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New species of flea of the genus *Dactylopsylla* Jordan (Insecta: Siphonaptera) from the Flora and Fauna Protection Area Médanos de Samalayuca, Chihuahua, Mexico

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Abstract

A new species of *Dactylopsylla* Jordan, parasites of Geomyidae rodents from Chihuahua, is described and illustrated as *D. samalayucae* **n. sp.** This species is compared with their morphologically closest relatives. Males are characterized by the shape of the upper lobe of the inmovable and movable process, the shape and chaetotaxy of the distal arm of sternum IX and the shape of the crochet; and females by the contour of the distal margin of sternum VII. The geographical distribution of *Dactylopsylla* is extended to the Chihuahuan desert in Mexico as *D. samalayucae* **n. sp.** is reported from south of the Natural Protected Area Médanos de Samalayuca (MS). A recent key to *Dactylopsylla* species is updated with inclusion of the new species.

Key words: Mexico, fleas, Ceratophyllidae, Dactyllopsyllinae, borderline, pocket gophers

Introduction

A Natural Protected Area (NPA) is a natural physical space where the original environment has not been significantly altered by anthropogenic activities or that require preservation and restoration, due to their structure and function for the recharge of the aquifer and the preservation of biodiversity; they also have scenic and biological characteristics that make them unique (Gatica-Colima 2019). Mexico has more than 180 NPA, one of which is the Flora and Fauna Protection Area Médanos de Samalayuca (FFPAMS), decreed on June 5, 2009. The fauna registered in the FFPAMS includes 161 birds, 64 mammals, seven amphibians and 48 reptiles among which there are endemic species or species with some degree of protection. Among the mammals that inhabit the FFPAMS (CONANP 2013) is the desert pocket gopher *Geomys arenarius* Merriam, 1895, which is endemic to the Chihuahuan desert (Mexico and USA).

Geomys arenarius is limited to border areas of New Mexico, Texas (USA) and Chihuahua (Mexico) (Hafner *et al*. 2008). The location of this rodent species is important because the association between Geomyidae and dactylopsylline fleas has been considered as specific to the genera *Cratogeomys*, *Thomomys*, *Pappogeomys*, *Zygogeomys* and *Geomys* (Medvedev 1997).

The flea fauna (Insecta: Siphonaptera) in Mexico is represented by 172 species and subspecies. However, the knowledge of this group of parasites is scarce in the northern states of Mexico (Acosta 2014) and relatively few flea records exist in the border area, although several members of Ceratophyllidae occur in this region.

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The subfamily Dactylopsyllinae (Ceratophyllidae) contains three genera: *Dactylopsylla* Jordan, 1929, *Foxella* Wagner, 1929 and *Spicata* I. Fox, 1940, all described as pocket gopher fleas (Lewis 2003). The genus *Dactylopsylla* has seven known species distributed in western North America and Mexico, of which five are in the border region of the United States and Mexico: *D. digitenua* Prince and Stark, 1951, *D. neomexicana* Prince, 1945, *D. pentachaeta* Prince & Stark, 1951, *D. percernis* Eads & Menzies, 1949 and *Dactylopsylla megasoma* Barrera, 1953 (Lewis & Wilson 2006). *Dactylopsylla megasoma* is known from a few records in northern and central Mexico, parasitizing pocket gophers (Muñiz *et al*. 1981; Haddow *et al*. 1983; Ayala-Barajas *et al*. 1988). Herein, we describe a new species of *Dactylopsylla* from Samalayuca, Chihuahua, in northern Mexico, collected from pocket gophers.

Material and methods

The Arantxa Ranch (Fig. 1) is located south of the FFPAMS in northern Chihuahua, Mexico. The ranch is primarily a pecan nut producer system, it has an extension that encompasses 400 hectares of *Carya ilionensis* crops; it also has irrigated crops of grapes and pistachio. The sampling area was conducted in the pecan productive zone.

