



A new Mexican species of *Folsomides* (Collembola: Isotomidae)

Una nueva especie mexicana de *Folsomides* (Collembola: Isotomidae)

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Abstract. A new species of *Folsomides* from Baja California Sur is described and illustrated. It is clearly differentiated from *F. chichinautzini* Kovác et Palacios-Vargas and *F. decemoculatus* Scherbakov by its smaller size, the different shape of the postantennal organ, the number of sensillae in the antennal segment IV, the number of dental setae and the body chaetotaxy. In addition a key for identification of the American species of *Folsomides* is provided.

Key words: Baja California Sur, sarcocaulous scrub, microarthropods, taxonomy.

Resumen. Se describe e ilustra una especie nueva de *Folsomides* de Baja California Sur, la cual se diferencia claramente de *F. chichinautzini* Kovác et Palacios-Vargas y de *F. decemoculatus* Scherbakov por ser de mucho menor tamaño, por la forma del órgano postantenal, por el número de sensilas en el antenito IV, por el número de sedas dentales y por la quetotaxia del cuerpo. Además, se proporciona una clave para identificar las especies de *Folsomides* del continente americano.

Palabras clave: Baja California Sur, matorral sarcocaul, microartrópodos, taxonomía.

Introduction

The genus *Folsomides* has a cosmopolitan distribution with 60 named species (Bellinger et al., 2012). From Mexico there have been described *F. yucatanicus*, *F. socorrensis*, and *F. chichinautzini* (described by Kovác and Palacios-Vargas, 1996), other recorded species given by Kovác and Palacios-Vargas (1996) are *F. angularis*, *F. centralis*, *F. parvulus*, and *F. semiparvulus*. During a recent study of the microarthropods from Baja California, we found some specimens of this genus which belonged to a new species that is described and illustrated herein. Regarding the extreme climate conditions of the locality where the organisms were found, it might be probable that this species is able to dehydrate and enter an inactive phase, strategy called cryptobiosis, which is far from being common in terrestrial invertebrates; however, it has been well described in *F. angularis* Axelson (Belgnaoui and Barra, 1989).

Materials and methods

Samples of biological soil crusts were collected from Baja California Sur. They were extracted into 75% alcohol by the Berlese-Tullgren funnels. Collembola specimens

were sorted and mounted under slides in Hoyer's solution. Drawings were done using a contrast face microscope and a *camera lucida*. Measurements were done with an ocular micrometer.

Description

Folsomides

Type species: *F. parvulus* Stach, 1922

Diagnosis (after Fjellberg, 1992). *Folsomides* is characterized by its long and cylindrical body, with an abrupt bend in dorsal profile between abdominal segments IV and V. Furcula present, dens always shorter than manubrium, with 2-6 dorsal and 0-3 ventroapical setae. Ventral setae absent on manubrium. Mucro present or absent, at most with 2 teeth. Mucronal seta absent. Head with 1-8 eyes on each side. PAO present. Prelabral setae 2. Maxillary palp simple or bifurcate, 3 sublobal hairs. Maxilla and mandibles unmodified. 3+3 setae along ventral line on head (postlabial). Antennae IV without apical bulb, subapical pit sometimes present, sensilla unmodified. Thorax without ventral setae. Ventral tube with 3+3 anterior and 1+1 posterior setae, frontals absent. Tenaculum with 2-4 teeth on each side, seta present or absent. Tibiotarsi with 20-20-22 or 19-19-21 setae, apical T-setae and clavate tenent hairs absent. Setae B₄ and B₅ on tibiotarsi 1-2 either absent or present as a single midline

seta ($B_{4/5}$) on inner side. Seta $\times$ on tibiotarsi third erect but unmodified. Unguis toothless. Tergites of thorax and abdomen with 33/22224 macrosensillae, in midtergal position on abdomen I-III. One microsensillum always present on thoracic segment II, absent or present on

thoracic III- abdominal segment III (at most 11/111). Body hairs smooth (or faintly serrate towards tip of abdomen), acuminate. Macrochaetae variable but generally poorly developed. Cuticle smooth, nontuberculate. Anal spines absent.

