smooth. Prodorsal shield bears 4 pairs of setae (*vi*, *ve*, *sci*, *sce*) and 1 pair of eyes between setae *ve* and *sci*. Six pairs of setae (c_1 , d_1 , d_2 , e_1 , e_2 , f_1) occur on the opisthosomal shield and 2 pairs of setae (h_1 , h_2) on the suranal shield. Humeral shield ventro-laterally and with 1 pair of setae (c_2). All dorsal body setae similar in form, with minute spinules. Dimensions of dorsal setae are as follows: $vi = c_1 = d_1 = 27$, $ve = 44$, $sci = 31$, $sce = d_2 = e_2 = 34$, $c_2 = 26$, $e_1 = 31$, $f_1 = 52$, $h_1 = 18$, $h_2 = 39$; distances between setae: $vi-vi = 42$, $vi-ve = 39$, $ve-ve = 78$, $ve-sci = 27$, $sci-sci = 144$, $sci-sce = 16$, $sce-sce = 143$, $sce-c_1 = 42$, $c_1-c_1 = 70$, c_1-d_1

$= 52$, $c_2-c_2 = 203$, $d_1-d_1 = 75$, $d_1-d_2 = 47$, $d_2-d_2 = 156$, $d_1-e_1 = 42$, $e_1-e_1 = 75$, $e_1-e_2 = 27$, $e_1-f_1 = 27$, $f_1-f_1 = 62$, $h_1-h_1 = 27$, $h_1-h_2 = 16$, $h_2-h_2 = 52$.

Venter

Coxisternal shields divided, bearing *1a*, *3a*, and *4a*; dimensions of these setae: $1a = 16$, $3a = 18$, $4a = 16$. Aggenital shield and anogenital covers each 3 pairs of setae ($ag_1 = ag_2 = ag_3 = 16$), (ps_1 , ps_2 , ps_3). Setae ps_1 slightly longer than the other 2 pairs. Aedeagus long, thickened in the middle, very attenuate and upcurved posteriorly; calyx campanulate. Bulb small, compact, enwraps thickened midsection of aedeagus. There are 2 pairs of accessory copulatory appendages; unciform appendages long, very slender, basal pieces tightly appressed to basal third of aedeagus, hooked ends widely divergent, barely upturned at tips. Forcipiform appendages end in slightly curved sclerotized blades with medially directed, pointed ends (Figure 4H). Male solenidion (ω^δ) on tarsus I surpasses base of ω .

Legs

Length of legs I-IV (from base of femur to tip of tarsal claw): 239, 177, 156, 187, respectively. Setal formulae of legs I-IV: coxae 2-2-2-2, trochanters 1-1-2-1, femora 6-5-3-2, genua 4(+*k*)-3(+*k*)-1-1, tibiae 5(+ $\varphi\rho$, + ω)-5(+ $\varphi\rho$)-5(+ $\varphi\rho$)-5(+ $\varphi\rho$), tarsi 13(+ ω + ω^δ)-9(+ ω + ω^δ)-7(+ ω + ω^δ)-7(+ ω + ω^δ).

Material examined

Three ♀♀ and 1 ♂ from litter under *Phragmites australis*, Çay district, near Eber Lake, 1000 m, 26.07.2005; 1 ♀ from litter under *Prunus domestica*, Başmakçı district, 820 m, 22.08.2005; 1 ♀ from litter under *Phragmites australis*, Dazkiri district, near Acıgöl Lake, 800 m, 22.08.2005; 3 ♀♀ from litter under *Cerasus vulgaris*, Afyonkarahisar, near Özdilek, fruit garden, 1040 m, 15.09.2005; 1 ♀ from litter under *Juniperus* sp., Sincanlı district, Güney town, 1100 m, 15.09.2005; 1 ♀ from litter under *Quercus* sp., Kızılören district, Akdağ mountains, 1200 m, 17.10.2005; 1 ♀ from litter under *Phragmites australis*, Çay district, Eber town, near Eber Lake, 950 m, 06.11.2005; 1 ♀ from litter under *Quercus* sp., Dinar district, Akcaköy village, Kumalar mountains, 1180 m, 17.12.2005; 1 ♀ from litter under *Pinus brutia* and *Quercus* sp., Çay district, Sultandağı

