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Taxonomy and systematics

Five new species of *Pseudachorutes* (Collembola: Neanuridae) from Mexico

Cinco especies nuevas de Pseudachorutes *(Collembola: Neanuridae) de México*

José G. Palacios-Vargas [a], Erika Rivero-Sánchez [a], Yan Gao [b], Margarita Ojeda [a, *]

[a] *Universidad Nacional Autónoma de México, Facultad de Ciencias, Departamento de Ecología y Recursos Naturales, Laboratorio de Ecología y Sistemática de Microartrópodos, Circuito Exterior s/n, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico*

[b] *China Shanghai Natural History Museum, Shanghai Science & Technology Museum, Shanhaiguan Road, Jing'an district, Shanghai 200041, China*

*Corresponding author: margojeda@gmail.com (M. Ojeda)

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Abstract

As a result of 40 years of work and many projects on soil fauna and especially springtails, a collection of edaphic microarthropods has been established at the Facultad de Ciencias, UNAM, and has the name of "Colección de ácaros y colémbolos del Laboratorio de Ecología y Sistemática de Microartrópodos". During the revision of material belonging to the subfamily Pseudachorutinae kept in the Collembola collection, we obtained 581 records of 28 species of *Pseudachorutes*, from 20 states and 62 localities from Mexico. Three are new records: *P.* ca. *algidensis*, *P.* ca. *crassus*, and *P. reductus*, and 5 new species from soil, litter and epiphytic plants in Mexico are described and illustrated herein: *P. tabasquensis* sp. nov., *P. mexicanus* sp. nov., *P. chichinautzin* sp. nov., *P. tillandsiodes* sp. nov., and *P. veracruzensis* sp. nov.

Keywords: Springtails; Records; Distribution; Taxonomy

Resumen

Como resultado del trabajo de más de 40 años y diversos proyectos sobre la fauna del suelo, especialmente colémbolos, se estableció en la Facultad de Ciencias, UNAM, una colección de microartrópodos edáficos, registrada con el nombre de "Colección de ácaros y colémbolos del Laboratorio de Ecología y Sistemática de Microartrópodos".

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Durante la revisión del material depositado en ella, especialmente de la subfamilia Pseudachorutinae, se obtuvo información de 581 registros de 28 especies de *Pseudachorutes* distribuidos en 20 estados y 62 localidades del país. De éstas, 3 son nuevos registros (*P.* ca. *algidensis*, *P.* ca. *crasus* y *P. reductus*) y 5 son especies nuevas provenientes de suelo, hojarasca y plantas epífitas en México, que se describen e ilustran aquí: *P. tabasquensis* sp. nov., *P. mexicanus* sp. nov., *P. chichinautzin* sp. nov., *P. tillandsiodes* sp. nov. y *P. veracruzensis* sp. nov.

Palabras clave: Colémbolos; Registros; Distribución; Taxonomía

Introduction

The genus *Pseudachorutes* Tullberg, 1871 (Neanuridae: Pseudachorutinae) was based on the type species *Pseudachorutes subcrassus* Tullberg, 1871 characterized by: *1)* ocelli 8+8; *2)* postantennal organ in one circle or ellipse; *3)* Ant. III and IV dorsally fused, Ant. IV generally with 6 sensilla and apical bulb, Ant. III organ with 2 microsensilla in a cuticular fold, 2 guard sensilla and one microsensillum; *4)* bucal cone sharp, mandible with 2 or more teeth, maxilla styliform; *5)* unguiculus absent; *6)* furcula usually well developed, mucro present; *7)* sixth abdominal segment always visible in dorsal view, anal spines absent (Christiansen & Bellinger, 1998; Fjellberg, 1998; Palacios-Vargas, 1990).

Currently there are 119 species of *Pseudachorutes* in the world (Bellinger et al., 2023), and for Mexico records of 20 species from 18 states are known (Arango-Galván et al., 2007; Cutz-Pool et al., 2003, 2007a, b, 2008; Palacios-Vargas, 1997, 2005; Palacios-Vargas & Castaño-Meneses, 2003; Palacios-Vargas et al., 2000, 2007; Vázquez, 1988; Vázquez & Palacios-Vargas, 1990, 2004). The genus is found in great abundance in many ecosystems and biotopes, including soil, litter, mosses, epiphytic plants and even the forest canopy.

During a recent project to study a collection of the subfamily Pseudachorutinae housed in the Collembola collection of the Laboratorio de Ecología y Sistemática de Microartrópodos (LESM), we found 5 new species of *Pseudachorutes* and their descriptions and illustrations are given herein.

Materials and methods

Examination of the material deposited in the LESM scientific collection "Colección de ácaros y colémbolos" (register number D.F.-ENT-229-09-09, issued by Subsecretaría de Gestión para la Protección Ambiental, Dirección de Vida Silvestre) was made to separate all the specimens of the genus *Pseudachorutes*. The specimens are permanently mounted in Hoyer's medium slides. Measurements are presented as the range with means in parentheses and expressed in micrometers (µm). Drawings were made with the aid of a phase contrast microscope Carl Zeiss Standard 3 K7, equipped with a drawing tube. The full body scales correspond to 500 µm, and the rest of the structures to 100 µm.

Type specimens are deposited in the LESM. The chaetotaxy system follows that of Jordana et al. (1997). Abbreviations used in this paper are: Ant. = antennal segment (s), Abd. = abdominal segment (s), PAO = postantennal organ, sgd = dorsal guard sensillum, sgv = ventral guard sensillum, Th. = thoracic segment (s).

Descriptions

Class Collembola Lubbock, 1870
Order Poduromorpha Börner, 1913
Family Neanuridae Börner, 1901
Subfamily Pseudachorutinae Börner, 1906
Genus *Pseudachorutes* Tullberg, 1871
New records

Pseudachorutes ca. *algidensis* Carpenter, 1925. Mexico: Hidalgo: Mineral El Chico, 2,900 m asl, 1 specimen, ex *Tillandsia violacea*, 10-IX-1998, J.A. Monterrubio, col. *Pseudachorutes* ca. *crassus* da Gama, 1964. Mexico: Popocatépetl, 3,800 m asl, 1 specimen, ex litter, 29-I-1983, J.G. Palacios, col. *Pseudachorutes reductus* Thibaud & Massoud, 1983. Mexico: Veracruz: Estación de Biología Tropical, Los Tuxtlas, 8 specimens, 20-X-1997, J. Álvarez, col. Tamaulipas: Rancho El Cielo, 975 m asl, 1 specimen, ex soil, XI-1987, F. J. Villalobos, col.

Pseudachorutes tabasquensis sp. nov.
(Fig. 1 A-L, Table 1a-c)
http://zoobank.org/urn:lsid:zoobank.org:act:C3BDFC0D-8F06-41F2-83317E7904656BB5

Description. Body length (n = 7): 2,625 µm (range: 1,250-4,000 µm). Body color gray-violet, with dark eyes patches. Granulations are fine and homogenous. Body setae simple and smooth, but with 2 kinds of setae, long macrosetae (M 22-24 µm) and short microsetae (m 10-12 µm), the sensorial setae relatively long (54-56 µm) (Fig. 1 A, B).