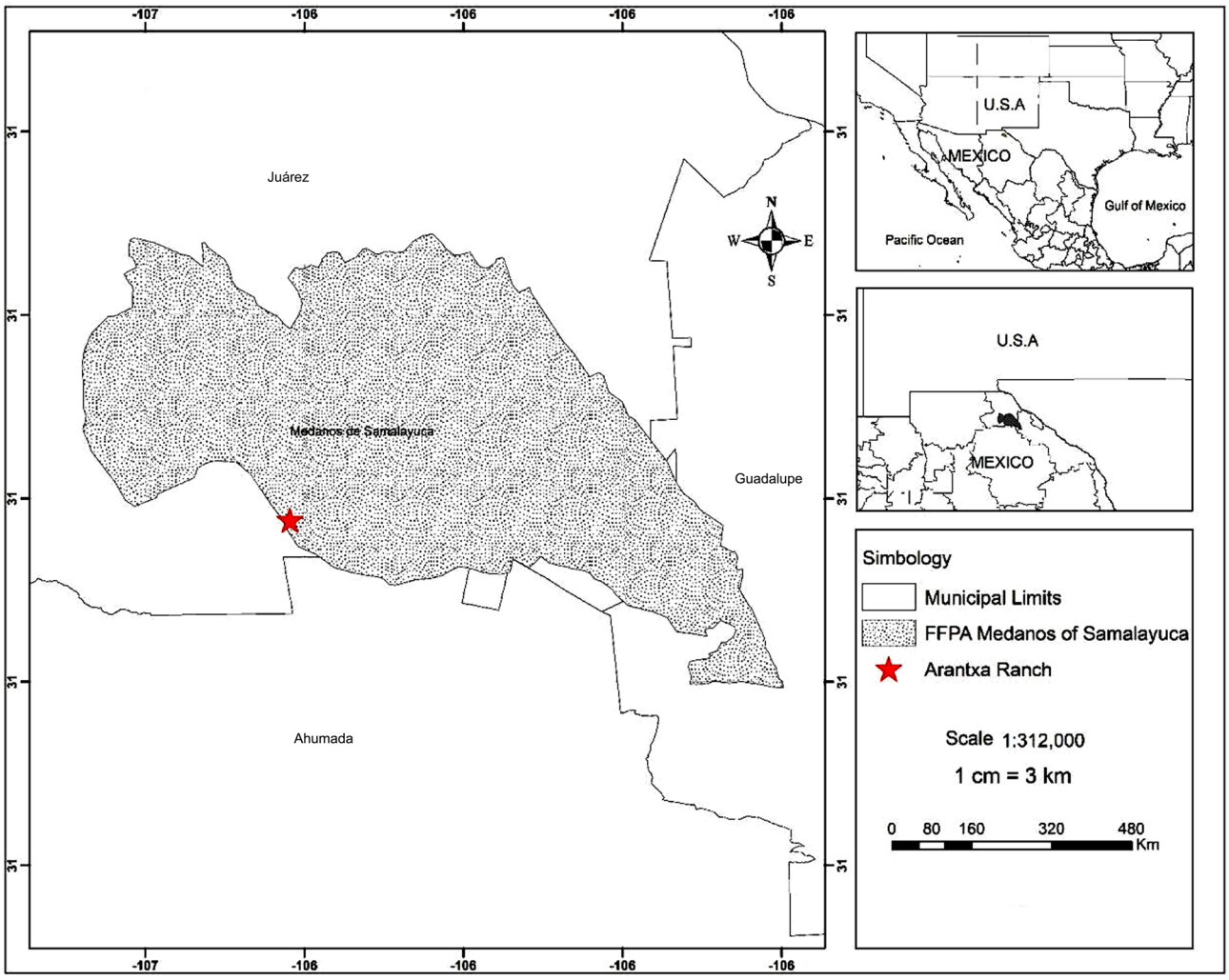


FIGURE 1. Study area: Arantxa Ranch locality, Area of Protection of Flora and Fauna Médanos de Samalayuca, Chihuahua, Mexico (Source CONABIO, 1990).

Geomys arenarius were captured with the use of eight Gophinator traps (Trapline Products, Menlo Park, California). Other gophers were provided as pest control by the technical personal of the ranch. Field work was conducted between October 2019 and November 2020 in four seasons: post-humid 2019 (October 19), dry (June 21), humid (September 27) and post-humid 2020 (November 13). Following Sikes & Gannon (2011) the gophers were euthanized by cervical dislocation. Fleas were collected from animals and stored in 70% ethanol for transport to

the Animal Ecology and Biodiversity Laboratory. Fleas were cleared and softened in 10% KOH, dehydrated in an increasing series of ethanol (70%, 80% 96%), further diaphanized in eugenol and mounted on slides as described by Martin (1994). Fleas were described and identified with the aid of an Olympus Vanox-T microscope and photographed with a digital camera (Canon, Tokyo). Flea structures were drawn and digitized with Adobe Photoshop 8.0.1 (Adobe Systems, San Jose, California). For morphology nomenclature and identification we followed Fritz & Pratt (1947), Prince & Stark (1951), Rothschild & Traub (1971) and Lewis & Wilson (2006).

