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THE CAVERNICOLOUS FAUNA OF HAWAIIAN LAVA TUBES
13. A new subgenus and two new species of Rhagidiidae (Acari: Eupodoidea)[1]

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Abstract. *Foveacheles goffi,* n. sp., and *Foveacheles tenorioae,* n. sp., are described and their interspecific relationships discussed. The new subgenus *Trofocheles* is defined on the basis of unique adaptive morphological characters.

Eupodiform mites of the Hawaiian Islands are poorly known. Up to the present, only Strandtmann & Goff (1978) and Zacharda (1980) have contributed to the knowledge of these soil dwelling mites.

In 1981, Dr M. Lee Goff, B.P. Bishop Museum, Honolulu, sent me some rhagidiids originating from lava tubes on the islands of Hawaii and Molokai. As Dr Goff had correctly supposed, these represent 2 new species. They are representatives of the genus *Foveacheles* Zacharda, 1980, having unique adaptive morphological characters: troglomorphisms (Zacharda 1980, 1981). All types are in the collection of the B.P. Bishop Museum, Honolulu, Hawaii (BPBM).

Genus **Foveacheles** Zacharda

Foveacheles Zacharda, 1980, *Acta Univ. Carol. Biol.* (1978) **5–6:** 661.

Trofocheles Zacharda, **new subgenus**

Type-species: Foveacheles (Trofocheles) goffi, n. sp.

Diagnosis. Hawaiian cave representatives of the genus *Foveacheles* with distinct but specific troglomorphisms, namely enlarged appendages, rhagidial setae, large dorsodistal solenidia on tibiae I, and larger lanceolate setae on tibiae II. Epimeral formula 3-1-5-3. Rhagidial organ I consists of 4 rhagidial setae, stellate seta between 1st and 2nd proximal rhagidial setae; rhagidial organ II consists of 3 rhagidial setae and small proximal spiniform seta. Solenidia on tibia I dorsodistal. The representatives of this new subgenus appear similar to the species of the subgenus *Usitorhagidia* Zacharda, 1980, but *Trofocheles* differ by having distinct troglomorphisms, a dorsodistal solenidion located on tibia I and the epimeral formula.

Discussion. Up to this time, only a few genuine troglobitic as well as troglomorphic representatives of the genus *Foveacheles* have been known. *Foveacheles titanica* Zacharda & Elliot (in press) and *Foveacheles parallelosetа* Zacharda & Welbourn (in press) from North American caves also bear distinct but different troglomorphisms. Never-