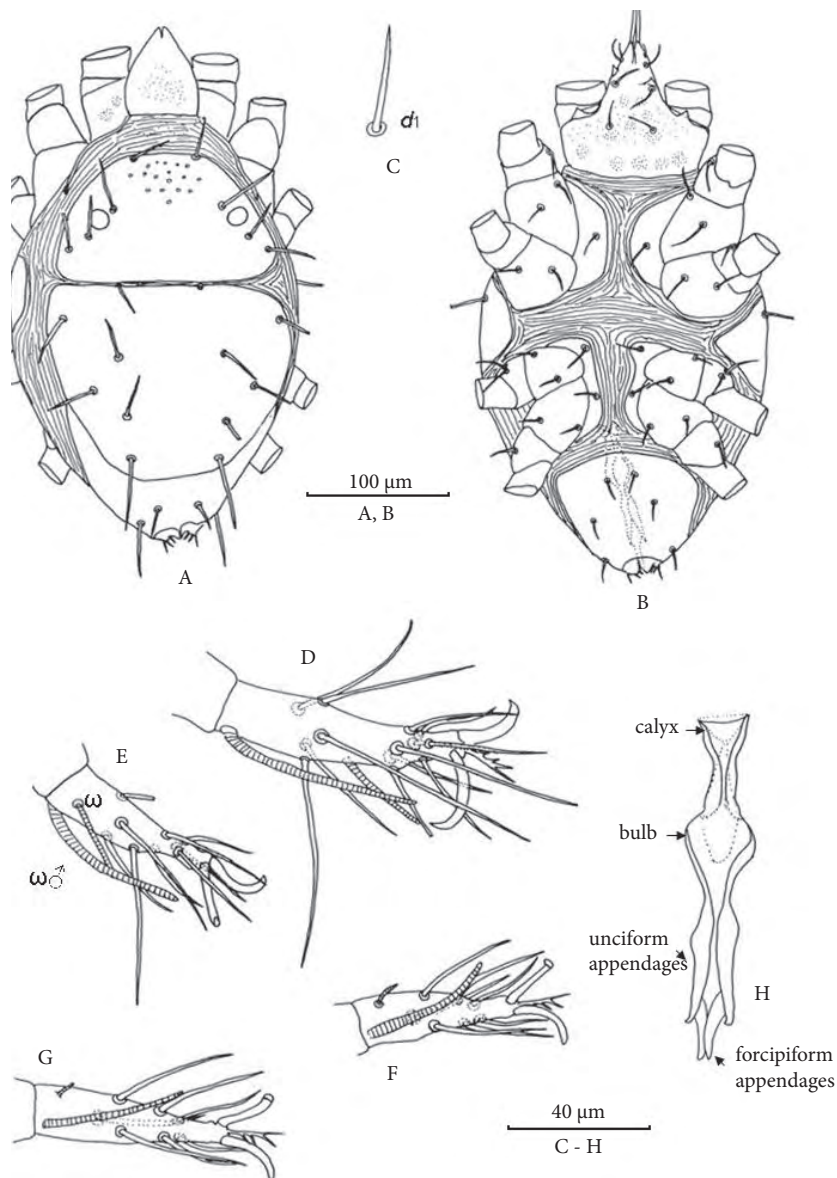


Figure 4. *Cheylostigmaeus californicus* (male). (A) Dorsal view, (B) ventral view, (C) seta d_1 , (D) leg I tarsus, (E) leg II tarsus, (F) leg III tarsus, (G) leg IV tarsus, and (H) Aedeagus.

mountains, 1150 m, 16.01.2006; Afyonkarahisar, Turkey, coll. M. Akyol.

Remarks

Setal lengths in *Cheylostigmaeus californicus* females according to Summers and Ehara are $c_1 = 56$; $c_1-d_1 = 56$; $c_2 = 63$; $ve/vi = 1.5$; length of chelicerae 69. In the Turkish specimens they are $c_1 = 60$; $c_1-d_1 = 60$; $c_2 = 65$; $ve/vi = 1.46-1.51$; length of chelicerae 42.

Distribution: U.S.A.: California (Summers and Ehara, 1965).

Acknowledgements

The authors wish to thank Dr. E. Ueckermann, ARC-Plant Protection Research Institute, South Africa, for his critical review of this paper.

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