The holotype male and three paratypes (two females, one male) were deposited in the Collection of Siphonaptera in the Museo de Zoología "Alfonso L. Herrera", Facultad de Ciencias, UNAM (Mexico City) and 17 paratypes (9 females, 8 males) were deposited in the Scientific Collection of Vertebrates of the Animal Ecology and Biodiversity Laboratory UACJ (Juárez, Chihuahua, Mexico). Hosts were processed, identified and deposited at the Scientific Collection of Vertebrates.

Results

Of a total of 53 captured individuals of *G. arenarius*, 15 gophers were parasitized (12 females and 3 males) with 21 fleas (11 females and 10 males). After processing of collected specimens and comparison with reports in the literature and noticing different unique diagnostic characters, it was apparent that these fleas represented an undescribed species.

Family Ceratophyllidae

Subfamily Dactylopsyllinae

***Dactylopsylla samalayucae* n. sp.**
Figures 2–9

Type Material. Holotype: male, *ex Geomys arenarius*, Mexico, Chihuahua, Juaréz, Rancho Arantxa in walnut (*Carya illionensis*) crop in Médanos de Samalayuca, elev. 975 m (3200 ft), 31º 12' 2.9" N, -106º 29'27.60" W, 21 June 2020 (09817 MZFC-S), colls. Rolando Rueda-Torres, Ana Gatica-Colima and Eduardo Macias-Rodriguez. Paratypes: Rancho Arantxa, 31º 11' 59.53" N, -106º 29'32.98" W, 19 October 2019, 3 males (CCV-UACJ M669-1, CCV-UACJ M672-1, CCV-UACJ M675-2/2), 1 female (CCV-UACJ M675-1/2). Other paratypes, same locality as holotype: 21 June 2020, 2 males (9819 MZFC-S, CCV-UACJ M686-1/4), 3 females (9816 MZFC-S, CCV-UACJ M686-3/4 and CCV-UACJ M686-4/4); 27 September 2020, 3 males (CCV-UACJ M708-1, CCV-UACJ M711-1, CCV-UACJ M696-1), 5 females (CCV-UACJ M694-1, CCV-UACJ M697-1/2, CCV-UACJ M697-2/2, CCV-UACJ M709-1, CCV-UACJ M703-1), colls. Rolando Rueda-Torres, Ana Gatica-Colima and Sandra Ramos; 13 November 2020, 1 male (CCV-UACJ M716-2/2), 2 females (9820 MZFC-S, CCV-UACJ M716-1/2), colls. Rolando Rueda-Torres, Natalia Guerra-Murcia and Elkin Quiroga-Calderón.

Type host: *Geomys arenarius* Merriam, 1895 (desert pocket gopher) (CCV-UACJ-M683).

Diagnosis. The male VIII sternum of *D. samalayucae* **n. sp.** is developed, not truncated, with five large distinct setae, dorsal margin pronounced and rounded without bristles; crochet with sinuous shape, slender through to the apex, bent and pointed, with a transparent veil in the anterior margin. *Dactylopsylla pentachaeta* differs by the presence of a blunt protuberance in the anterior margin. The distal part of the movable finger is slender and long compared with *D. pentachaeta*, and on the tip has one straight, long bristle. On females the upper lobe of the posterior border of VII sternum is wider than the lower lobe and the margin almost straight with acute apex in dorsal margin.