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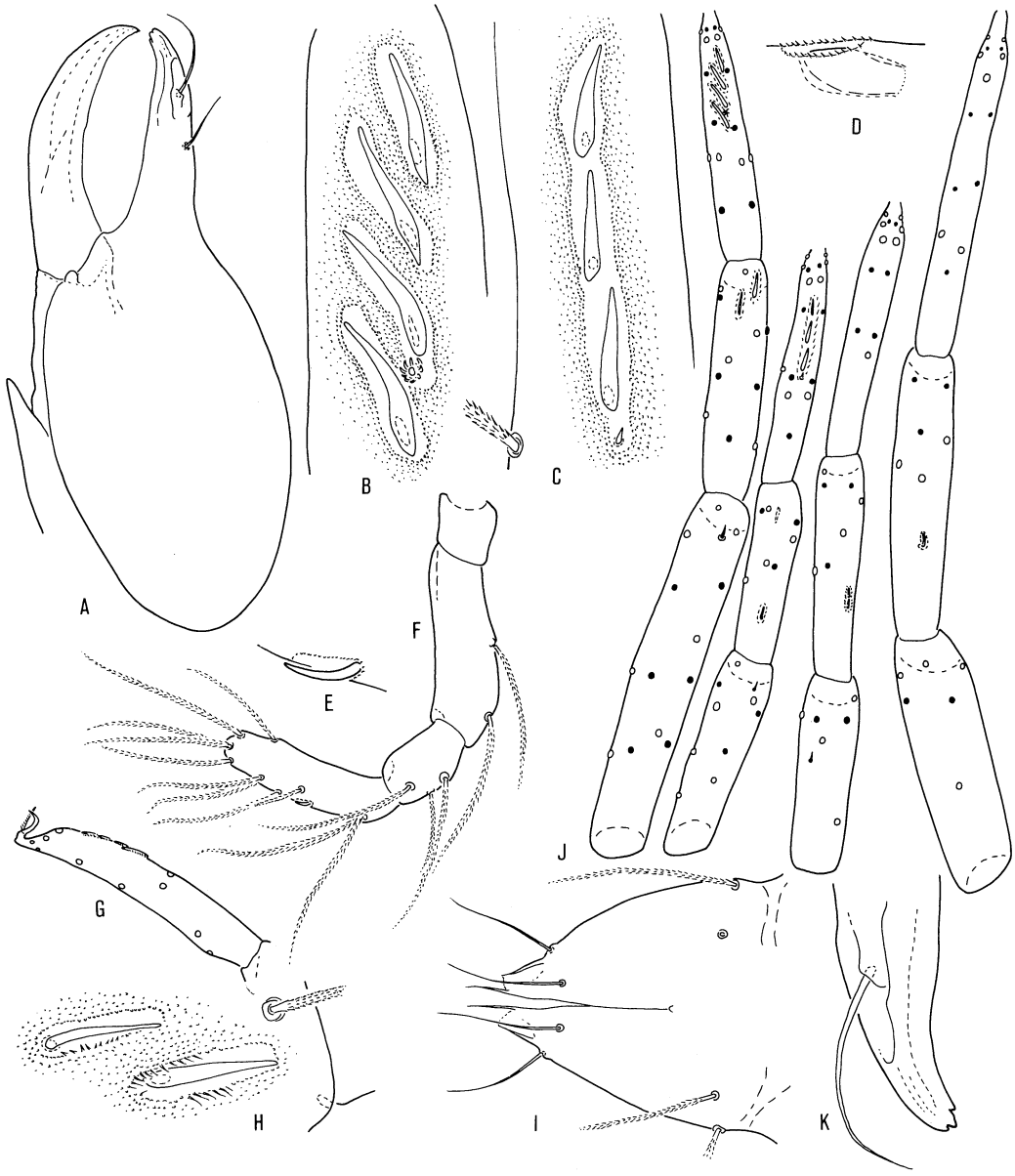

FIG. 1. *Foveacheles (T.) goffi* Zacharda: **A,** chelicera; **B,** rhagidial organ I; **C,** rhagidial organ II; **D,** lanceolate seta on tibia II; **E,** solenidion of terminal palpal segment; **F,** pedipalp; **G,** tarsus I profile; **H,** rhagidial seta and recumbent solenidion of tibia I; **I,** hypostome; **J,** legs I–IV, showing chaetotaxy and locations of solenidia; **K,** dorsodistal portion of digitus fixus.

theless, these species should be compared with *F. goffi,* n. sp., and *F. tenorioae,* n. sp., and their current subgeneric status should be discussed.

The subgeneric name *Trofocheles* has been derived from the words troglobitic (tro) *Foveacheles* (Fo-cheles). Gender is feminine.

KEY TO THE SPECIES OF *Trofocheles,* N. SUBGEN.

1. Large species, about 1100–1250 μm long; rhagidial organ II with 3 rhagidial setae in confluent insertion pit; terminal palpal segment with 11 ciliated setae and 1 small recumbent solenidion; lanceolate seta small ..... **goffi, n. sp.**
   Smaller species, about 740 μm long; rhagidial organ II with 3 separated rhagidial setae, 2 distal which are nearly parallel; terminal palpal segment with 10 ciliated setae and 1 small recumbent solenidion; lanceolate seta large in broadly open depression ..... **tenorioae, n. sp.**

Foveacheles (Trofocheles) goffi Zacharda, **new species** Fig. 1

Diagnosis. Length of body 1100–1250 μm; both cheliceral setae distal to joint of digitus mobilis; rhagidial organ II consisting of 3 rhagidial setae, tandem in confluent pit; terminal palpal segment with 11 ciliated setae and 1 small recumbent solenidion; tibia II with dorsoproximal recumbent solenidion and small dorsodistal lanceolate seta in deep depression.