Antennae as long as head. Ant. I with 7 setae, Ant. II with 11 setae. Ant. III and IV dorsally fused. Ant.

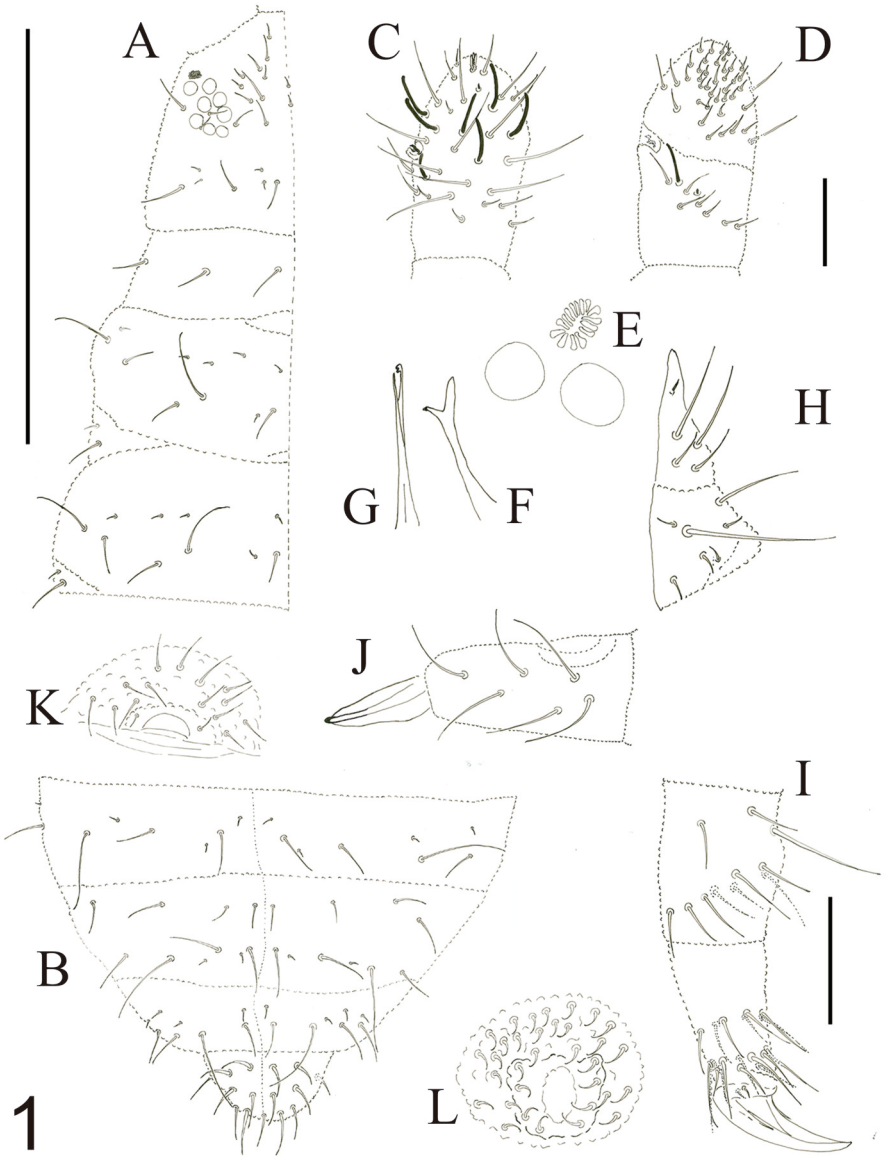

Figure 1. A-L. *Pseudachorutes tabasquensis* sp. nov. A) Dorsal chaetotaxy from head to Th. III; B) dorsal chaetotaxy from Abd. III. to Abd. VI; C) Ant. III-IV right antenna, dorsal view; D) Ant. III-IV right antenna, ventral view; E) PAO and nearby eyes; F) mandible; G) maxilla; H) labium; I) femur, tibiotarsus, and unguis III; J) dens and mucron; K) female genital plate; L) male genital plate.

segments ratio I: II: III+IV as 1: 1; 1.8. Ant. III-organ with 2 small straight internal sensilla under a cuticular fold, 2 guard sensilla (sgv about 1.4 times as long as sgd) and 1 microsensillum close to ventral guard sensillum. Ant. IV with trilobed apical bulb, 6 cylindrical sensilla, seta "i", and one subapical organite (Fig. 1C), ventral file with 25-30 short and strongly spine-like setae (Fig. 1D). PAO elliptical composed of 13-17 simple vesicles, 0.9 times smaller than the nearest eyes (Fig. 1E). 8+8 eyes, F, G are 0.7 times smaller than others. Buccal cone elongated. Mandible with 2 slender teeth (Fig. 1F). Maxilla styliform, with 2 blades, one has an apical tooth, another has 2 apical teeth (Fig. 1G). Labium with normal chaetotaxy of the genus from setae A to G and 4 lateral setae. Setae L spine-shape (Fig. 1H).

Dorsal chaetotaxy as in figure 1A-B, table 1a, b. Seta a0 on the head absent, unpaired seta d1 present, sometimes, one additional seta d3' between the seta d3 present. Th. I

Table 1

Pseudachorutes tabasquensis sp. nov. a) Head chaetotaxy, b) dorsal chaetotaxy, c) main characters between *P. orghidani*, *P. conicus*, and P. *tabasquensis* sp. nov.

1a.

	sd	d	oc	c	p
Number of setae	5	4+1	3	1	4
Setae absent				c_1, c_3, c_4	

1b.

	a	m	p	Setae absent	
Th. I	-	3	-		m_2
Th. II	4	2	5	a_5	m_5
Th. III	3	2	5	a_2, a_5	m_5
Abd. I-III	4	-	5	a_2	
Abd. IV	4	-	6		
Abd. V	4	-	4		
Abd. VI	2	2	2+1		

1c.

Characters	*P. conicus*	*P. tabasquensis* sp. nov.	*P. orghidani*
Labium setae L	-	+	?
Ant. IV sensilla	5	6	5
Ventral tube setae	3+3	4+4	?
Mandible teeth	3	2	3
Ventral file on Ant. IV	-	25-30 short setae	25-30 cuniform
Vesicles of PAO	13-15	13-17	17

with 3+3 setae, plus 1+1 lateral. Seta a2 present on Th. II, but absent from Th. III to Abd. V. Sensorial setae s on the body in position of p4 and m6 on the thoracic segments II and III, and p5 from Abd. I to IV and p2 on Abd. V. Sensorial formula of the body 022/11111. Sensorial setae 2 times as long as the macrosetae. The ratio of the largest Abd. V setae and inner unguis length is 1.0. Thoracic sterna without setae.

Legs setation from I to III is, tibiotarsi 19, 19, 18, without tenent hairs; Femora 10, 10, 11, one ventro-proximal seta is an acuminate tenent hair; trochanters with 5,5,5; coxae 3, 7, 7; subcoxae 2: 0, 2, 2; subcoxae 1: 1, 2, 2. Unguis wide with one inner tooth near 1/3 part from the basal, and a weakly subbasal lateral tooth. Ratio of tibiotarsus III and unguis about 1.6. Unguiculus absent (Fig. 1I).

