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## NEW SPECIES OF THE FAMILY RHAGIDIIDAE (ACARINA: ACTINEDIDA: EUPODOIDEA) FROM CALIFORNIA CAVES

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Abstract: *Poecilophysis melanoseta* sp. n., *Foveacheles auricularia* sp. n., and *F. titanica* sp. n. are described as new species from caves and epigean localities in the Sierra Nevada and Klamath Mountains of California.

### INTRODUCTION

In 1977 a group of American speleologists was employed by the United States Army Corps of Engineers to make a scientific inventory and evaluation of 87 caves in the Stanislaus River basin of the Sierra Nevada in California (MCEACHERN and GRADY, 1978). Many of the caves will be inundated by the recently completed New Melones Dam. Mr. ANDY GRUBBS, a field biologist with the group, sent one of us (ELLIOTT) a mite that he had collected. Upon examination, the specimen appeared to be a troglomorphic species of *Rhagidia*, near *cavernarum* (PACKARD) (op. cit.).

In the winter of 1977—78, ELLIOTT was employed by the Corps of Engineers to conduct an unusual ecological transplant of *Banksula* phalangids and other fauna from McLean's Cave, which was to be flooded, to a mine. During that study several more rhagidiids were collected from mine tailings outside the Transplant Mine. Although several other caves were checked for fauna, no more rhagidiids were found, perhaps because of dry conditions. At least six species of mites were transplanted from McLean's Cave, but none appeared to be rhagidiids (ELLIOTT, 1978, 1981).

In 1979 D. Craig Rudolph conducted a study for the U. S. Fish and Wildlife Service, Office of Endangered Species, to evaluate the status of *Banksula melones* BRIGGS in the mine and caves in the area. Elliott assisted in the study along with several other biologists. Moisture conditions had improved in the caves and microarthropods were seemingly more abundant than previously. In addition to his intensive studies in Calaveras and Tuolumne Counties, Dr. Rudolph investigated numerous caves in eight other counties of central, coastal, and northern California. In all, 80 caves were visited (RUDOLPH, 1979). A forthcoming report will discuss the California cave fauna that has been studied since 1977, as well as existing literature records (RUDOLPH, ELLIOTT, REDELL, and BRIGGS, in litt.).

We describe herein three new species of Rhagidiidae. One of them is an apparent troglobite of the genus *Foveacheles* and is presently known from two caves on opposite sides of the Stanislaus River (Fig. 1). It is among the largest rhagidiids known. It probably could be found in many of the approximately 100 caves that have formed in the river canyon in the Calaveras Formation, a marble of Carboni-

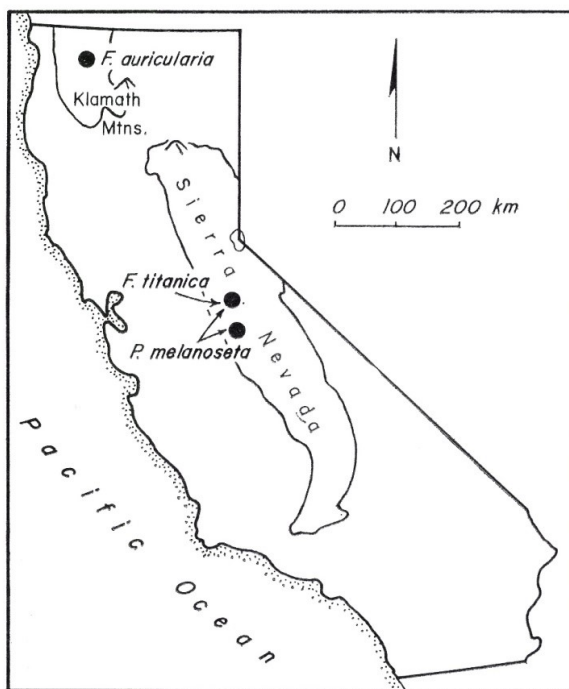


Fig. 1. General locations of new rhagidiid species in California.

ferous age. A troglophilic member of the same genus is described from two adjacent caves in the Klamath Mountains, about 450 km to the northwest. Another troglophile of the genus *Poecilophysis* is known from five caves and two epigeal localities in the Stanislaus River canyon (occurring in one of the same caves as the troglobitic *Foveacheles*) as well as a cave 50 km to the south in Mariposa County. At present the zoogeographic significance of these species distributions cannot be fully evaluated.

*Poecilophysis (Dentocheles) melanoseta* sp. n.

Figs 2–3

Diagnosis: 4 separated, oblique rhagidial setae in rhagidial organ II, stellate seta beside 2nd distal rhagidial seta, or between 1st and 2nd distal rhagidial setae.

Tarsus I with 1 dorsoproximal solenidion, tibia I with dorsoproximal solenidion. Inner margin of digitus mobilis with 2 small denticles. Epimeral formula 3-1-6-4.

Description: Females - 9 specimens examined. Body length: 1 267 (1,095 to 1 561)  $\mu\text{m}$ , ratio of leg I length to body length: 1.18 (0.96-1.46).