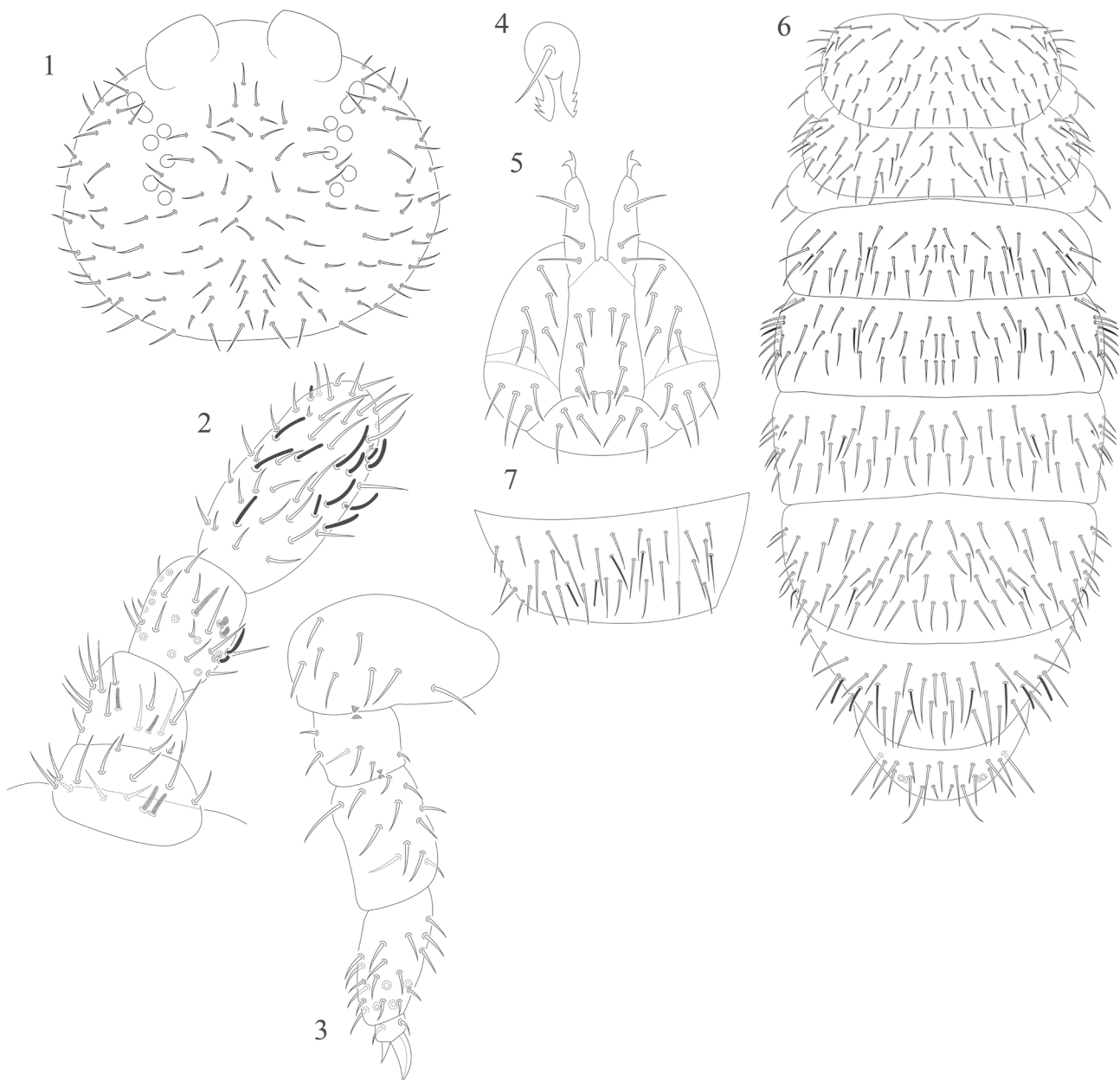
Key for the identification of the American species of *Folsomides*.