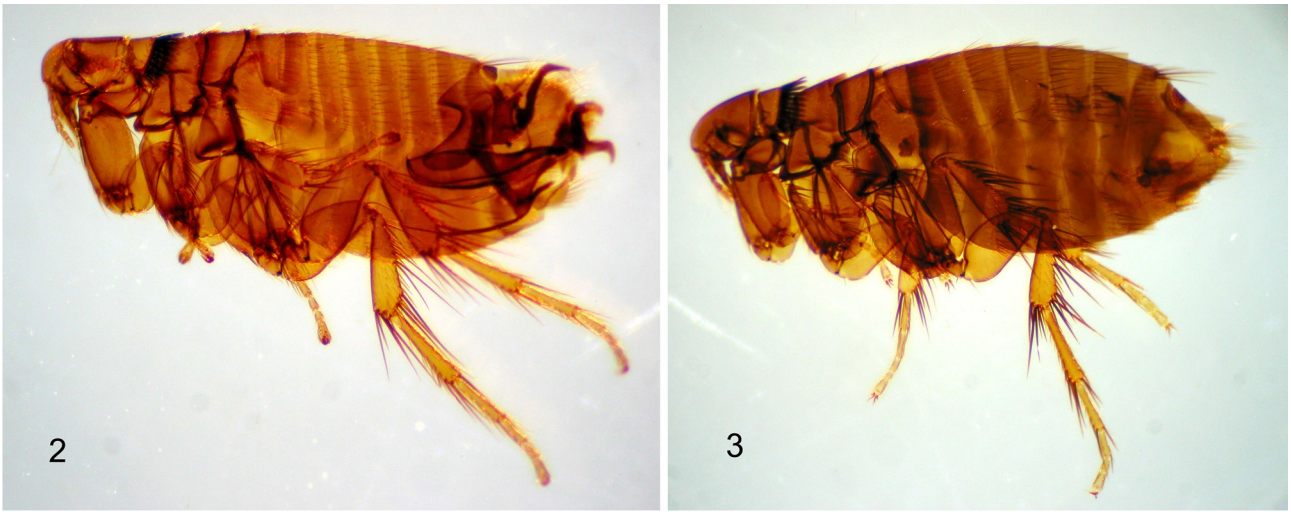
Description

Head. Clypeal tubercle absent. Notch present but barely discernible in both sexes. Antennae extending to posterior border of head in the male but not in the female. Scape with four small setae and three spiniform bristles. Five setae on pedicel of male; scape with seven small setae and ten setae on pedicel of female, reaching to end of the clava. Clava with 9 distinct segments. Occiput of cranium (male only) and borders of gena heavily chitinized. Two

distinct rows of large-sized bristles on gena, anterior row with nine such bristles and posterior row with one small and four large bristles. Small setae border antennae beginning as two rows anteriorly and grading into three together, irregular rows posteriorly. Occiput with two long bristles near the antenna in males. Mouth parts short; labial palps extend only two-thirds length of fore coxa.

Thorax. Pronotal ctenidium with 24 teeth in both sexes. Meso and metathorax as in other members of the genus. Hind tibia with 15–16 long, stout, dorsal bristles. First pair of plantar bristles of segments V of tarsi turned downward and inward.

Abdomen. General chaetotaxy as in other members of genus (Figs. 2, 3). Two antepygidial bristles in male, one large and stout, the uppermost small; three antepygidial bristles in female, the uppermost smaller and the other two larger.



FIGURES 2–3. *Dactylopsylla samalayucae* **n. sp.** 2) Male. 3) Female.

Modified abdominal segments of male. Tergum VIII large, covering most of the external genitalia. Sternum VIII distinct, almost completely lacking posterior process; broadly with five large, distinct setae, the uppermost large, and the lowermost setae small, tip of the apex rounded, without bristles, outline of sternum VIII widening towards the base (Fig. 4). Crochet with sinuous shape, wide at base and becoming more slender toward the apex, bent and pointed, with a transparent veil in the anterior margin (Fig. 5). Tergum IX distinct and well inside the body cavity. Immovable process small (Fig. 6), with narrow dorsally curved process possessing four slender bristles at its apex, two large and one small, one intermediate. Movable process (Fig. 6) large, twice the length of immovable process. Distal part slender, extended posteriorly at 60–70° angle, with one large bristle on posterior margin, two tiny bristles near the apex and one stout, straight, long bristle at the tip. Anterior margin with a small but prominent protrusion at the level of clasper near the middle. Posterior border with one large bristle in the middle and two thinner bristles lowermost at the level of the protrusion. The proximal arm of sternum IX prominent with a rectangle shape in the distal portion; distal arm of sternum IX (Fig. 7) with median lobe bearing setae of various sizes, on the posterior part with 10–12 medium-sized setae and on the lateral part with 14–16 small, slender setae. Upper lobe large and prominent, bearing five or six thin, medium-sized setae in the central part of the lobe, and scattered small setae laterally and marginally.