Dorsum (measurements in  $\mu\text{m}$ ): internal verticals 88, external verticals 88, trichobothrium 167, scapulars 193, internal humerals 88, external humerals 184-264, dorsals I 96, dorsals II 79-88, internal lumbar 123-158, external lumbar 70, internal sacral 140, external sacral 88.

Venter: Epimeral formula 3-1-6-4, trochanteral formula 1-1-2-2. 5 pairs of progenital and 5 pairs of paragenital setae. Length of progenital lips 135 (105-176)  $\mu\text{m}$ .

Gnathosoma: Hypostome longitudinally oval; internal malae small, spiniform; external ones membranous; ratio of length to breadth: 1.25 (1.20-1.33). Chelicerae with long, slender shears. Digitus fixus with 2 terminal cusps and 2 dorsal setae; proximal seta 30 (24-38)  $\mu\text{m}$  long and distal seta 67 (53-79)  $\mu\text{m}$ . Distance between

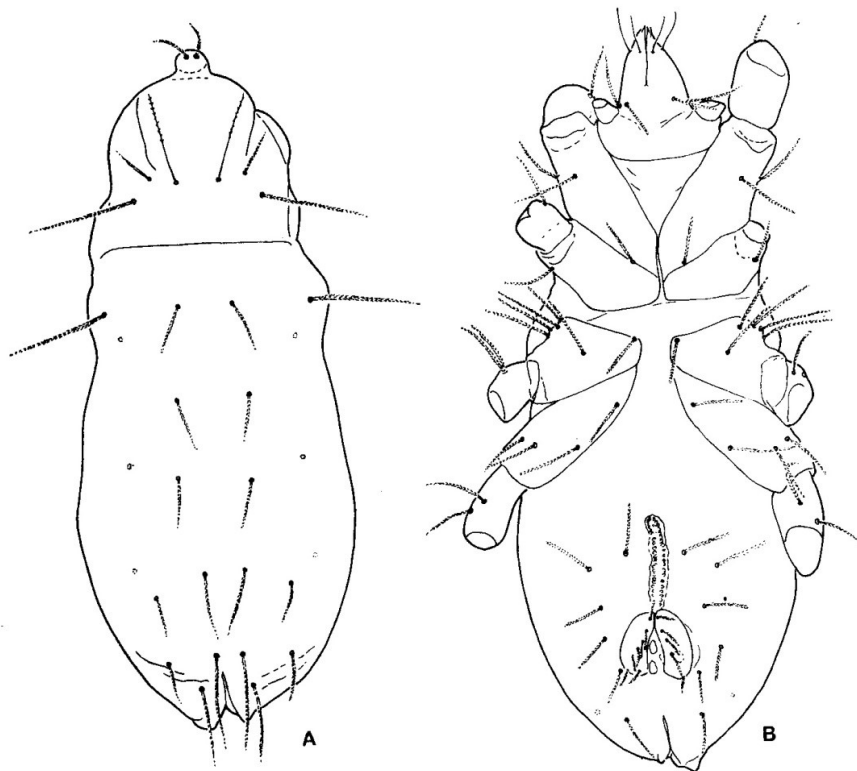


Fig. 2. *Poecilophysis (D.) melanoseta* sp. n., A - dorsum, B - venter.