♀ (2 specimens examined). Body length 1235 μm, ratio of leg I length to body length: 1.43. *Dorsum* (measurements in micrometres). iv, 77; ev, 84; tr, absent; sc, 175; ih, absent; eh, 182; other dorsal chaetotaxy missing from specimens. *Venter.* Epimeral formula 3-1-5-3; trochanteral formula 1-1-2-2. 6 pairs of progenital setae and 5 pairs of paragenital setae; length of progenital lips 190. *Gnathosoma.* Hypostome longitudinally oval; internal malae spiniform, external malae membranous; ratio of length to breadth: 1.10. Chelicerae with strong, partially attenuated shears. Both cheliceral setae inserted distinctly distal to joint of digitus mobilis. Proximal cheliceral seta 45 long, distal 55 long; distance between bases of cheliceral setae 35–55. Inner margin of digitus mobilis smooth. Length of chelicera 378–409, breadth 140–167; digitus mobilis 167–176 long; ratio of cheliceral length to breadth: 2.44–2.70; length of digitus mobilis to cheliceral length: 0.43–0.44; length of digitus mobilis to breadth of chelicera: 1.05–1.19. Terminal palpal segment oval with 11 ciliated setae and 1 small recumbent banana-shaped solenidion. Ratio of length to breadth: 3.53–3.83. *Legs.* Tarsus I slender, gently rounded forward, ratio of length to breadth: 6.12. Empodium slender, overlapping tips of claws with distinct basal clawlets. Rhagidial organ I consists of 4 oblique, separated rhagidial setae, stellate seta between 1st and 2nd proximal rhagidial setae. Rhagidial organ II consists of 3 tandem rhagidial setae in confluent insertion pit, small spiniform seta proximal. *Solenidia.* Tibia I with 1 recumbent dorsodistal solenidion approximating dorsodistal rhagidial seta. Genu I with 1 long distoventral solenidion. Tibia II with 1 recumbent solenidion and dorsodistal lanceolate seta in broadly open insertion pit. Genu II with 1 distodorsal solenidion. Tibia III with 2 recumbent, laterodorsal proximal solenidia. Genu III with 1 ventral, distomedial solenidion. Tibia IV with 1 recumbent, dorsoproximal solenidion. Other solenidia not observed.

♂ (1 specimen examined). Body length 1120 μm. Ventral and palpal chaetotaxy as in ♀. Chelicera 352 long, breadth 140; length of digitus mobilis 140; proximal cheliceral seta 35 long, distal 53 long. Ratio of cheliceral length to breadth: 2.51; length of digitus mobilis to cheliceral length: 0.39; length of digitus mobilis to breadth of chelicera: 1.0; ratio of terminal palpal segment length to breadth: 4.45; hypostome length to breadth: 1.11. Otherwise as in ♀.

Tritonymph (1 specimen examined). Body length 955 μm. 4 pairs of progenital and 5 pairs of paragenital setae. Epimeral formula 3-1-4-3. Rhagidial organ I consists of 3 oblique, separated setae, stellate seta between 1st and 2nd distal rhagidial setae. Rhagidial organ II and solenidia as adult.

Type data. Holotype ♀ (BPBM 12,515) and 1 paratype: HAWAIIAN IS: Hawaii I: Kau Forest Res, Manu Cave, dark zone, 2100 m, 21.VII.1976 (F.G. Howarth). 2 paratypes (1♂, 1TNY): HAWAIIAN IS: Molokai I: Kawela, Wheelchair Cave, ex rat dung, 1265 m, 6.I.1981 (S.L. Montgomery & F.G. Howarth).

Differential diagnosis. F. (*T.*) *goffi* differs from *F.* (*T.*) *tenorioae,* n. sp., in all of the diagnostic characters given above. In the cheliceral morphology and epimeral formula *F. goffi* partially resembles *Foveacheles* (*Hirschmannetta*) *magna* Zacharda, 1980, from which it differs in having rhagidial setae of rhagidial organ II arising from a confluent insertion pit (arising separately in *F. magna*), by the location of the solenidia, and by the morphology of the rhagidial seta on tibia I.

Remarks. Some morphological characters of *F. goffi* can be evaluated as troglomorphisms (cf. Zacharda 1979, 1980; Zacharda & Elliott 1981a, 1981b) the enlarged and attenuated cheliceral shears, pedipalps and legs, the enlarged dorsodistal solenidia on tibia I, the larger lanceolate seta on tibia III, and possibly the 11 ciliated setae on the terminal palpal segment. These characters indicate that this is a cave-adapted species.

This species is named in honor of Dr M. Lee Goff, B.P. Bishop Museum, Honolulu, who kindly provided me with the unique specimens of Hawaiian cave rhagidiids.