1. Furcula with well developed mucro	3
1'. Furcula without mucro	2
2. 5 + 5 eyes, tenaculum with 3 + 3 teeth and 1 seta	<i>F. andinesis</i> Díaz et Najt
2'. 2 + 2 eyes, tenaculum with 2 + 2 teeth and without seta	<i>F. yucatanicus</i> Kovác et Palacios-Vargas
3. 8 + 8 eyes, manubrium with 9 pairs of setae	<i>F. teres</i> Christiansen et Bellinger
3'. Less than 8 + 8 eyes, manubrium with less setae	4
4. 6 + 6 eyes	13
4'. Less than 6 + 6 eyes	5
5. 5 + 5 eyes	10
5'. Less than 5 + 5 eyes	6
6. 4 + 4 eyes, dens with 2 dorsal and 1 ventral seta	<i>F. socorrensis</i> Kovác and Palacios-Vargas
6'. Less than 4 + 4 eyes and different combination of dental setae	7
7. 2 + 2 eyes	8
7'. 1 + 1 eyes	9
8. Tenaculum with 4 + 4 teeth and 1 seta, dens with 11 setae	<i>F. troglobius</i> Rapoport et Maño
8'. Tenaculum with 2 + 2 teeth and without seta, dens with only 2 dorsal setae	<i>F. semiparvulus</i> Fjellberg
9. Dens with only 1 seta; tenaculum with 2 + 2 teeth	<i>F. monosetis</i> Massoud et Rapoport
9'. Dens with 3 dorsal setae; tenaculum with 3 + 3 teeth (sometimes with 2 + 2 eyes of different size)	<i>F. parvulus</i> Stach
10. Tenaculum with 4 + 4 teeth and 1 seta; dens with 3 dorsal and 1 ventral seta	<i>F. angularis</i> Axelson
10'. Tenaculum with 3 + 3 teeth and 1 seta; dens with 2-3 dorsal setae and none ventral	11
11. Dens with only 2 dorsal setae	<i>F. chichinautzini</i> Kovác et Palacios-Vargas
11'. Dens with 3 dorsal setae	12
12. Mucro clearly fused to dens, body length of 0.8 to 1.0 mm	<i>F. marchicus</i> Frenzel
12'. Mucro clearly separated from dens, body length less than 0.5 mm	<i>F. californicus</i> n. sp.
13. Dens with 6 dorsal setae, and none ventral setae	<i>F. centralis</i> Denis
13'. Dens with 3 dorsal setae and 1 ventral	<i>F. delamarei</i> Thibaud et Jacquemart

Folsomides californicus n. sp. (Figs. 1-7)

Body length of 432 μ m, cylindrically shaped and smooth cuticle typical for the genus. Color white and pigmentation absent, except 5+5 ocelli (Fig. 1). Ocelli diameter of 4 μ m. Post antennal organ elliptical with slight constriction in the middle, 9 μ m long and 5 μ m wide, with 2 posterior setae. Ratio eyes: PAO=1:2. Head length of 99 μ m, antennae 93 μ m. Antennal segments length I-IV: 14, 20, 23 and 40 μ m. Antennal segment I with 2 ventral proximal sensillae shorter than the antennal segment IV, and 10 ordinary setae. Antennal segment II with 3 basal microsetae, 2 external medial sensillae with similar length to those in antennal segment I, and 14 ordinary setae. Sensorial organ of antennal segment III with 4 sensory setae: 2 inner short and straight sensory rods not covered

by integumentary fold, situated in a cupulate depression and with 2 long and curved guard sensillae (Fig. 2). One dorso-external microsensillum, 1 lateral microseta and 22 ordinary setae present on antennal segment III. Antennal segment IV without apical bulb, with 12 sensillae of which 2 are shorter than the others, 1 microsensillum, 4 microsetae, and a subapical pit present (Fig. 2). Maxillary palp simple with 3 sublobal hairs and 3+3 setae along ventral line on head (postlabial). Thorax without ventral setae. Microsensillae of thoracic II-abdominal segment III 1,0/0,0,1 freely exposed on the body surface. Abdominal chaetotaxy in figure 6. Sensillae slender and long as surrounding setae with 3,3/2,2,2,2,4 (Fig. 6). In abdominal segment V a pair of sensillae situated on the p-row, distinctly thicker and shorter (Fig. 7). Tergal macrosetae