Female. Posterior border of sternum VII with distinct sinus. Upper lobe wider than lower lobe, posterior margin almost straight with acute apex in dorsal margin (Fig. 8). Spermatheca without demarcation between head and tail. Small prominence at tip of tail (Fig. 9). Head heavily pigmented. Stylet terminating with large bristle and two ventral bristles, upper bristle almost as large as the apex, lower bristle half the size of the upper one.

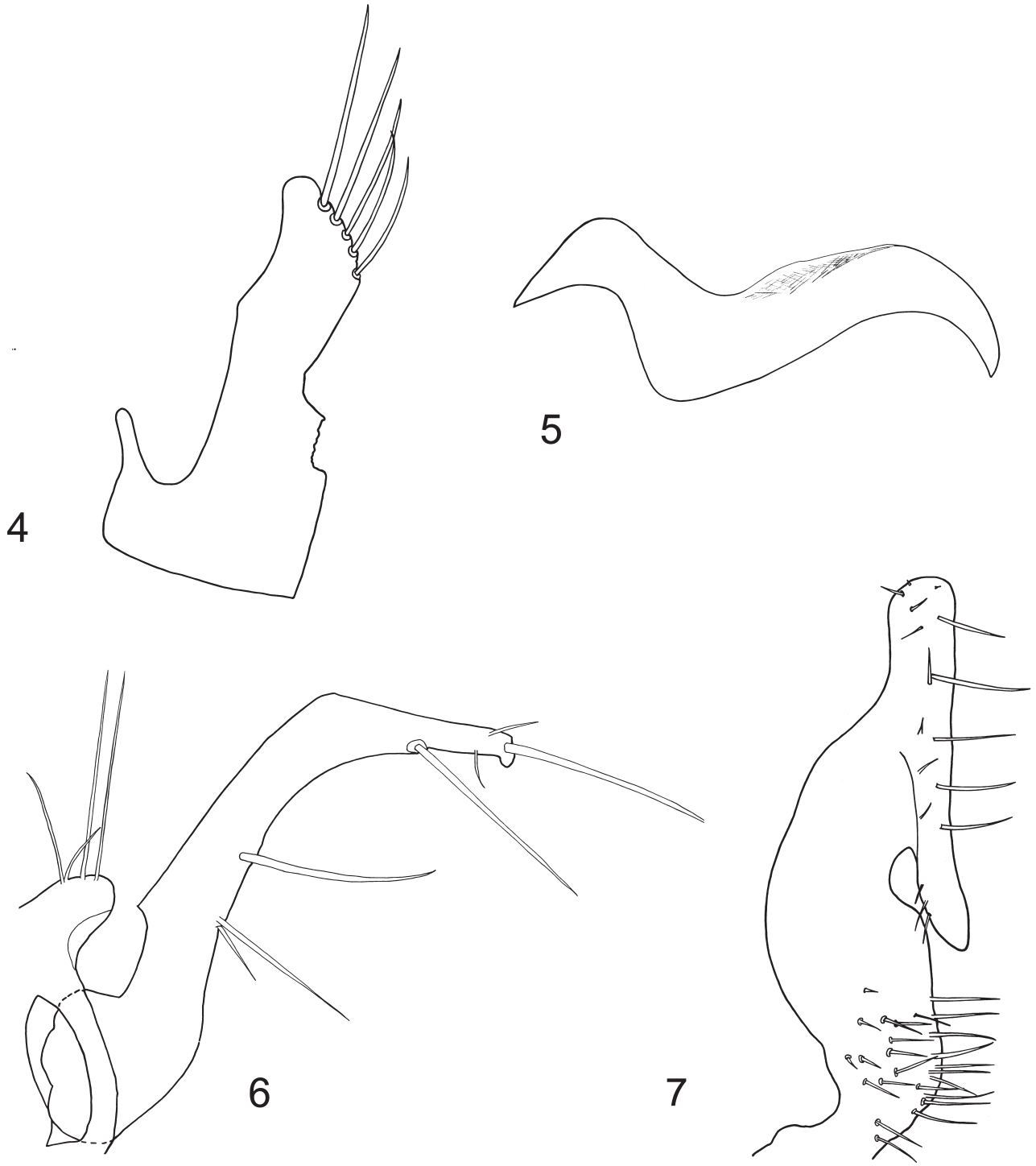
Measurements (lengths). Holotype male 3.20 mm. Mean length of paratypes (n = 21) 3.45 mm, range 3.10–4.50 mm. Female mean length 3.50 mm (n = 11), male mean length 3.41 mm (n = 10).