Furcula is well developed. Dens dorsally with 6 setae, ventral with a smooth area. Mucro straight, 1.8 times shorter than dens, with granulations and 2 small lamellae (Fig. 1J). Tenaculum with 3+3 teeth. Ventral tube with 4+4 setae. Female genital plate with 3+3 pregenital setae, 6-14 circumgenital setae and 1+1 eugenital setae (Fig. 1K). Male genital plate with 3+3 pregenital setae, 25 circumgenital setae and 4+4 eugenital setae (Fig. 1L).

Taxonomic summary

Type material. Holotype: male mounted on a slide (FC-UNAM: LESM-AC: 23013). 5 paratypes females and 1 juvenile mounted on slides (FC-UNAM: LESM-AC: 23014-23019), same data as holotype.

Type locality. Mexico, Tabasco, Tapijulapa, outside cave “Las Sardinas”, ex litter, 14-III-2002, D.A. Estrada col.

Etymology. The name is locative for the state of Tabasco where the type locality is.

Remarks

Pseudachorutes tabasquensis sp. nov. shares with *P. orghidani* Massoud & Gruia, 1973 the presence of 1 internal and 1 lateral tooth on unguis. The new species also resembles *P. conicus* Lee & Kim, 1994 from Korea due to the presence of 2 types of body setae. They all share a similar number of PAO vesicles (Table 1c), dens with 6 setae and tenaculum with 3+3 teeth. Main differences between them are shown in Table 1c. Additionally, *P. conicus* has a very long and thin unguis, but in *P. tabasquensis* it is short and thick.

Pseudachorutes mexicanus sp. nov.
(Fig. 2A-K, Table 2a-b)
http://zoobank.org/urn:lsid:zoobank.org:act:96997B68-7B09-4EC1-9563-2D3DF01AEA77

Description. Body length (n = 17): 814 µm (range: 470-1,350 µm). Color of the body gray-violet, with a dark eyes patch. Granulations are fine and homogenous. Posterior setae of body long and capitated (Fig. 2A).

Antennae as long as head. Ant. I with 7 setae, Ant. II with 11 setae. Ant. III and IV dorsally fused. Ant. segments ratio I: II; III+IV as 1: 1.4; 3.2. Ant. III-organ with 2 small straight internal sensilla under a cuticular fold, 2 guard sensilla (sgv about 1.2 times as long as sgd) and 1 microsensillum close to ventral guard sensillum. Ant. IV with simple apical bulb, 6 cylindrical sensilla, seta "i", 1 microsensillum and 1 subapical organite (Fig. 2B), ventral file poorly developed, with 20-35 short setae (Fig. 2C). PAO elliptical composed of 5-6 simple vesicles, 1.1 times as long as the nearest ocelli (Fig. 2D). 8+8 small ocelli, F, G are 0.9 times smaller than others. Buccal cone short. Mandible with 2 slender teeth (Fig. 2E). Maxilla with 2 blades, each has 2 apical teeth (Fig. 2F). Labium with normal chaetotaxy of the genus from setae A to G and 4 lateral setae, setae L spine-shape (Fig. 2G).

Dorsal chaetotaxy as in figure 2A, table 2b. Seta a0 on head absent, unpaired seta d1 present. Th. I with 3+3 setae. Setae a2 present on Th. II, but absent from Th. III to Abd. V. Sensory setae s on the body in position of p4 and m6 on Th. II and III, and p5 from Abd. I to IV and p2 on Abd. V. Sensorial formula of the body 022/11111. Sensory setae longer than 1.1-1.5 times as long as body setae. Ratio of largest Abd. V setae and inner unguis length is 1.4. Thoracic sterna without setae. Ventral tube with 4+4 setae. Female genital plate with 2+2 pregenital setae, 4-9 circumgenital setae and 1+1 eugenital setae (Fig. 2H). Male genital plate with 3+3 pregenital setae, 10 circumgenital setae and 4+4 eugenital setae (Fig. 2I).

Tibiotarsi I, II, III with 18, 18, 17 setae respectively, with 1 tenent hair long and capitate (Fig. B8). Femora I, II, III with 9, 9, 10 setae respectively. Trochanters with 5 setae each. Coxae I, II, III with 3, 7, 7 setae respectively. Subcoxae 2 I, II, III with 0, 2, 2 setae respectively. Subcoxae 1. I, II, III with 1, 2-3, 2-3 setae respectively. Unguis wide with 1 weakly apical inner tooth. Ratio of tibiotarsus III and unguis about 1.0. Unguiculus absent (Fig. 2J).

Furcula well developed. Dens dorsally with 5 setae. Mucro straight, 3 times shorter than dens, with two larger bladder-like swelling visible and a hook-like end (Fig. 2K). Tenaculum with 3+3 teeth.

Taxonomic summary

Type material. Holotype: female mounted on a slide (FC-UNAM: LESM-AC: 22996). 16 paratypes: 4 females, 1 male and 11 juveniles under slides (FC-UNAM: LESM-AC: 22997-23012), same data as holotype.

Type locality. Mexico, Hidalgo, Mineral El Chico, 10-IX-98, J.A. Monterrubio, col. Ex *Tillandsia violacea*.

Etymology. The name of the new species is after the country of the type locality: Mexico.

Remarks

This species resembles *P. americanus* Stach, 1949 with a similar number of vesicles in PAO (*P. americanus* with 5-8 vesicles), unguis with 1 minute tooth near apex, one large, clavate tenent hair, ventral tube with 4+4 setae, tenaculum with 3+3 teeth and posterior abdominal setae clearly capitate. However, dens of the new species with 5 setae, maxilla with 2 blades and each has 2 apical teeth, 6 cylindrical sensilla on Ant. IV and a poorly developed ventral file with 20-35 short setae is different from *P. americanus.*

Pseudachorutes chichinautzin sp. nov.
(Fig. 3A-J, Table 3a-c)
http://zoobank.org/urn:lsid:zoobank.org:act:1098FF48-F5CE-4D51-8F9E-0EB9E217AA40

Description. Body length (n = 8): 1,904 µm (range: 850-2,010 µm). Color of the body gray-violet, with a dark eyes patch. Granulations homogenous. Lateral and posterior body setae are longer and truncate (Fig. 3A).