Foveacheles (Trofocheles) tenorioae Zacharda, **new species** Fig. 2

Diagnosis. Length of body ca. 740 μm; proximal cheliceral seta almost opposite joint of digitus mobilis; rhagidial organ II consists of 3 separated rhagidial setae, distal 2 nearly parallel; terminal palpal segment with 10 ciliated setae and 1 small recumbent solenidion; tibia II with large distodorsal solenidion lying just beside large troglomorphic lanceolate seta in broadly open depression.

Description (based on 1 ♂ examined). Body length 740 μm, ratio of leg I to body length: 1.01. *Dorsum* (measurements in micrometres). iv, 45; ev, 50; filiform trichobothrium, 112; sc, 112; ih, 42; eh, 91; $d_{1,2}$, 40; il, 63; el, absent; is, 84; es, 42. *Venter.* Epimeral formula 3-1-5-3; trochanteral formula 1-1-2-2. 6 pairs of progenital and 5 pairs of paragenital setae; length of progenital lips 112. *Gnathosoma.* Hypostome longitudinally oval; internal malae spiniform, external malae membranous, rutellae small, serrate. Ratio of hypostomal length to breadth: 1.07. Chelicerae slender with weak shears, inner margin of digitus mobilis smooth. Proximal cheliceral seta slightly distad of joint of digitus mobilis, barely reaching base of distal cheliceral seta. Proximal cheliceral seta measuring 24 long, distal 35 long, distance between bases of cheliceral setae 24. Length of chelicera 199, breadth 63; digitus mobilis 73; ratio of cheliceral length to breadth: 3.15; length of digitus mobilis to cheliceral length: 0.36; length of digitus mobilis to breadth of chelicera: 1.18. Terminal palpal segment with 10 ciliated setae and 1 small recumbent solenidion. Ratio of length to breadth: 2.55. *Legs.* Tarsus I relatively short, ratio of length to breadth: 3.58, abruptly rounded distally. Empodium slender, distinctly overlapping tips of claws, with very short, blunt clawlets. Rhagidial organ I consists of 4 oblique, separated rhagidial setae, stellate seta between 1st and 2nd proximal rhagidial setae. Rhagidial organ II consists