Taxonomic summary. *Dactylopsylla samalayucae* **n. sp.** shares characters of the *D. neomexicana* species group (*D. neomexicana*, *D. percernis* and *D. pentachaeta*) (Lewis & Wilson 2006). It is close to *D. pentachaeta* in having five large setae on sternum VIII and in the crochet shape, but *D. samalayucae* **n. sp.** has a rounded dorsal margin, whereas *D. pentachaeta* has an anterior blunt protuberance in the dorsal margin. The species of the *D.*

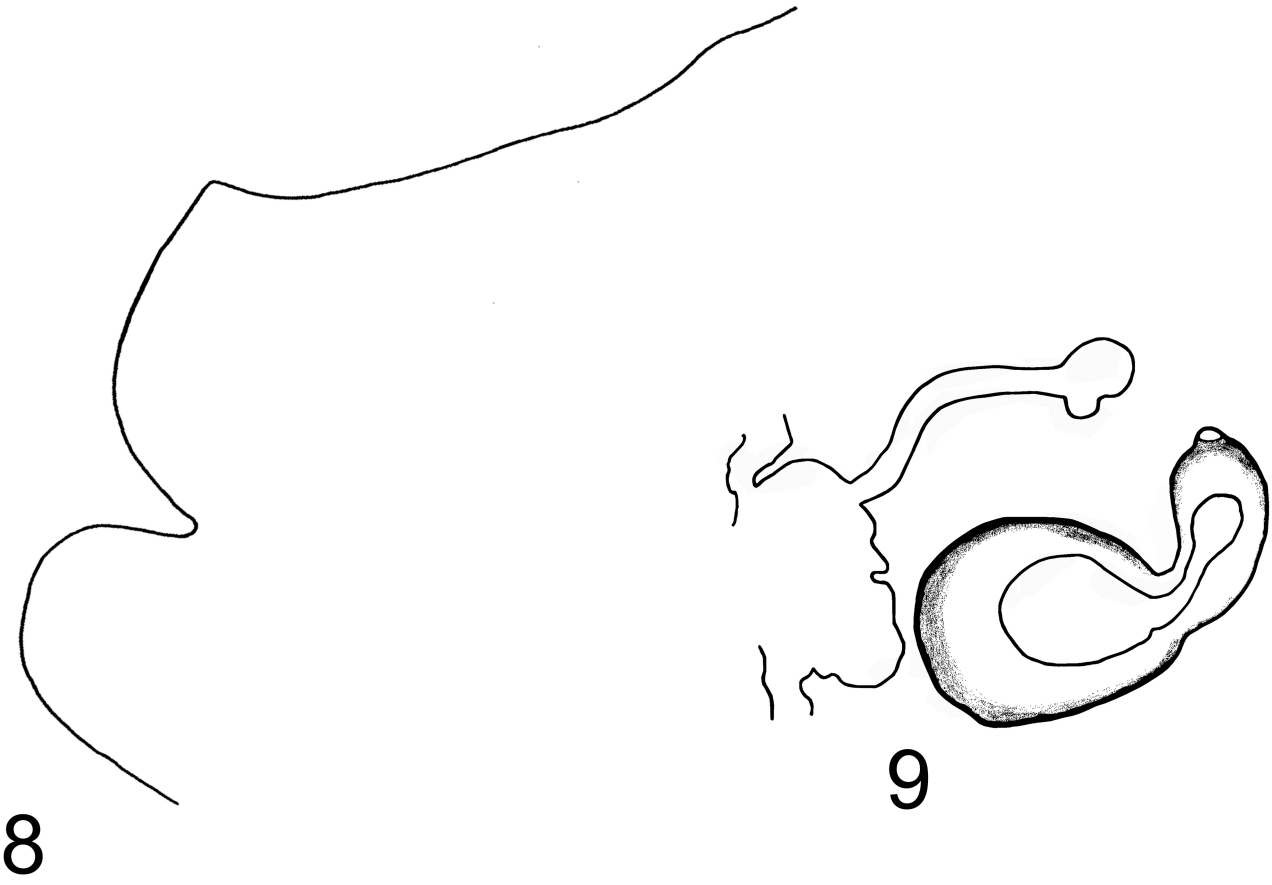
neomexicana group are distributed along the border of the U.S. and Mexico, but *D. pentachaeta* is also found in the western Great Plains east of the Rocky Mountains (Ford, 2004).