Antennae as long as head. Ant. I with 7 setae, Ant. II with 12 setae. Ant. III and IV dorsally fused. Ant. segments ratio I: II; III+IV as 1: 1.2: 2.0. Ant. III-organ with 2 small internal sensilla under a cuticular fold, 2 guard sensilla (sgv about 1.1 times as long as sgd) and 1 microsensillum close to ventral guard sensillum. Ant. IV with trilobed apical bulb, 6 cylindrical sensilla, seta "i", and one subapical organite (Fig. 3B), ventral file with about 10 strong, spine-like setae and several slender, normal setae (Fig. 3C). Some setae on Ant. IV are blunt. PAO elliptical composed of 10-12 vesicles, sometimes, 1 or 2 of them inside in the others, subequal to nearest eyes

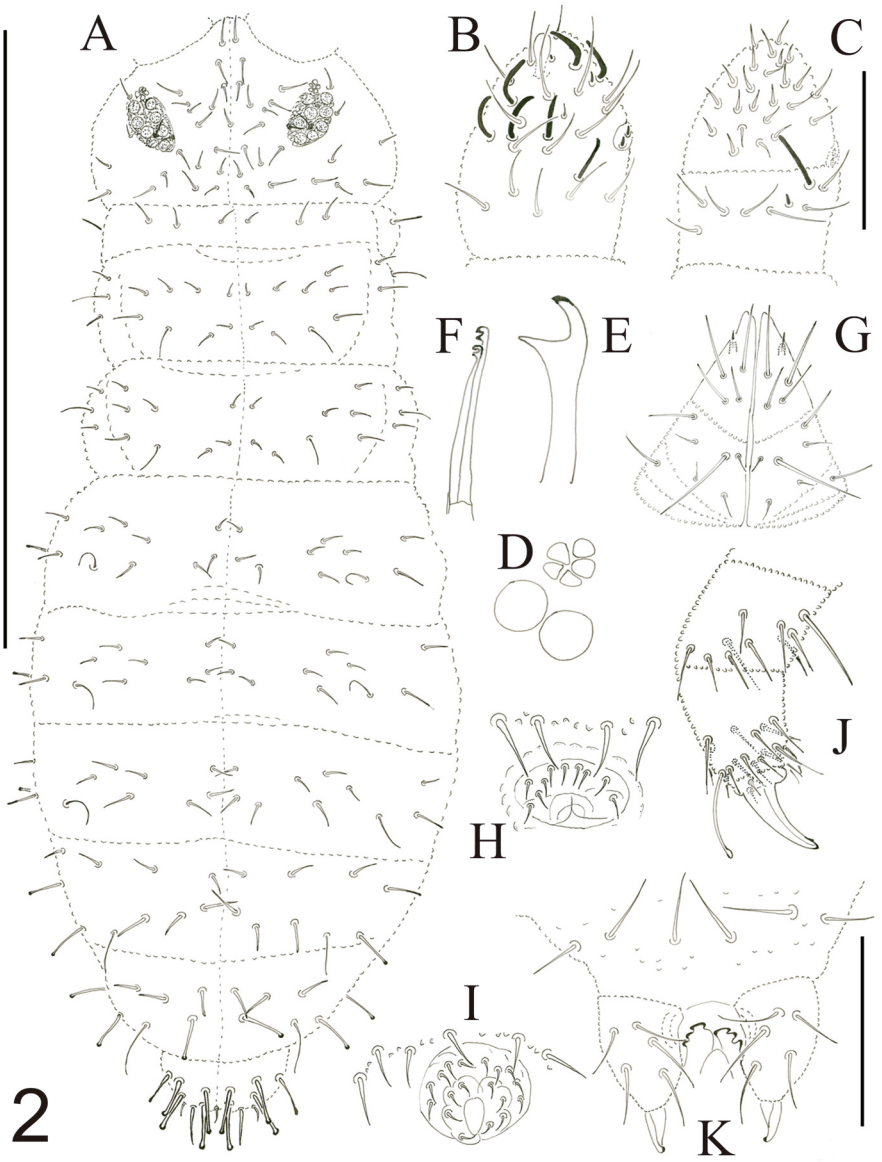

Figure 2. A-K. *Pseudachorutes mexicanus* sp. nov. A) Dorsal chaetotaxy from head to abdomen VI; B) Ant. III-IV right antenna, dorsal view; C) Ant. III-IV right antenna, ventral view; D) PAO and nearby eye; E) mandible; F) maxilla; G) labium; H) female genital plate; I) male genital plate; J) femur, tibiotarsus, and unguis III; K) furcula and tenaculum.

(Fig. 3D). 8+8 eyes, F, G are 0.7 times smaller than others. Buccal cone elongated. Mandible is not clearly detected, about 2 or 3 slender teeth. Maxilla with 2 blades and one has an apical tooth, and the other styliform (Fig. 3E). Labium with normal chaetotaxy of the genus from setae A to G and 5 lateral setae, setae L spine-shape (Fig. 3F).

Dorsal chaetotaxy as in Fig. 3A, table 3a, b. Seta a0 on the head absent, unpaired seta d1 present. Th. I with 3+3 setae, plus 1+1 lateral. Setae a2 present on Th. II, but absent from Th. III to Abd. V. Sensorial setae s on the body in position of p4 and m6 on the thoracic segments II and III, and p5 from Abd. I to IV and p3 on Abd. V. Sensorial formula of the body 022/11111. Sensorial setae 1.2-1.7 times as long as the normal setae. The lateral setae of the body longer and blunt. Ratio of largest Abd. V setae and inner unguis length is 1.0. Thoracic sterna without setae. Ventral tube with 4+4 setae. Female genital plate with 3+3 pregenital setae, 9 circumgenital setae and 1+1

Table 2

Pseudachorutes mexicanus sp. nov. a) Head chaetotaxy, b) dorsal chaetotaxy.

2a.						
	sd	d	oc	c	p	
Number of setae	5	4+1	3	4	4	
2b.						
	a	m	p	Setae absent		
Th. I	-	3	-			m_2
Th. II	4	3	5	a_4		
Th. III	3	3	5			
Abd. I-III	3	2	5			
Abd. IV	4	-	5			
Abd. V	3	-	4			
Abd. VI	2	2	2+1			

eugenital setae (Fig. 3G). Male genital plate with 3+3 pregenital setae, 8 circumgenital setae and 4+4 eugenital setae (Fig. 3H).

Leg setation from I to III, is tibiotarsi 19, 19, 18, with 1 acuminate tenent hair a little longer than others; femora 9, 9,10, one ventro-proximal seta is an acuminate tenent hair; trochanters with 5,5,5; coxae 3, 7, 7; subcoxae 2: 0, 2, 2; subcoxae 1: 1, 2, 2. Unguis wide, with one inner tooth near 1/3 part from the basal. Sometimes, a pair of weakly subbasal lateral tooth is present. Ratio of tibiotarsus III and unguis about 1.6. Unguiculus absent (Fig. 3I).

Furcula well developed. Dens dorsally with 6 setae, ventral with fine granulate. Mucro straight, 1.7 times shorter than dens, with 2 big lamella and a clearly hook-like end. Tenaculum with 3+3 teeth (Fig. 3J).

Taxonomic summary

Material examined. Holotype: female under slide (FC-UNAM: LESM-AC: 22974). 7 paratypes: 4 females, 2 males and 1 juvenile under slides, same data as holotype (FC-UNAM: LESM-AC: 22975-22981).

Type locality. Mexico; Morelos, Derrame Chichinautzin. 12-IX-1976. J. Palacios, col. Ex. *Tillandsia prodigiosa.*

Etymology. The name is that of the Chichinautzin lava flow (state of Morelos), as a noun of type locality.