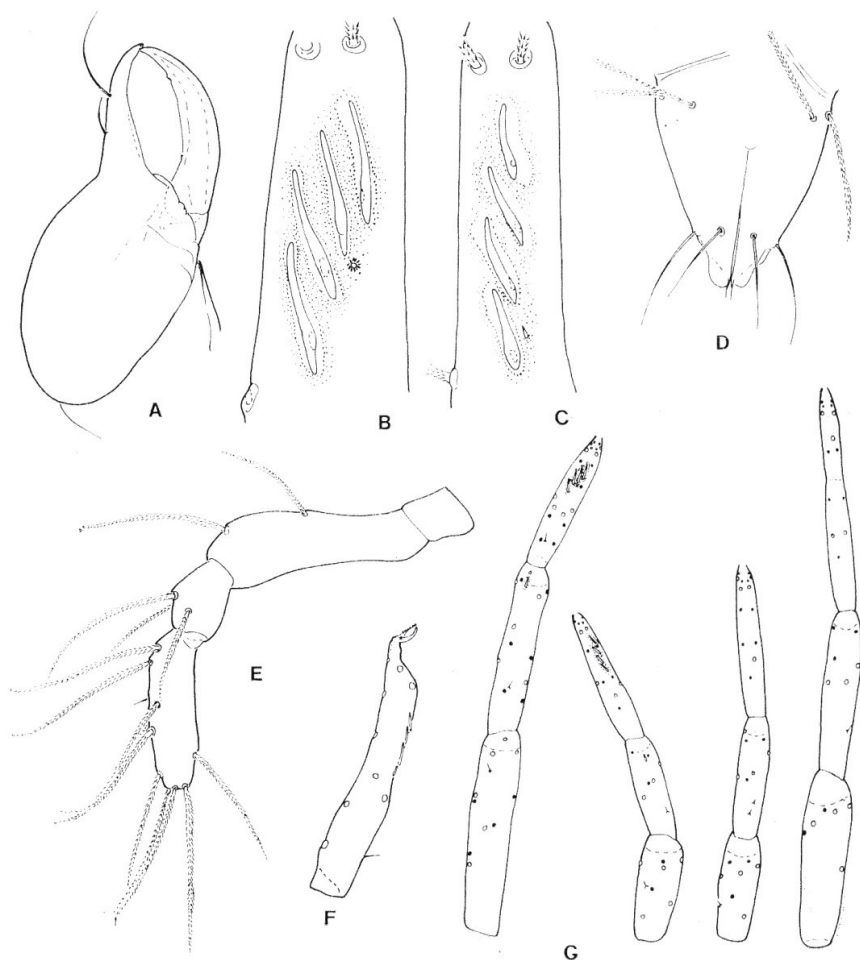


Fig. 3. *Poecilophysys (D.) melanoseta* sp. n., A - chelicera, B - rhagidial organ I, C - rhagidial organ II, D - hypostome, E - pedipalpus, F - tarsus I in profile, G - location of solenidia and setae on legs I-IV.

bases of cheliceral setae 27 (22-35)  $\mu\text{m}$ . Inner margin of digitus mobilis with 2 small denticles. Length of chelicera 290 (248-340)  $\mu\text{m}$ , breadth 130 (114-164)  $\mu\text{m}$ ; length of digitus mobilis 147 (123-171)  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.20 (2.03-2.39), length of digitus mobilis to chelicera length: 0.50 (0.45-0.57), length of digitus mobilis to breadth of chelicera: 1.13 (1.04-1.19).

Terminal palpal segment oval with 10 setae and 1 spiniform solenidion. Ratio of length to breadth: 3.10 (2.60-3.40).

Tarsus I gently rounded forward, ratio of length to breadth: 5.47 (4.83–6.15). Empodium sledner, reaching tips of claws with small basal clawlets.

Rhagidial organ I consists of 4 oblique, separated rhagidial setae; stellate seta beside 2nd distal, or between 1st and 2nd distal rhagidial setae. Rhagidial organ II consists of 4 oblique, separated rhagidial setae; spiniform seta lateral beside proximal rhagidial seta.

Solenidia: Tarsus I with 1 small, dorsoproximal solenidion, tibia I with 1 dorso-proximal solenidion and small dorsodistal rhagidial seta in open, shallow depression. Genu I with 1 distoventral solenidion. Tibia II with 1 dorsoproximal solenidion and dorsodistal lanceolate seta in open depression, genu II with 1 vetromedial solenidion. Tibia III with 2 proximal, laterodorsal solenidia; genu III with 1 latero-proximal (medioproximal) solenidion. Tibia IV with 1 laterodorsal, proximal solenidion.

Males - 3 specimens examined. Body length 932, 1 002, 1 072  $\mu\text{m}$ ; ratio of leg I length to body length: 1.27, 1.30, 1.56.

Dorsum: internal verticals 62; external verticals 70–79; trichobothrium 132, 167; scapulars 150, internal humerals 70, 75, 88; external humerals torn off; dorsals I 61, 70, 88; dorsals II 70, 88; internal lumbar 97, 114; external lumbar 60, 70; internal sacral 140, 149, 158; external sacral 70, 92.

Venter: Epimeral and trochanteral formula as in female, 6 pairs (or 6/7) of progenital and 5 pairs (or 4/5) of paragenital setae. Progenital lips 97, 123  $\mu\text{m}$  long.

Gnathosoma: Ratio of hypostome length to breadth: 1.20. Chelicera length 241, 246, 272  $\mu\text{m}$ ; breadth 101, 105, 114  $\mu\text{m}$ ; length of digitus mobilis 119, 123  $\mu\text{m}$ ; length of proximal cheliceral seta 21, 26, 31  $\mu\text{m}$ ; length of distal cheliceral seta 61, 66, 70  $\mu\text{m}$ ; distance between bases of these setae 22, 26, 28  $\mu\text{m}$ ; ratio of chelicera length to breadth: 2.33, 2.37, 2.38; digitus mobilis length to chelicera breadth: 1.07, 1.16, 1.17; digitus mobilis length to chelicera length: 0.45, 0.49, 0.50. Ratio of length of terminal palpal segment to breadth: 2.66, 3.0. Length to breadth of tarsus I: 5.0, 6.0. Rhagidial organs I and II, and solenidia as in females.