Figures 1-7. *Folsomides californicus* n. sp. 1, head chaetotaxy in dorsal view. 2, antennal segments I to IV. 3, coxa to tibiotarsus of leg III. 4, tenaculum. 5, furcula. 6, dorsal chaetotaxy of thoracic II to abdominal segment IV. 7, lateral view of abdominal segment V.

developed as type 2 (Fjellberg, 1992). In the abdominal segment VI 4+4 macrosetae present, 1 posterior pair thicker than others. 5+5 setae on abdominal segment VI, with 1 pair reduced. Axial chaetotaxy from thoracic II-abdominal segment IV: 5,3/3,3,3,5. Chaetotaxy of legs I to III: coxae: 4,7,7; trochanter: 6,6,6; femora: 12,12,13 (in the Fig. 3 the specimen had only 12 setae); tibiotarsi: 19,19,21. Unguis and unguiculus without teeth. Tibiotarsi I and II

without seta B 4/5, seta $\times$ absent on Tibiotarsus III (Fig. 3). Ventral tube with 3+3 anterior setae and 1+1 posterior seta, frontal setae absent. Tenaculum with 3+3 teeth and 1 seta on corpus (Fig. 4). Variable number of *subcoxae furcalis* setae, anterior with 5-6 setae whereas the posterior has 4, with a medial setae developed as macrochaetae (Fig. 5). Manubrium dorsal side with 6+6 pairs of setae: 2 distal, 1 medial and 3 proximal. Dens with 3+3 dorsal setae and

Table 1. Differential characters of *Folsomides angularis*-group (described in Fjellberg, 1992)

	Length (mm)*	Shape of PAO	Maxillary palp	Microsensillae (Th. 2-Abd. III)	Macrosensillae on Abd. V**	Macrochaetae	B 4/5 on tibiotalarsus I and II	Tenaculum (teeth/setae)	Setae on dens (dorsal/ventral)
<i>F. portulcalensis</i> Gama, 1961	0.85	Narrow and elongate	Bifurcate	11/111	Slightly shorter, not thicker	Type 3	+	3/1	2-6/1
<i>F. xerophilus</i> Fjellberg, 1992	0.75	Elongate	Bifurcate	11/111	Shorter, not thicker	Type 3	+	3/1	5(3-5)/0
<i>F. vinosus</i> Fjellberg, 1992	0.70	Wide, roundish	Bifurcate	10/001	Thicker	Type 3	+	3/1	1/3
<i>F. angularis</i> Axelson, 1905	0.60	Elongate	Bifurcate	10/001	Shorter and thicker	Type 3	+	4/1	3/1
<i>F. petiti</i> Delamare, 1951	0.60	Elongate	Bifurcate	10/000	Shorter and thicker	Type 3	+	3/0	2/0
<i>F. cumbrosus</i> Fjellberg, 1992	0.80	Oval	Bifurcate	11/111	Shorter and thicker	Type 2-3	+	3/1	2/0
<i>F. unicus</i> Fjellberg, 1992	0.60	Elongate	Bifurcate	11/100	Shorter and thicker	Type 3	+	3/1	2/0
<i>F. terrus</i> Fjellberg, 1992	0.55	Narrow and elongate	Simple	11/000	Shorter and slightly thicker	Type 3	+	3/0-3/1	2/0
<i>F. pocsensillatus</i> Fjellberg, 1992	0.85	Narrow and elongate	Simple	11/000	Shorter and slightly thicker	Type 3	+	3/1	2/1
<i>F. californicus</i> sp. nov.	0.56	Elliptical	Simple	10/001	Shorter and thicker	Type 2	+	3/1	3/0

+, present; -, absent; *, largest specimen; **, compared with the upper pair.

none on ventral surface, being the medial shortest; and the proximal largest, with 5, 6 and 10 μm each one. Mucro distinctly separated from dens with 2 apical teeth without lamella. Manubrium length of 31 μm , dens 23 μm and mucro 6 μm (Fig. 5). Both sexes known. Female with 3+3 pregenital, 2 circumgenital and 2 eugenital setae. Male with 3+3 pregenital, 6 circumgenital and 4+4 eugenital setae. A variability of 1 plus or 1 seta less on dorsal side of manubrium was observed in 4 specimens. An adult specimen had 2+2 setae on dorsal side of dens instead of 3+3. Another specimen had 2+3 setae on dens, with the distal missing. Also found a variation from 4 up to 9 setae on anterior *subcoxae furcalis* and of 2 up to 8 on posterior. Unpaired axial setae were seen on some specimens: in medial setae of 3 specimens in thoracic segment III and of 2 specimens in abdominal segment II, while 4 specimens had not paired axial setae in the p-row of thoracic segment II. An inconstant number of axial setae (4-5), some of them unpaired were seen on abdominal segment IV.