Remarks

Pseudachorutes chichinautzin sp. nov. shares with *P. orghidani* and *P. subcrassus* Tullberg, 1871 the presence of 1 internal and 1 pair of lateral teeth on unguis. The new species also resembles *P. tabasquensis* sp. nov. with 2 types of body setae, Ant. IV with 6 sensilla, trilobed apical bulb. Dens with 6 setae and tenaculum with 3+3 teeth. Main differences between them can be seen in table 3c.

Pseudachorutes tillandsiodes sp. nov.
(Fig. 4A-K, Table 4a-c)
http://zoobank.org/urn:lsid:zoobank.org:act:9FFB9169-78E7-4BA3-8C9A-8F3EBEA4DD10

Description. Body length (n = 6): 2,260 µm (range: 1,750-2,860 µm). Color of the body violet, with a white strip from Th. I to Th. II and a dark eyes patch. Granulations fine and homogenous. Body with simple and spine-like setae, p row longer on last abdominal segments (24-40 µm), long sensorial setae (75-100 µm) (Fig. 4A, B).

Antennae shorter than head, 155 µm and 180 µm respectively. Ant. I with 7 setae Ant. II with 12 setae. Ant. III and IV dorsally fused. Ant. segments ratio I: II; III+IV as 1: 1; 1.9. Ant. III-organ with 2 small curving sensilla under a cuticular fold, 2 guard sensilla (sgv is about 1.4 times as long as sgd) and 1 microsensillum close to ventral guard sensillum. Ant. IV with trilobed apical bulb, 6 thin and cylindrical sensilla, seta "i", one microsensillum and one subapical organite (Fig. 4C), ventral side with about 20 setae with some thick and spine-like (Fig. 4D). PAO elliptical composed of 14 vesicles, 1.2 times as long as the nearest eyes. 8+8 eyes, F, G 0.9 times as big as others (Fig. 4E). Buccal cone elongated. Mandible has 2 big teeth, the apical with clearly 3 small teeth (Fig. 4F). Maxilla with 2 blades, one with 2 apical teeth (Fig. 4G). Labium with normal chaetotaxy of the genus from setae A to G and 4 lateral setae, setae L reduced to a minus spine, difficult to see (Fig. 4H).

Dorsal chaetotaxy as in figure 4A, B, table 4a, b. Seta a0 on head absent, unpaired seta d1 present. Th. I with 3+3 setae. Setae a2 present on Th. II, but absent from Th. III to Abd. V. m5 present on Th. II to Th. III. Sensorial setae on body in position of p4 and m6 on thoracic segments II and III, p5 from Abd. I to IV and p2 on Abd. V. Sensorial formula of the body 022/11111. Sensorial setae 2.5-4.0 times as long as the normal setae. Ratio of largest Abd. V setae and inner unguis length is 0.6. Thoracic sterna without setae. Ventral tube with 4+4 setae. Female genital plate with 3+3 pregenital setae, 9 circumgenital setae and 1+1 eugenital setae (Fig. 4I). No males were found.

Leg setation from I to III, is tibiotarsi 19, 19, 18, no tenent hair; femora 9, 10, 10, one ventro-proximal seta is an acuminate tenent hair; trochanters with 5,5,5; coxae 3, 7, 8; subcoxae 2: 0, 2, 2; subcoxae 1: 1, 2, 2. Unguis with one clearly inner tooth at the basal side. Ratio of tibiotarsus III and unguis about 1.5. Unguiculus absent (Fig. 4J).

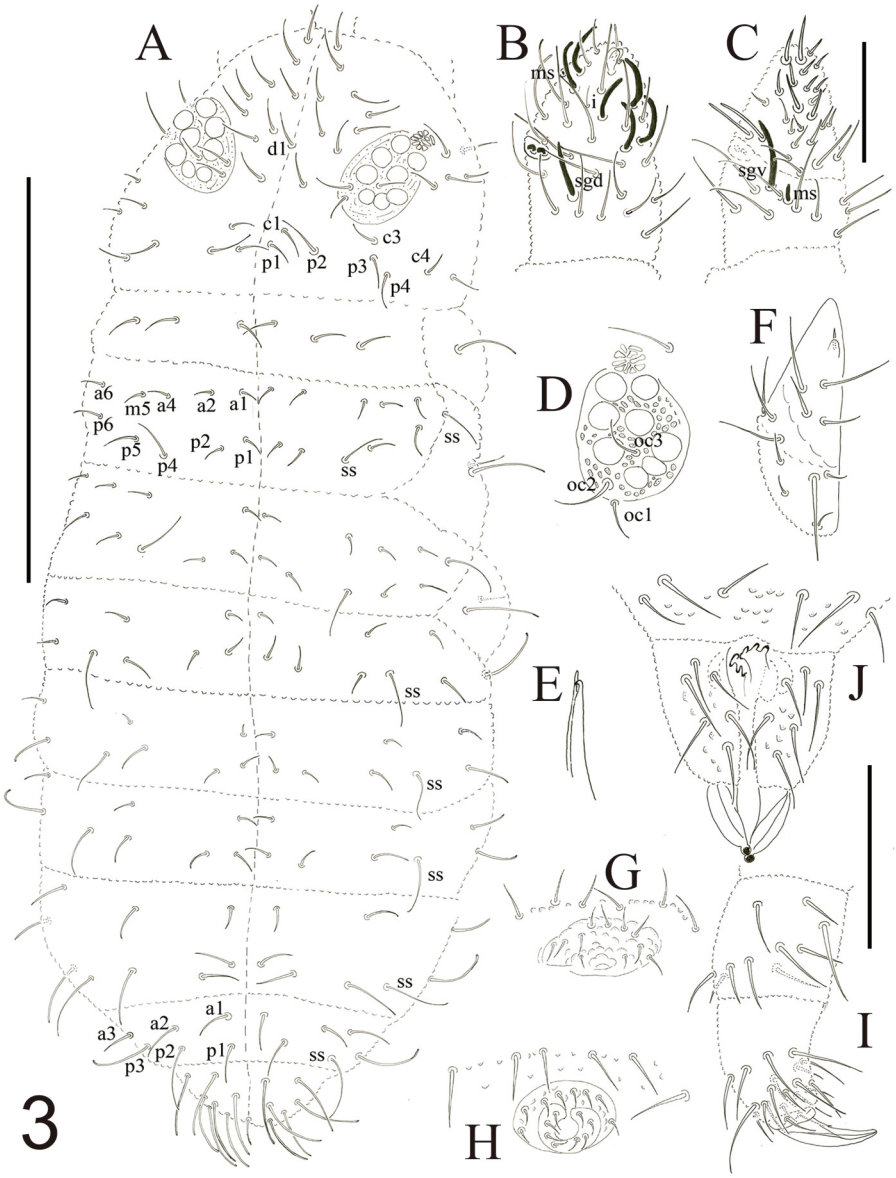

Figure 3. A-J. *Pseudachorutes chichinautzin* sp. nov. A) Dorsal chaetotaxy; B) Ant. III-IV right antenna, dorsal view; C) Ant. III-IV right antenna, ventral view; D) PAO, eye patch and ocular setae; E) maxilla; F) labium; G) female genital plate; H) male genital plate; I) femur, tibiotarsus, and unguis III; J) furcula and tenaculum.