Etymology. The name was assigned according to the place where the finding was made: Flora and Fauna Protection Area Médanos de Samalayuca Chihuahua, Mexico.

Ecological association. Pecan (*Carya illinoinensis* (Wangenh.) K. Koch), Russian thistle (*Salsola kali* Schrad.), salt heliotropium (*Heliotropium curassavicum* L.), Pale evening primrose (*Oenothera pallida* Lindl.), common sandbur (*Cenchrus spinifex* Cav.), bristlegrass (*Setaria macrostachya* Kunth.), bigleaf groundcherry (*Physalis hederifolia* A. Gray).



FIGURES 4–7. *Dactylopsylla samalayucae* **n. sp.**, male genitalia. 4) Sternite VIII. 5) Crochet. 6) Fixed and movable processes. 7) Distal arm of sternite IX.



FIGURES 8–9. *Dactylopsylla samalayucae* **n. sp.**, female. 8) Sternite VII. 9) Spermathecae.

Key to *Dactylopsylla*

To accommodate *D. samalayucae* **n. sp.**, the key by Lewis & Wilson (2006) is modified as follows

1. Males . . . 2
- Females (that of *D. digitenua* is undescribed) . . . 9
2. Movable process of relatively uniform width from base to apex; apex of sternite VIII bent cephalad; apical half of distal arm of sternite IX with concave caudal margin, its apex somewhat sclerotized and acuminated; aedeagal crochet with sharp-pointed, deflected apex . . . 3
- Movable process strongly flexed caudad, its dorsal margin strongly forming a right angle; apex of sternite VIII acuminate or obliquely blunt, terminated by 4–5 long setae or a subapical caudoventral fringe of shorter setae; aedeagal crochet shaped otherwise . . . 4
3. Movable process with approximately parallel margins from base to apex, the latter not strongly flexed caudad; apex of sternite VIII tapering to a rounded point; apex of sternite IX pointed and tapered . . . *D. stimsoni*
- Movable process with subparallel margins, widest in the middle and with a rugulose band along the caudal margin; apex of sternite VIII blunt and squared; apex of sternite IX blunt, not tapered . . . *D. bluei*
4. Fixed process of clasper with two widely separated acetabular setae; sternite VIII short and broad, its caudoventral margin with a row of short and setulae; apical lobe of distal arm of sternite IX broadly tapered to a point, its caudal margin straight; aedeagal crochet with a blunt, deflected apex . . . *D. megasoma*
- Acetabular setae absent; apex of sternite VIII terminated by 4-5 long setae; apical lobe of distal margin of sternite IX oval in profile and borne on a stalk arising from proximal lobe; aedeagal crochet otherwise . . . 5
5. Cephalic and dorsal margins of movable process forming a strong right angle; sternite VIII divided into a dorsal and ventral lobe, the latter of which tapers to a conical apex terminated by 3-4 long setae; apical lobe of sternite IX long and narrow; aedeagal crochet with a sclerotized, aserrated, claw-shaped apex . . . *D. percernis*
- Cephalic and dorsal margins of movable process forming a weak right angle; sternite VIII distal apex with subparallel margins and bearing long setae; apical lobe of sternite IX broad; aedeagal crochet with dorsal and ventral lobes . . . 6
6. Apex of fixed process of clasper as wide as tall; dorsal margin of sternite VIII with distinct median convexity and oblique apex; apex of sternite IX not particularly distinctive; lobes of aedeagal crochet subequal, the ventral shorter than the dorsal . . . *D. digitenua*