Material examined: 1 ♂, holotype, Vulture Cave, 5 km NW of Columbia, Tuolumne Co., California, elevation about 350 m, 22 February 1979, D. C. Rudolph, S. Winterath, Barbara Martin leg., coll. Nat. Mus. Nat. Hist., Washington, D. C.; 1 ♀, paratype, 17 February 1979, otherwise the same data as for the holotype; 1 ♀, paratype, Indian Quarry Cave no. 1, 5.5 km N of Columbia, Tuolumne Co., California, elevation 305 m, 28 March 1979, J. Reddell leg.; 1 ♀, paratype, Stanislaus River Canyon, near Indian Quarry Caves, 5.5 km N of Columbia, Tuolumne Co., California, under stone, elevation 305 m, 28 March 1979, W. R. Elliott, leg.; 3 ♀, 2 ♂, paratypes, from tailings (mining rubble) outside of Transplant Mine, 3.7 km NE of Columbia, Tuolumne Co., California, elevation about 430 m, soil temperature 9 °C, 10 January 1978, W. R. Elliott, A. G. Grubbs, S. Winterath leg.; 1 ♀, paratype, Damp Cave, 24 km NW of Mariposa, Mariposa Co., California, elevation 884 m, 7 April 1979, D. C. Rudolph, Barbara Martin, S. Winterath leg.; 2 ♀, paratypes, Diane's Cave, 8.8 km E of Angel's Camp, Calaveras Co., California, elevation 549 m, 28 March 1979, D. C. Rudolph, S. Winterath leg.; the paratypes are deposited in the Nat. Mus. Nat. Hist., Washington, D. C.

Other material reviewed: 1 ♀, Dirty Fissure (Cave), 6.0 km SE of Angel's Camp, Cala-

veras Co., California, elevation 476 m, 26 May 1977, A. G. Grubbs leg.; 2 ♀, Poison Oak Cave, 8.5 km E of Angel's Camp, Calaveras Co., California, elevation 356 m, 29 March 1979, D. C. Rudolph, Barbara Martin, S. Winterath, W. R. Elliott, J. Reddell leg.; air temperature 15–17 °C; coll. of M. Zacharda.

Differential diagnosis: *Poecilophysis* (*D.*) *melanoseta* sp. n. explicitly differs from the other representatives of the subgenus *Dentocheles* ZACHARDA, 1980 with the rhagidial organs II.

Discussion: *P. (D.) melanoseta* sp. n. is undoubtedly very close to *P. (D.) pratensis* (C. L. KOCH), which is known from the U.S.A. as *Rhagidia whartoni* STRANDTMANN, 1971. No troglomorphisms (ZACHARDA, 1979) have been found in this species, which also occurs outside the caves (cf. Material examined). Therefore, *P. melanoseta* sp. n. should be considered only a troglophilic species, as should the majority of the other representatives of this genus (ZACHARDA, 1980). This species has been named according to its strikingly swarthy cheatotaxy.

*Foveacheles (Foveacheles) auricularia* sp. n.

Figs 4–5

Diagnosis: 4 rhagidial setae in both rhagidial organs I and II tandem in common insertion pit, sometimes only distal rhagidial seta separated. Claws II, III, IV auriculate apically (seen from above). 11 ciliated setae on terminal palpal segment.

Description: 1 ♂ and 1 ♀ examined. Length of body 1 445, 1 462,  $\mu\text{m}$  respectively; ratio of leg I length to body length: 1.40, 1.20.

Dorsum: fine, filiform trichobothrium 176  $\mu\text{m}$  long, the other dorsal setae torn off.

Venter: Epimeral formula 3-1-6-3, trochanteral formula 1-1-2-2. 5 pairs of pro-genital and 5 pairs (or 4/5) of paragenital setae. Progenital lip 158, 176  $\mu\text{m}$  long.

Gnathosoma: Hypostome slenderly oval, ratio of length to breadth: 1.37, 1.23. Internal malae short, spiniform; external ones membranous. Chelicerae with robust shears. Distal cheliceral seta inserted in open, laterodorsal pit. Proximal cheliceral seta inserted above joint of (or just before) digitus mobilis with finely serrate inner margin. Length of chelicera 396, 343  $\mu\text{m}$ , breadth 158, 132  $\mu\text{m}$ ; length of digitus mobilis 140, 132  $\mu\text{m}$ ; length of proximal and distal cheliceral setae 53, 44 and 79, 62  $\mu\text{m}$ ; respectively; distance between bases of these setae 53, 61  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.50, 2.60; length of digitus mobilis to chelicera length: 0.35, 0.38; digitus mobilis length to chelicera breadth: 0.88, 1.0.

Terminal palpal segment oval, with 11 setae and 1 spiniform solenidion. Ratio of length to breadth: 3.16, 2.83.

Tarsus I slender, gently rounded forward; ratio of length to breadth: 8.33, 6.83. Slender empodium distinctly overlapping claws with small basal clawlets. Claws II, III, IV auriculate subapically (seen from above).