Furcula well developed. Dens dorsally with 6 setae, ventral with fine granulations. Mucro straight, 2.2 times shorter than dens, with 2 thin but long lamella, without hook-like end (Fig. 4K). Tenaculum with 3+3 teeth.

Taxonomic summary

Material examined. Holotype: female under slide (FC-UNAM: LESM-AC: 23172). 5 Paratypes: 4 female and 1 juvenile (FC-UNAM: LESM-AC: 23173-23177).

Type locality. Mexico; Hidalgo, Mineral El Chico. 10-IX-98. J. A. Monterrubio, col. Ex *Tillandsia violacea.*

Etymology. The name is taken from the epiphytic genus *Tillandsia* (Bromeliacea) habitat where the species was found.

Remarks

Pseudachorutes tillandsiodes sp. nov. resembles *P. gilvus* Oliveira & Deharveng, 1995 with white strips and long sensilla on the body, similar number of postantennal organ vesicles (*P. gilvus* with 11-15 vesicles), unguis with 1 inner tooth, tibiotarsi I-III with 19, 19, 18 setae and dens with 6 setae. The main differences between them are

Table 3

Pseudachorutes chichinautzin sp. nov. a) Head chaetotaxy, b) dorsal chaetotaxy, c) main characters between *P. orghidani*, *P. subcrassus*, *P. chichinautzin* sp. nov. and *P. tabasquensis* sp. nov.

3a.

	sd	d	oc	c	p
Number of setae	5	4+1	3	2	4
Setae absent				c_1, c_4	

3b.

	a	m	p	Setae absent		
Th. I	-	3	-		m_2	
Th. II	4	2	5	a_5	m_4	
Th. III	3	2	5	a_2, a_5	m_4	
Abd. I-III	3	-	5	a_2, a_5		
Abd. IV	3	-	5	a2, a3, a5		
Abd. V	3	-	3	a_2		P_2
Abd. VI	2	2	2+1			

3c.

Characters	*P. subcrassus*	*P. chichinautzin* sp. nov.	*P. tabasquensis* sp. nov.	*P. orghidani*
Ant. IV sensilla	5-6	6	6	5
Mandible teeth	4	2-3	2	3
Ventral file on Ant. IV	20	10 strong setae	25-30 short setae	25-30 cuniform
Vesicles of PAO	8-10	10-12	13-17	17
Lateral blunt setae	-	+	-	+

shown in table 4c. However, *P. gilvus* has 3 white stripes on the body: the first on the posterior part of head and the middle of Th. I, the second on the mesothorax and the third on Abd. I-II; *P. tillandsiodes* sp. nov. only with 1 white stripe from Th. I to Th. II.

Pseudachorutes veracruzensis sp. nov.
(Fig. 5A-L, Table 5a, b)
http://zoobank.org/urn:lsid:zoobank.org:act:2C15B37C-080B-4DF9-AD8E-9AE899AEA907

Material examined. Holotype: female under slide (FC-UNAM: LESM-AC: 2133a). 10 paratypes: 7 females and 3 males under slides, same data as holotype (FC-UNAM: LESM-AC: 2131a-2132c, 2132a-2132e, 2133b, 2133c)

Type locality. Mexico; Veracruz, Xalapa, La Herradura. 26-IX-26-10/1998, ex Bosque Mesófilo de Montaña, J. Márquez, col.

Description. Body length (n = 11): 1,900 (range: 1,050-3,400 µm). Color body violet, with a dark eyes patch. Granulations fine and homogenous. Body with short and simple setae (10-12), some of them longer in abdomen segments, especially on 4th segment (22-26 µm), long sensorial setae (67-75 µm) (Fig. 5A).

Antennae little shorter than head, 100 µm and 105 µm, respectively. Ant. I with 7 setae, Ant. II with 12 setae. Ant. III and IV dorsally fused. Ant. segments ratio I: II; III+IV as 1: 1; 2. Ant. III-organ with 2 small straight sensilla under a cuticular fold, 2 guard sensilla (the sgv is about 1.1 times as long as sgd) and 1 microsensillum close to ventral guard sensillum. Ant. IV dorsally with trilobed apical bulb, 6 thin and cylindrical sensilla, seta "i", 1 microsensillum and 1 subapical organite (Fig. 5B), ventral side has a distinct ventral file with about 40 short setae (Fig. 5C). PAO elliptical composed of 17-20 vesicles, 1.5 times as long as the nearest eyes. 8+8 eyes, F, G 0.8 times as big as others (Fig. 5D). Buccal cone elongated. Mandible has 2-3 big teeth (Fig. 5E). Maxilla with 1 blade and 2 apical teeth (Fig. 5F). Labium with normal chaetotaxy of the genus from setae A to G and 3 lateral setae, one longer spine-like setae present at the place of setae L (Fig. 5G).