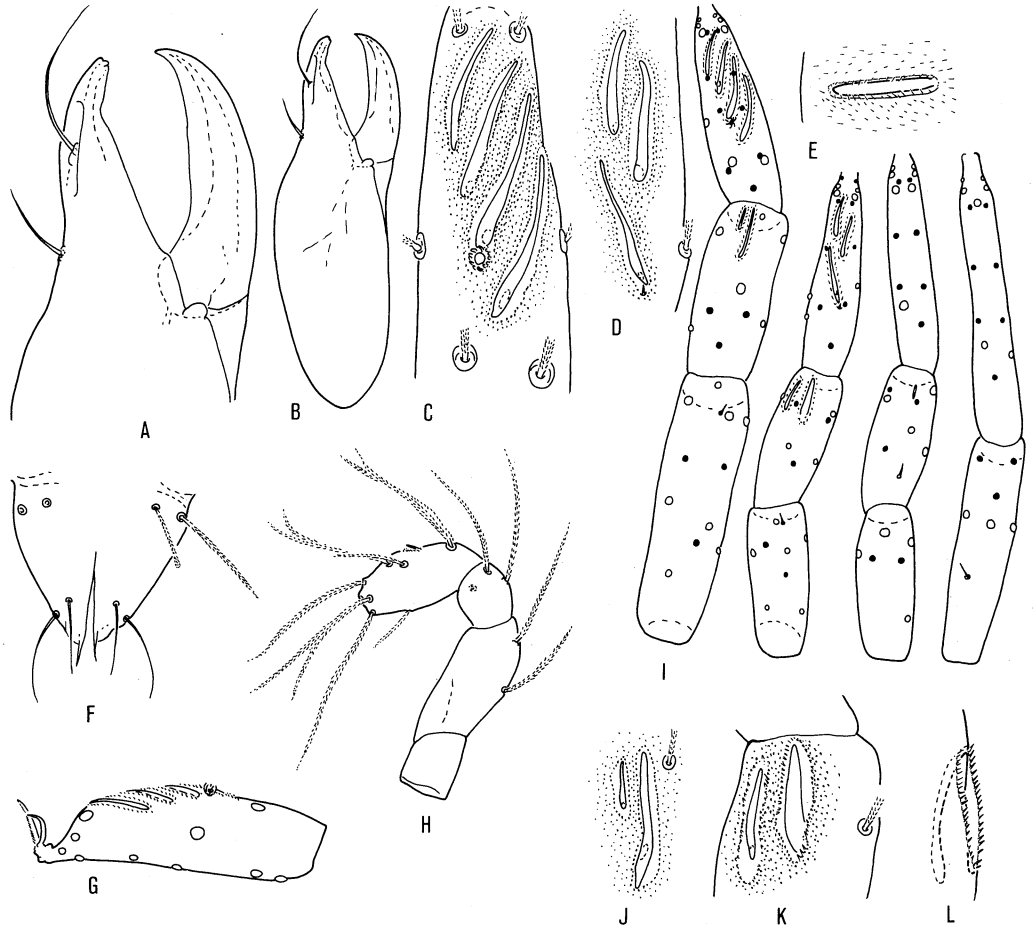

FIG. 2. *Foveacheles (T.) tenorioae* Zacharda: **A,** cheliceral shears; **B,** chelicera; **C,** rhagidial organ I; **D,** rhagidial organ II; **E,** lanceolate seta on tibia II; **F,** hypostome; **G,** tarsus I profile; **H,** pedipalp; **I,** legs I–IV, showing chaetotaxy and locations of solenidia; **J,** recumbent solenidion and rhagidial seta of tibia I; **K,** recumbent solenidion and lanceolate seta of tibia II; **L,** lanceolate seta of tibia II in profile.

of 3 separated rhagidial setae, distal 2 setae almost parallel, small spiniform seta proximal. *Solenidia.* Tibia I with 1 very long, recumbent dorsodistal solenidion approximating dorsodistal rhagidial seta. Genu I with 1 spiniform distoventral solenidion. Tibia II with 1 very long recumbent dorsodistal solenidion, just lateral to very large, hypertrophied troglomorphic lanceolate seta. Genu II with 1 spiniform distoventral solenidion. Tibia III with 1 long recumbent dorsoproximal solenidion and 1 dorsodistal rhagidial seta (=cryptical solenidion). Genu III without observable solenidion. Tibia IV with 1 spiniform, dorsal, medioproximal solenidion. No additional solenidia observed.

Tritonymph (1 specimen examined). Body length 616 μm. 3 pairs of progenital and 4 pairs of paragenital setae. Epimeral formula 3-1-4-3. Rhagidial organ I torn from specimen; rhagidial organ II and solenidia as adult.

Type data. Holotype ♂ (BPBM 12,516): HAWAIIAN IS: Hawaii I: Hawaii Volcanoes National Park, Kipuka Puaulu, Cave no. 3 (F.G. Howarth & W.G. Gagne); 2 paratypes (1♂, 1TNY): Kau Forest Res, Manu Cave, dark zone, 21.VII.1976 (Howarth); 1 paratype: Kaumana Cave, upper section, 290 m, dark zone, 26.IV.1972 (Howarth).

Differential diagnosis. F. (*T.*) *tenorioae* differs from *F.* (*T.*) *goffi* in the characters given above in the key and diagnosis.

Remarks. The smaller *F.* (*T.*) *tenorioae* bears 1 more set of troglomorphisms than *F.* (*T.*) *goffi*: the enlarged and attenuated rhagidial setae, the large dorsodistal solenidia on tibiae I and II and the conspicuously enlarged lanceolate seta on tibia II. However, the appendages of this species are nontroglomorphic, being somewhat shorter than encountered in the epigean of cave-surface dwelling species. These specific, adaptive morphologic characters probably indicate different habits for *F.* (*T.*) *tenorioae* than for *F.* (*T.*) *goffi*. Unfortunately, no additional data on the autecology of these mites in the Hawaiian caves are available at the present time. Moreover, there are many morphological characters common to both species, suggesting very close interspecific relationships between these 2 sympatric species, including: form of cheliceral shears, rhagidial organs, and the dorsodistal location of the solenidia on tibiae I.

This species is named in honor of Dr JoAnn M. Tenorio, B.P. Bishop Museum, Honolulu, who kindly assisted me many times in my acarological work.

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