Rhagidial organ I consists of 4 rhagidial setae tandem in common insertion

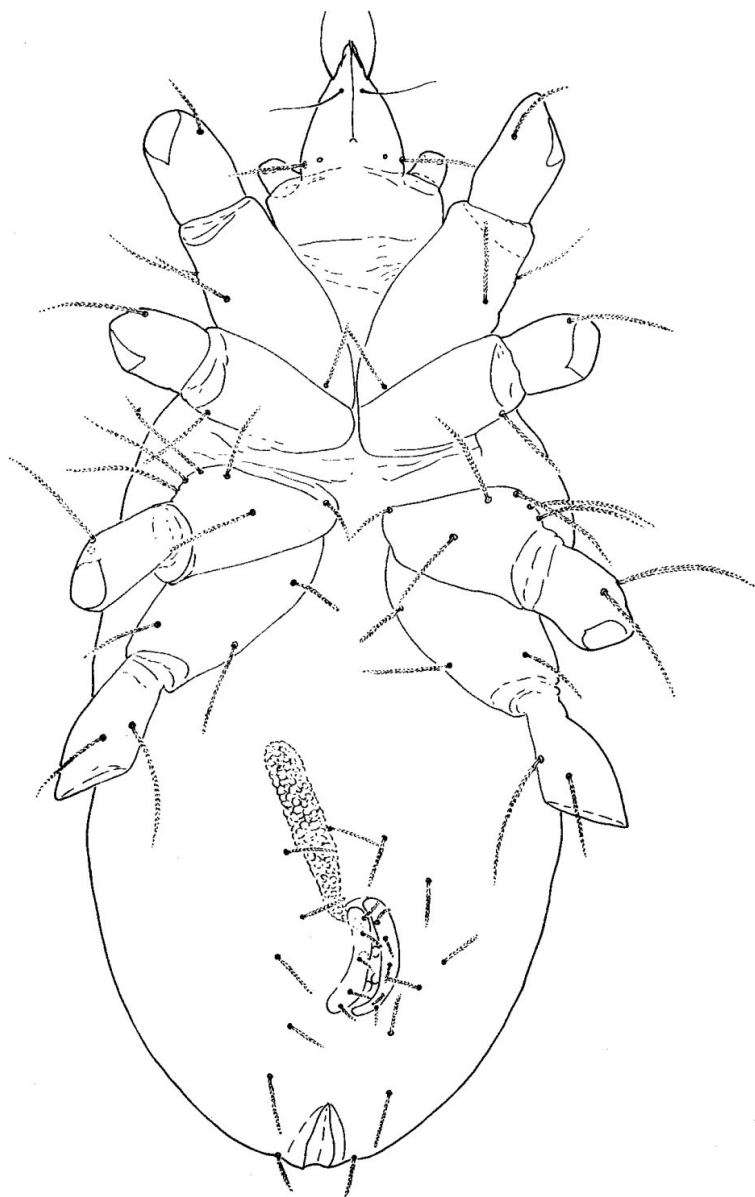


Fig. 4. *Foveacheles (F.) auricularia* sp. n., venter.