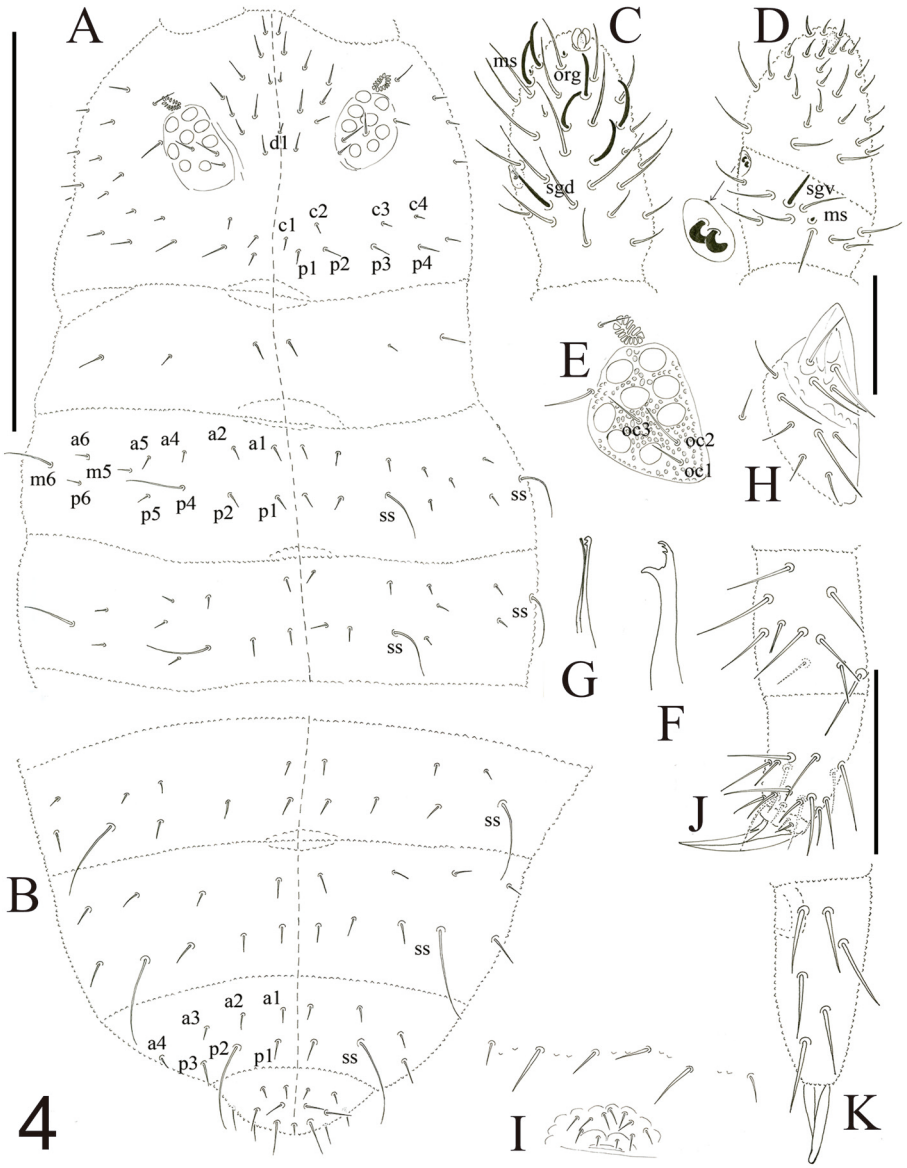

Figure 4. A-K. *Pseudachorutes tillandsiodes* sp. nov. A) Dorsal chaetotaxy from head to Th. III; B) dorsal chaetotaxy from Abd. III. to Abd. VI; C) Ant. III-IV right antenna, dorsal view; D) Ant. III-IV right antenna, ventral view; E) PAO, eye patch and ocular setae; F) mandible; G) maxilla; H) labium; I) female genital plate; J) femur, tibiotarsus, and unguis III; K) dens and mucron.

Dorsal chaetotaxy as in figure 5A and table 5a,b. Seta a0 on head absent, unpaired seta d1 present. Th. I with 3+3 setae. Setae a2 present on Th. II, but absent from Th. III to Abd. IV. m5 present on Th. II to Th. III. Sensorial setae s on the body in position of p4 and m6 on Th. II and III, p5 from Abd. I to IV and p2 on Abd. V. Sensorial formula of the body 022/11111. Sensorial setae 6.5-7.0 times as long as the shorter setae. The ratio of the largest Abd. V setae and inner unguis length is 0.5. Thoracic sterna without setae. Ventral tube with 4+4 setae. Female genital plate with 3+3 pregenital setae, 7 circumgenital setae and 1+1 eugenital setae (Fig. 5H). Male genital plate with 2+2 pregenital setae, 16 circumgenital setae and 4+4 eugenital setae (Fig. 5I).

Leg setation from I to III, is tibiotarsi 19, 19, 18, no tenent hairs; femora 13, 11, 10, one ventro-proximal seta is an acuminate tenent hair; trochanters with 6,6,5; coxae 3, 7, 8; subcoxae 2: 0, 2, 2; subcoxae 1: 1, 2, 2. Unguis

Table 4

Pseudachorutes tillandsiodes sp. nov. a) Head chaetotaxy, b) dorsal chaetotaxy, c) main characters between *P. gilvusi*, and *P. tillandsiodes* sp. nov.

4a.

	sd	d	oc	c	p
Number of setae	5	4+1	3	4	4

4b.

	a	m	p	Setae absent	
Th. I	-	3	-		m_2
Th. II	5	2	5		m_4
Th. III	4	2	5	a_2	m_4
Abd. I-III	4	-	5	a_2	
Abd. IV	4	-	5	a2	
Abd. V	4	-	3		P_4
Abd. VI	2	2	2+1		

4c.

Characters	*P. gilvus*	*P. tillandsiodes* sp. nov.
Setae d1 on head	1+1	1
Setae number on Th. I	2+2	3+3
Setae a_2 on Th. II	-	+
Ant. IV sensilla	7	6
Ventral tuve setae	3+3	4+4

with 1 big and 1 small inner tooth together with 2 pairs of lateral teeth (Fig. 5J). Ratio of tibiotarsus III and unguis about 1.4. Unguiculus absent (Fig. 5K).

Furcula well developed. Dens dorsally with 6 setae, ventral granulate. Mucron granulated with broad and long lamella, 1 slightly hook-like end, 2.0 times shorter than dens (Fig. 5L). Tenaculum with 3+3 teeth.

Etymology. The name is a locative for the State of Veracruz where the type locality is found.

Remarks

Pseudachorutes veracruzensis sp. nov. resembles *P. orghidani* with granules on mucron and dens with 6 setae, mandible with 3 teeth, unguis with lateral teeth, similar number of PAO (*P. orghidani* with 17 vesicles) and ventral file on Ant. IV. The main difference between the species is the shape of short setae in the ventral file (*P. orghidani* has small setae with apex truncate) and number of sensilla on Ant. IV (*P. orghidani* with 5) and the teeth on unguis (*P. orghidani* only with 1+1 lateral teeth).

Discussion

After revision and analysis of the material deposited in the LESM collection, we were able to update the knowledge of genus *Pseudachorutes* in Mexico, describing 5 new species: *P. tabasquensis* sp. nov., *P. veracrucensis* sp. nov., *P. tillandsiodes* sp. nov., *P. chichinautzin* sp. nov., and *P. mexicanus* sp. nov. Three new records for the country are added, for the following species: *P.* ca. *algidensis* from Hidalgo, *P.* ca. *crassus* from Estado de México, these must be confirmed with the collection of more specimens that will allow the species to be fully determined. For now, this information is presented as an element to show the richness of species of the genus in the country. *Pseudachorutes reductus* has a distribution in the Antilles and southern Florida, the new records in Mexico extend its distribution area and confirm the affinity of the species to the Atlantic area. Total records for *Pseudachorutes* is increased to 28 species, from 20 states and 62 localities within the country. Quintana Roo and Hidalgo were the states with the highest number of species present (11 and 10, respectively), followed by Morelos, Estado de México, Puebla, Veracruz, and Guerrero (8, 7, 6, 6, and 4 species recorded in each one), 6 states have 3 species, 5 have 2 and Querétaro and San Luis Potosí only have 1 species recorded. Three species are widely distributed in Mexico: *P. corticolus*, *P. simplex*, and *P. subcrassoides*. Diversity of the genus in Mexico is around 21% of the total known worldwide, and therefore the country becomes one with the greatest number of species present.

Regarding biotopes where the species preferably live, we found that litter, epiphytic plants, soil, mosses and decaying wood are the most suitable habitats for this springtail. However, sand, canopy, wood, caves and anthills are also microhabitats used by some species.