Taxonomic summary

Type material: holotype male and 11 paratypes on slides (9 females and 2 males): Mexico, Baja California Sur, Estación Biológica "Dra. Laura Arriaga Cabrera", sarcocaulous scrub, soil and leaf litter, 26- IX-2011, J. Villarreal-Rosas, col. The type material is deposited in the Collembola collection of the Microarthropod Ecology and Systematics Lab, UNAM.

Etymology: the specific name derives from the type locality.

Remarks. *Folsomides californicus* n. sp. is similar to *F. chichinautzini* and to *F. decemoculatus* in the number of eyes on each side (5). Also the new species is smaller (432, 700 and 900 μm , respectively). On the other hand, *F. californicus* n. sp. differs from *F. chichinautzini* in the post antennal organ: elliptical vs. elongated (9 μm long and 5 μm wide, vs. 17 long and 6 wide). Antennal segment I with 2 short ventral sensillae and even in length versus the unequal found in *F. chichinautzini*, the external one being thicker and longer. Antennal segment II with 2 external medial sensillae (vs. one) and 14 ordinary setae (vs. 15). Antennal segment III with 1 microseta (vs. none). Antennal segment IV with 12 sensillae (vs. 19) and the presence of a subapical pit (versus none). There are also differences in body chaetotaxy, tibiotarsi I-II without seta B 4/5 (vs. with), axial chaetotaxy thoracic segment II–

abdominal segment IV 5,3/3,3,3,5 (vs. 6,4/3,3,3,6); dorsal side of manubrium with 6+6 pairs of setae (vs. 8); dens with 3+3 dorsal setae (vs. 2). Manubrium length of 31 μm , dens 23 μm and mucro 6 μm (vs. 50, 18, 10).

The differences between *F. californicus* n. sp. and *F. decemoculatus* are the sensillae from antennal segment IV (12 vs. 5-7), number of tenacular teeth (3+3 vs. 4+4), dens with 3 setae (vs. 4) and mucro distinctly separated from dens (vs. fused). The 5+5 ocelli and the presence of mucro on dens makes *F. californicus* n. sp. part of *F. angularis*-group (Fjellberg, 1992). Differential characters among all the species with 5 ocelli on each side are given in Table 1. *Folsomides californicus* together with *F. terrus* Fjellberg, 1992 and *F. pocosensillatus* Fjellberg, 1992 are the only species that have simple maxillary palp, this characteristic is related to the very dry environmental conditions in which those species were found. Of these *F. californicus* n. sp. is the only with a distribution of microsensillae at 10/001, development of macrosetae type 2, and 3 setae on dorsal part of dens. Among all the other species, *F. californicus* n. sp. is shortest in average, even though the largest specimen found is very similar in length to *F. terrus*.

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Literature cited

- Belgnaoui, S. and J. A. Barra. 1989. Water loss and survival in the anhydrobiotic Collembola *Folsomides angularis* (Insecta). *Revue d'Écologie et de Biologie du Sol* 26:123-132.
- Bellinger, P. F., K. A. Christiansen and F. Janssens. 2012. Checklist of the Collembola of the World. On line at <http://www.collembola.org>; last access: 6.VIII.2012.
- Fjellberg, A. 1992. Revision of European and North African *Folsomides* Stach with special emphasis on the Canarian fauna (Collembola: Isotomidae). *Entomologica Scandinavica* 23:453-473.
- Kováč, L. and J. G. Palacios-Vargas. 1996. Survey of Mexican *Folsomides* (Collembola: Isotomidae) with description of 3 new species. *European Journal of Entomology* 93:595-606.