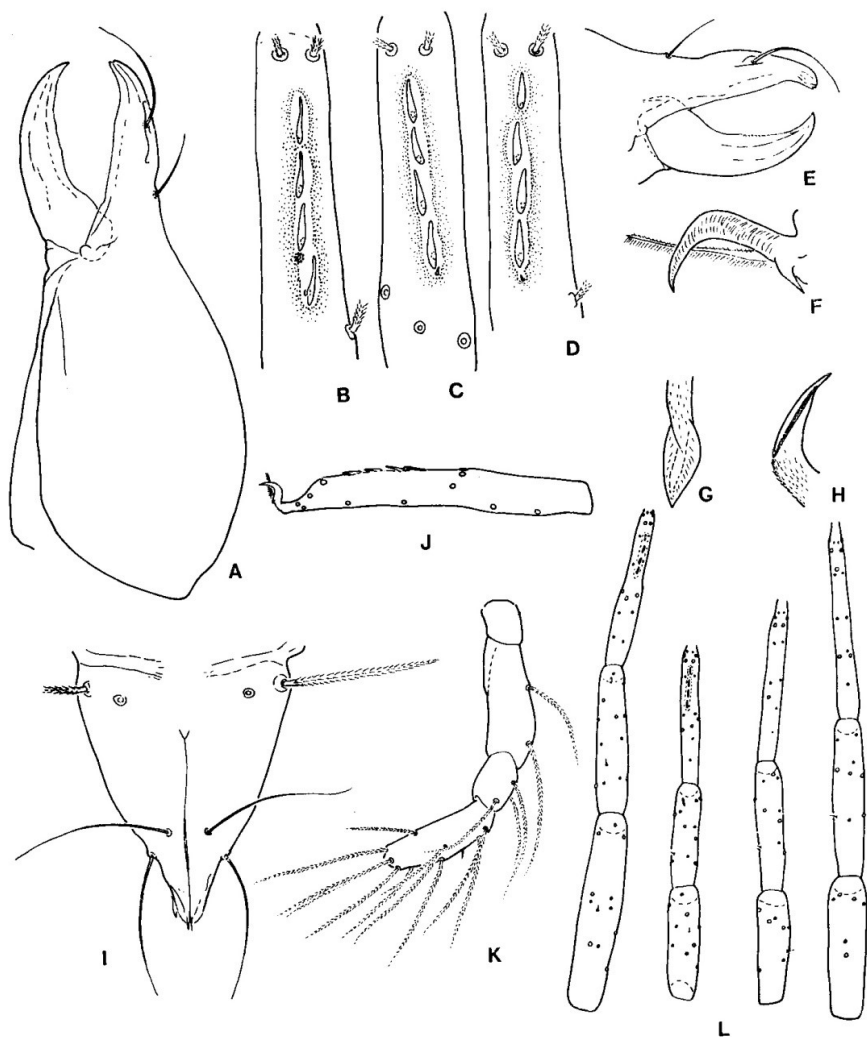


Fig. 5. *Foveacheles* (F.) *auricularia* sp. n., A - chelicera, B - rhagidial organ I, C-D - rhagidial organ II, E - cheliceral shears, F - empodium and claw on tarsus I, G-H - apical parts of claws III, I - hypostome, J - tarsus I in profile, K - pedipalpus, L - location of solenidia and setae on legs I-IV.



pit, sometimes only distal rhagidial seta separated. Stellate seta lateral beside 2nd proximal, or between 1st and 2nd proximal rhagidial setae. Rhagidial organ II consists of 4 rhagidial setae of the same arrangement, and in r. o. I. Small spiniform seta proximal.

Solenidia: Tibia I with 1 laterodorsal, proximal solenidion and dorsodistal rhagidial seta in deep depression, resembling usual lanceolate, dorsodistal seta on tibia II. Genu I with 1 ventromedial solenidion. Tibia II with 1 laterodorsal, proximal solenidion and dorsodistal lanceolate seta in deep depression with terminal pore. Genu II with 1 ventral, distomedial solenidion. Tibia III with 2 lateroproximal solenidia side by side; genu III with 1 mediolateral solenidion. Tibia IV with 1 laterodorsal, proximal solenidion. No other solenidia observed.

Material examined: 1 ♂, holotype, Trail Junction Cave, 24 km W of Fort Jones, Siskiyou Co., California, elevation 1 675 m, air temperature 3 °C, 29 April 1979, D. C. Rudolph, D. Cowan, B. van Ingen leg., coll. Nat. Mus. Nat. Hist., Washington, D. C.; 1 ♀, paratype, Planetary Dairy Cave, 24 km W of Fort Jones, Siskiyou Co., California, elevation 1 750 m, air temperature 3 °C, 29 April 1979, otherwise the same data as for the holotype.

Differential diagnosis: *Foveacheles* (*F.*) *auricularia* sp. n. seems to be very close to *F. (F.) osloensis* (SIG THOR) (cf. ZACHARDA, 1980), but it differs with the rhagidial organs I and II (separated and oblique rhagidial setae in *F. osloensis*), with 11 setae on the terminal palpal segment (the solenidion not included). The claws II, III, IV are also distinctly auriculate (indistinctly auriculate in *F. osloensis*).

Discussion: No distinct troglomorphisms have been observed. The species is named for its auriculate claws II, III, and IV. The two caves from which the specimens were taken are in an alpine environment, the Marble Mountains Wilderness of the Klamath Mountains. Snow cover was still 1.3 m on the date of collection. The two caves overlap in horizontal extent but no physical connection has yet been made between them by explorers. A large *Neotoma* nest in Planetary Dairy Cave was the organic source for several arthropods collected on 29 April 1979. Trail Junction Cave lies in a valley and occasionally takes surface runoff, as evidenced by logs and other organic debris in the cave (pers. comm., D. C. RUDOLPH and D. COWAN).

*Foveacheles* (*Uditorhagidia*) *titanica* sp. n.

Figs 6–7

Diagnosis: Large species (1 747–2 330  $\mu$ m) with distinct troglomorphisms and ventral polytrichy in progenital region. Epimeral formula 3-1-6-5, trochanteral formula 1-1-2-3 (4). Terminal palpal segment with distinct, short, blunt, apical projection, 13 ciliated setae and 1 spiniform solenidion.

Description: 3 ♀ examined. Body length 2 330, 1 957, 1 747  $\mu$ m; ratio of leg I length to body length: 1.16, 1.28, 1.48.

Dorsum: internal verticals 132; external verticals 211, 237; filiform trichoboth-

rium 255, 264; scapulars 325; internal humerals 167; internal sacrales 290; external sacrales 185; the other setae torn off.

Venter: Epimeral formula 3-1-6-5, trochanteral formula 1-1-2-3, 1-1-2-4/3; 7/8, 8, 9 pairs of progenital setae; 9/10 paragenitals. Progenital lips 255, 273  $\mu\text{m}$  long.