- Apex of fixed process of clasper taller than wide; dorsal margin of sternite VIII without such a distinct convexity and with a blunt or tapered apex 7
7. Apex of movable process strongly tapered to caudal apex; apex of sternite VIII obliquely tapered and usually bearing 4 long setae; dorsal margin of apex sternite IX evenly rounded; dorsal and ventral lobes of aedeagal crochet about equal in length and width . . . . . *D. neomexicana*
- Apex of movable process blunt or slightly expanded subapically; apex of sternite VIII blunt with 5 long setae; crochet not as the anterior 8
8. Apex of movable process blunt or slightly expanded subapically; apex of sternite VIII blunt, slightly expanded apically and usually with 5 long setae; dorsal margin of apex of sternite IX more squared; dorsal lobe of aedeagal crochet a triangular projection above the strongly deflected ventral lobe . . . . . *D. pentachaeta*
- Apex of movable process slender and slightly expanded subapically (Fig. 6); apex of sternite VIII blunt, slightly expanded apically and usually with 5 long setae, dorsal margin ending rounded; dorsal margin of apex of sternite IX rounded (Fig. 7); dorsal lobe of aedeagal crochet with rounded margin above the strongly deflected ventral lobe (Fig. 5) . . . . . *Dactylopsylla samalayucae* **n. sp.**
9. Caudal margins of female sternite VII with a deep emargination 10
- Caudal margin of female sternite VII sinaute or weakly to strongly bilobed 12
10. Lobe above the caudal emargination of sternite VII more rounded apically . . . . . *D. percernis*
- Lobe above the caudal emargination of sternite VII broad and blunt, almost straight 11
11. Lobe above the caudal emargination of sternite VII broad and blunt, almost straight, and rounded dorsal margin . . . . . *D. pentachaeta*
- Lobe above the caudal emargination of sternite VII broad and almost straight with acute apex in dorsal margin (Fig. 8) . . . . . *Dactylopsylla samalayucae* **n. sp.**
12. Caudal margin of sternite VII with a prominent lobe subtended by at least a shallow sinus 13
- Caudal margin of sternite VII more sinuate, its lobe and ventral sinus not so pronounced 14
13. Caudal lobe of sternite VII pronounced and acutely pointed above a small sinus . . . . . *D. bluei*
- Caudal lobe of sternite VII broad and rounded above a shallow but taller sinus . . . . . *D. neomexicana*
14. Caudal margin of sternite VII undulate, its lobe poorly developed, its ventral sinus tall and shallow . . . . . *D. megasoma*
- Caudal margin of sternite VII with a more pronounced lobe, its ventral sinus somewhat variably developed in the material available . . . . . *D. stimsoni*

Discussion

Traub *et al*. (1983) mentioned that fleas of the genus *Dactylopsylla* are probably considered nest fleas, which would explain their rarity and infrequency with which they are collected. In addition, geomyids are characterized by low dispersal activity and significant separation of pairs, families and populations. Many species and subspecies have small, isolated distributions, which may explain the large number of species and subspecies of *Foxella* and *Dactylopsylla* (Medvedev 1997; Fernández *et al*. 2014).

Fleas of the three genera of Dactylopsyllinae (*Dactylopsylla*, *Foxella*, *Spicata*) are found with pocket gophers mainly in the genera *Thomomys*, *Pappogeomys*, *Zygogeomys*, *Cratogeomys* and *Geomys*; however, they can parasitize other species of rodents and carnivores at low frequency (Medvedev 1997; Lewis & Wilson 2006).

Prior to the present study, only *D. megasoma* had been reported in Mexico (Ayala *et al*. 1988; Falcón-Ordaz *et al*. 2012). With the description of this new species, this study supports Acosta's hypotesis (2014) that half of the Mexico´s flea fauna is unknown. This record comprises the first report of *Dactylopsylla* in Chihuahua and the NPA Médanos de Samalayuca in the Chihuahuan desert and recognizes a new host species (*Geomys arenarius*). Moreover, the finding of *D. samalayucae* **n. sp.** at Arantxa Ranch represents the westernmost record for this genus, with *D. megasona* distributed in Coahuila, Nuevo León and Veracruz (Lewis & Wilson 2006; Falcon-Ordaz *et al*. 2012), and the southernmost record in the border area, with *D. neomexicana* in New Mexico (Ford *et al*. 2004) and *D. digitenua* in Texas (Prince & Stark, 1951).

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