The analysis and revision of the morphology of the 5 species described, allowed us to come to the following conclusions about the morphology of the genus that needs to be taken in consideration. Size of body setae should be a characteristic to be taken into consideration for the description of the species, since we observed that it is a variable character. Antennae are a uniform structure and characters associated with the sensory organ of Ant. III have little relevance at a specific level. Sensory file of Ant. IV, present a varied shape and number, from 8 to 40 setae. Apical vesicle of Ant. lV is trilobed in most

Figure 5. A-L. *Pseudachorutes veracruzensis* sp. nov. A) Dorsal chaetotaxy; B) Ant. III-IV right antenna, dorsal view; C) Ant. III-IV right antenna, ventral view; D) PAO, eye patch and ocular setae; E) mandible; F) maxilla; G) labium; H) female genital plate; I) male genital plate; J) femur, tibiotarsus, and unguis III; K) unguis III, ventral view; L) dens and mucron.

species and others have a simple shape. Number of ocelli is stable within the genus, presenting 8+8. The maxillae and mandibles vary in all species. Maxillae can be needle-shaped, crocheted or styliform, they may or may not be lamellar and the number of lamellae is variable, and in most cases, there are 1 to 2 apical teeth. The number of teeth in the mandibles in almost all species ranges from 1 to 5. The number of teeth in the retinaculum is a constant character among the species of the genus, with 3+3 teeth. The ventral tube in almost all species has 4+4 setae. The number of setae in the dens varies from three to seven, but most have six setae. The mucron has 2 lamellae in all species, except in *P. reductus*, where it is greatly reduced. The shape of the mucron is variable, from elliptical, triangular, elongated, short, curved, widened, or with a bladder-shaped base.

Table 5

Pseudachorutes veracruzensis sp. nov. a) Head chaetotaxy, b) dorsal chaetotaxy.

5a.					
	sd	d	oc	c	p
Number of setae	5	4+1	3	2	4
Setae absent				c_1, c_3 c4	
5b.					
	a	m	p	Setae absent	
Th. I	-	3	-		m_2
Th. II	4	2	5	a_5	m_4
Th. III	3	2	5	a_2, a_5	m_4
Abd. I-III	3	-	5	a_2, a_5	
Abd. IV	4	-	5	a_2, a_3	
Abd. V	3	-	4	a_4	
Abd. VI	3	2	2+1		

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References

Arango-Galván, A., Cutz-Pool, L. Q., & Cano-Santana, Z. (2007). Estructura de la comunidad de colémbolos del mantillo de la Reserva Ecológica del Pedregal de San Ángel: Riqueza, composición y abundancia relativa. *Entomología Mexicana*, *6*, 397–400.

Bellinger, P. F., Christiansen, K. A., & Janssens, F. (2023). *Checklist of the Collembola of the World*. Retrieved on November 11th, 2023 from: http://www.collembola.org

Christiansen, K. A., & Bellinger, P. F. (1998). *The Collembola of North America, North of the Río Grande: a taxonomic analysis*. Part I. Grinnell, Iowa Grinnell College.

Cutz-Pool, L. Q., Palacios-Vargas, J. G., & Vázquez, M. M. (2003). Comparación de algunos aspectos ecológicos de Collembola en cuatro asociaciones vegetales de Noh-Bec, Quintana Roo, México. *Folia Entomológica Mexicana*, *42*, 91–101.

Cutz-Pool, L. Q., García-Gómez, A., & Palacios-Vargas, J. G. (2007a). Primer estudio de colémbolos (Hexapoda: Collembola) de la Hoya de las Guaguas en el estado de San Luis Potosí, México. *Dugesiana*, *14*, 47–51.

Cutz-Pool, L. Q., Palacios-Vargas, J. G., Castaño-Meneses, G., & García-Calderón, N. E. (2007b). Edaphic Collembola from two agroecosystems with contrasting irrigation type in Hidalgo State, Mexico. *Applied Soil Ecology*, *36*, 46–52. https://doi.org/10.1016/j.apsoil.2006.11.009

Cutz-Pool, L. Q., Palacios-Vargas, J. G., & Castaño-Meneses, G. (2008). Estructura de la comunidad de colémbolos (Hexapoda: Collembola) en musgos corticícolas en un gradiente altitudinal de un bosque templado subhúmedo. *Revista de Biología Tropical*, *56*, 1–10. https://doi.org/10.15517/rbt.v56i2.5620

Fjellberg, A. (1998). *Fauna entomologica scandinavica*. The Collembola of Fennoscandia and Denmark. Part I: Poduromorpha. Vol. 35. Leiden: Brill Publishers.

Jordana, R., Arbea, J. I., Simón, C., & Luciáñez, M. J. (1997). *Fauna ibérica. Vol. 8. Collembola, Poduromorpha*. Madrid: Museo Nacional de Ciencias Naturales.

Palacios-Vargas, J. G. (1990). *Manuales y guías para el estudio de microartrópodos I. Diagnosis y clave para determinar las familias de los Collembola de la Región Neotropical.* México D.F.: Facultad de Ciencias, Universidad Nacional Autónoma de México.

Palacios-Vargas, J. G. (1997). *Catálogo de los Collembola de México.* Las Prensas de Ciencias, UNAM, México D.F.

Palacios-Vargas, J. G. (2005). *Collembola*. In G. Sánchez-Ramos, P. Reyes-Castillo y R. Dirzo (Eds.), *Historia natural de la Reserva de la Biosfera El Cielo Tamaulipas, México* (pp. 354–366). Ciudad Victoria, Tamaulipas: Universidad Autónoma de Tamaulipas.

Palacios-Vargas, J. G., & Castaño-Meneses, G. (2003). *Seasonality and community composition of springtails in Mexican forests.* In Y. Basset, V. Novotny, S. E. Millar, & R. L. Kitching (Eds.), *Arthropods of tropical forests. Spatio-temporal dynamics and resource use in the canopy* (pp. 159–169). Cambridge, UK: Cambridge University Press.

Palacios-Vargas, J. G., Castaño-Meneses, G., & Mejía-Recamier, B. E. (2000). *Collembola*. In J. Llorente-Bousquets, E. González-Soriano, & N. Papayero (Eds.), *Biodiversidad, taxonomía y biogeografía de artrópodos de México. Hacia una síntesis de su conocimiento II* (pp. 249–273). México D.F.: Las Prensas de Ciencias, UNAM.

Palacios-Vargas, J. G., Cutz-Pool, L. Q., & Estrada-Barcenas, D. A. (2007). *Collembola*. In I. Luna, J. J. Morrone, & D. Espinosa (Eds.). *Biodiversidad de la Faja Volcánica Transmexicana* (pp. 331–344). México D.F.: Las Prensas de Ciencias, UNAM.

Tullberg, T. (1871). Förteckning öfver Svenska Podukrider. Öfversigt *af Kongliga Vetenskaaps -Akademiens Förhandlingar*, *28*, 143–155.

Vázquez, M. M. (1988). *Fauna colembológica de hojarasca y suelo.* In L. Arriaga, & A. Ortega (Eds.), *La sierra de la Laguna de Baja California Sur* (pp. 133–148). La Paz, Baja California Sur: Centro de Investigaciones Biológicas de Baja California Sur, A.C.

Vázquez, M. M., & Palacios-Vargas, J. G. (1990). Nuevos registros y aspectos biogeográficos de los colémbolos de la sierra de la Laguna, B. C. S., México. *Folia Entomológica Mexicana*, *78*, 5–22.

Vázquez, M. M., & Palacios-Vargas, J. G. (2004). *Catálogo de colémbolos (Hexapoda: Collembola) de Sian Ka'an, Quintana Roo, México*. México D.F.: Universidad de Quintana Roo/ Comisión Nacional para el Conocimiento y Uso de la Biodiversidad.