Gnathosoma: Hypostome slenderly oval, internal malae spiniform, external ones membranous, dentate on outer margin; ratio of length to breadth: 1.13, 1.20. Chelicerae with slender shears, distal cheliceral seta inserted in laterodorsal depression. Proximal cheliceral seta inserted distinctly distally to joint of digitus mobilis. Inner margin of digitus mobilis finely serrate. Chelicera length 440, 396, 431  $\mu\text{m}$ ;

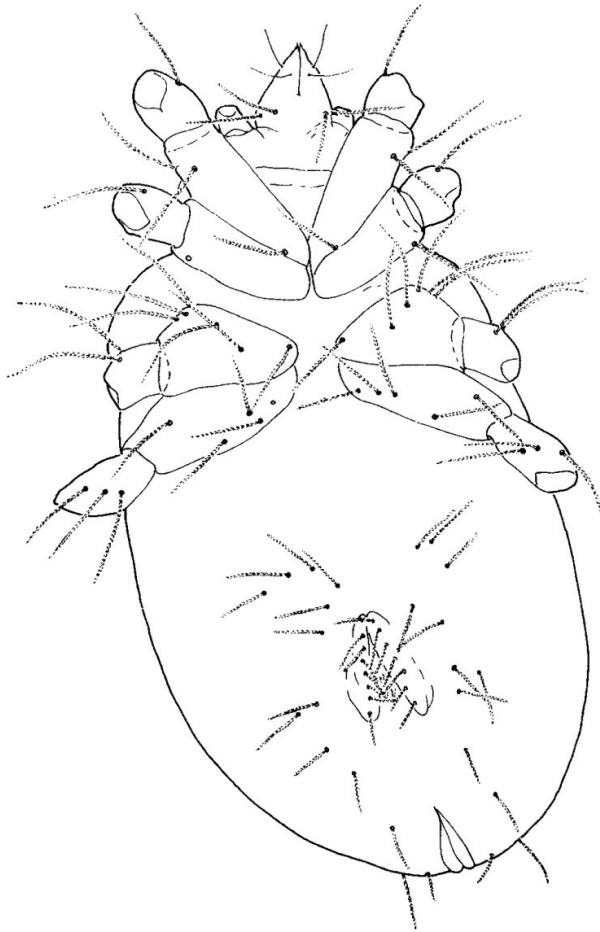


Fig. 6. *Foveacheles (U.) titanica* sp. n., venter.

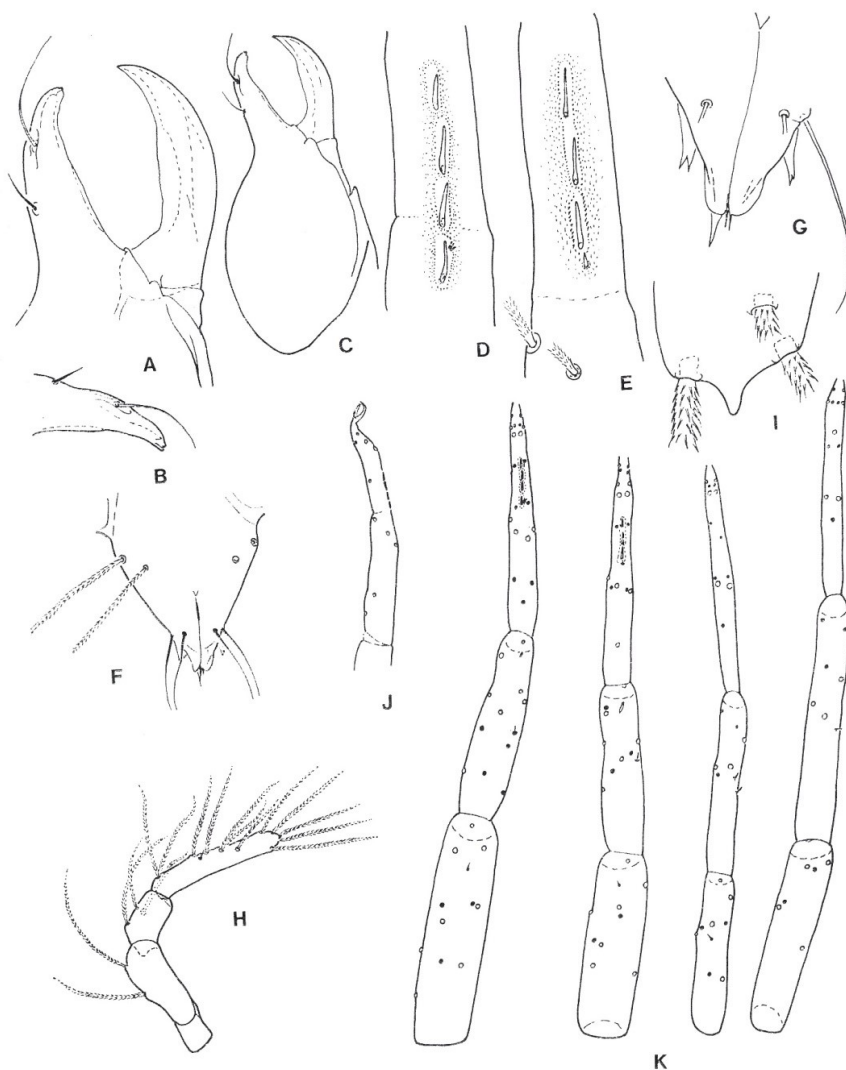


Fig. 7. *Foveacheles* (*U.*) *titanica* sp. n., A - cheliceral shears, B - insertion of cheliceral setae, C - chelicera, D - rhagidial organ I, E - rhagidial organ II, F - hypostome, G - terminal part of hypostome, H - pedipalpus, I - terminal part of terminal palpal segment, J - tarsus I in profile, K - location of solenidia and setae on legs I-IV.

breadth 202, 176, 167  $\mu\text{m}$ ; digitus mobilis length 167  $\mu\text{m}$ ; length of proximal and distal cheliceral setae 44, 35, and 80, 70  $\mu\text{m}$ , respectively; distance between bases of these setae 44, 53  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.17, 2.25, 2.58; digitus mobilis length to chelicera length: 0.37, 0.41; digitus mobilis length to chelicera breadth: 0.82, 0.94, 1.0.

Terminal palpal segment longitudinally oval, slender; ratio of length to breadth: 5.70, 5.14, 6.33; bearing 13 ciliated setae and 1 spiniform solenidion. Apex of terminal palpal segment with short, blunt projection. Tarsus I very long, slender; ratio of length to breadth: 7.88, 7.75, 9.28; gently rounded forward. Empodium relatively broad, not overlapping claws, with distinct basal clawlets.

Rhagidial organ I consists of 4 small, separated rhagidial setae lying tandem; stellate seta lateral to 1st proximal rhagidial seta, or between 1st and 2nd proximal r. setae. Rhagidial organ II consists of 3 separated, tandem rhagidial setae and 1 spiniform, proximal seta.

Solenidia: Tibia I with small, laterodorsal, proximomedial solenidion and small, dorsodistal rhagidial seta. Genu I with 1 distoventral solenidion. Tibia II with 1 lateromedial solenidion and dorsodistal, slender lanceolate seta in deep depression with terminal pore. Genu II with 1 distoventral solenidion. Tibia III with 2 very small solenidia - medioventral and mediolateral. Genu III with 1 mediodistoventral solenidion. Tibia IV with 1 medial, ventrolateral solenidion. No other solenidia observed.

Male - 1 specimen examined: body length 1 747  $\mu\text{m}$ ; ratio of leg I length to body length: 1.37. Rhagidial organs, ventral chaetotaxy, terminal palpal chaetotaxy, solenidia, as in females. Chelicera length 405  $\mu\text{m}$ , breadth 158  $\mu\text{m}$ ; digitus mobilis length 132  $\mu\text{m}$ ; length of proximal and distal cheliceral setae 35, 60  $\mu\text{m}$ , respectively; distance between their bases 44  $\mu\text{m}$ . Ratio of chelicera length to breadth: 2.56; digitus mobilis length to chelicera breadth: 0.83; digitus mobilis length to chelicera length: 0.32. Ratio of length of terminal palpal segment to its breadth: 5.33, the same for tarsus I: 9.14.

Material examined: 1 ♀, holotype, Indian Quarry Cave no. 1, 5.5 km N of Columbia, Tuolumne Co., California, elevation 305 m, 28 March 1979, J. Reddell leg., coll. Nat. Mus. Nat. Hist., Washington, D. C.; 1 ♂, paratype, otherwise the same data as for the holotype; 2 ♀, paratypes, Eagle View Cave no. 2, 9.8 km E of Angel's Camp, Calaveras Co., California, elevation 518 m, air temperature 14–15 °C, 30 March 1979, Barbara Martin, S. Winterath leg., coll. Nat. Mus. Nat. Hist., Washington, D. C.

Differential diagnosis: This species explicitly differs in its diagnostic characters from the other known representatives of the genus *Foveacheles*.

Discussion: *F. titanica* sp. n. bears distinct troglomorphisms (ZACHARDA, 1979), therefore it can be considered a genuine troglobitic species. However, the two caves in which *F. titanica* occurs, although only 1.7 km apart, are separated by the 200 to 300 m deep canyon of the Stanislaus River. The river probably began downcutting in its present position in the late Pliocene or early Pleistocene. Generally, the higher

caves in the canyon are thought to be older than the lower caves (BESSE and ROGERS, 1975). Indian Quarry Cave no. 1 is but a few meters above the river level and may be of Holocene age, whereas Eagle View Cave no. 2 is near the top and presumably is much older (late Pliocene-early Pleistocene). This situation is similar to that of the troglolithic harvestmen, *Banksula melones* BRIGGS and *B. grahami* BRIGGS, which also are found in caves at different elevations on both sides of the same river (BRIGGS, 1974; RUDOLPH, 1979). This suggests that conspecific troglolithic populations on both sides of the river have been isolated from each other for a short time, relative to the age of the canyon.

The name »*titanica*« has been used because the species is among the largest rhagidiids in the world (cf. ZACHARDA, 1980).

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