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## A NEW FLEA SPECIES OF THE GENUS *CLEOPSYLLA* (SIPHONAPTERA: STEPHANOCIRCIDAE) FROM NORTHWESTERN ARGENTINA

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**ABSTRACT:** A new species of flea of the genus *Cleopsylla* Rothschild, 1914 (Siphonaptera: Stephanocircidae) is described from sigmodontine rodents from northwestern Argentina. In Argentina, the genus was cited for the first time in 2008, but the species was erroneously identified. An identification key to species of *Cleopsylla* is presented.

The family Stephanocircidae (“helmet fleas”) is divided into 2 subfamilies: Stephanocircinae Wagner, 1928, distributed in Australia, and Craneopsyllinae Wagner, 1939, distributed in South America. Craneopsyllinae is represented by 7 genera; all are distributed in Argentina and were documented in the orders Didelphimorphia, Paucituberculata, and Rodentia (Hopkins and Rothschild, 1956; Autino and Lareschi, 1998; Colombetti et al., 2008; Lareschi et al., 2010). One of these genera, *Cleopsylla* Rothschild, 1914, has a broad distribution from Venezuela, through Colombia, Ecuador, and Peru to northern Argentina and southern Chile (Hopkins and Rothschild, 1956; Johnson, 1957; Tipton and Machado-Allison, 1972; Beaucournu and Gallardo, 1991; Beaucournu et al., 2014) and is represented by 3 species: *Cleopsylla townsendi* Rothschild, 1914; *Cleopsylla monticola* Smit, 1953; and *Cleopsylla vidua* Beaucournu and Gallardo, 1991.

In Argentina, the genus was documented from Catamarca Province and identified as *Cleopsylla townsendi* (Colombetti et al., 2008). Later López Berrizbeitia et al. (2013) mentioned the genus from Salta Province as an unknown species. Further studies of specimens collected on sigmodontid rodents from 3 Argentine provinces (Catamarca, Salta, and Tucumán), including the unknown species of López Berrizbeitia et al. (2013) and *C. townsendi* recorded by Colombetti et al. (2008), revealed a new species. We describe this new species of *Cleopsylla*.

### MATERIALS AND METHODS

The specimens studied are from several localities in the provinces of Catamarca, Tucumán, and Salta. The localities in the first 2 provinces correspond to the Yungas Forests eco-region, and the Salta localities correspond to the Monte Desert of Mountains and Isolated Valleys eco-region. The rodents were captured with Sherman live traps baited with peanut butter and oats, were subjected to a thorough post-mortem visual examination, and were inspected for fleas, which were removed with forceps. The fleas were prepared following conventional techniques for taxonomic identification. The images were prepared using an Olympus BX61 Compound Microscope with an Olympus CC12 digital camera in conjunction with an Olympus Microsuite™ B3SV program (Olympus, Melville, New York). The landmarks used to measure the fleas are described in Hastriter and Eckerlin (2003). For comparative purposes, we examined specimens of *Cleopsylla monticola*, 2 males (V-21836, V-21884) from Venezuela, and *Cleopsylla townsendi*, 1 male (PMH-82) and 2

females (PMH-64); the first is from Pariacota, and the others are from Huascarán National Park, all Ancash Department, Peru (deposited in Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah). Collection numbers designated as PMH are represented as a collection series of fleas from Peru in the Michael Hastriter flea collection, and V represents the collection from Venezuela in the Vernon J. Tipton flea collection.

Anatomical terms were adapted from Rothschild and Traub (1971), and the classification given by Whiting et al. (2008) was followed.

Mammal nomenclature follows Barquez et al. (2006), Gardner (2008), and Patton et al. (2015). Unless otherwise specified, counts of setae and ctenidia comprise only 1 side of flea. The host specimens were deposited in the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán and Fundación Miguel Lillo, Argentina, and at the Sam Noble Oklahoma Museum of Natural History (OMNH), University of Oklahoma, Norman, Oklahoma. The host specimens that have not been stored in an institutional collection or museum were labeled with the initials of the collector: MIC (Maria Ines Carma). A thorough search was made for these specimens, and it was confirmed that they were destroyed.

The holotype, allotype, paratypes, and additional specimens of the new species were deposited in the Annexes of the Colección Mamíferos Lillo (CMLA).

### DESCRIPTION

*Cleopsylla barquezi* n. sp. López Berrizbeitia, Hastriter, and Díaz  
(Figs. 1–3)

**Diagnosis:** The new species most closely resembles *C. townsendi* but can be distinguished from it and all other species of the genus by characteristics of the genitalia and modified sternites. In the male, total length of distal arm of sternite IX (S-IX) is more than 4 times the length of its swollen portion (Fig. 1C). In the aedeagus, the fulcrum of the apodeme is heavily sclerotized and the fulcral latero-ventral lobe is long, twice the length compared to the fulcral latero-ventral lobe of *C. townsendi*. Crescent sclerite is long and thin, twice the length of that of *C. townsendi* (Fig. 1C). In the female, the sinus on the caudal margin of the S-VII is considerably shorter than the other species, one-third of the total length of the sternite. The caudal margin of S-VII has 4 setae above and 4 setae below deepest apex of sinus (Fig. 3D). The spermatheca is similar to that of *C. townsendi*, but the bursa copulatrix is sclerotized with a short hyaline perula that expands into a long dilated (pars dilatata) of the duct of the spermatheca (Fig. 2C).

**Description:** Head (Fig. 1A, B). Frons strongly reclining backwards and slightly convex. The vertical comb on the frons with 7 spines in the male and 8 in the female, and as in other species of the genus, with the lowest spine elongated and curved ventrad. Row of 5 long setae parallel to vertical comb; numerous minute setae along frontal margin. Antennal scape longer in the male than in the female, and with 3–4 small setae in both sexes. Pedicel with 5 setae, none extending onto clavus, and numerous small setulae bordering the dorsal margin of the antennal fossa. Base of maxilla about as wide as length; moderately pointed at apex. Labial palpus of 4 segments (excluding palp bearing maxillary segment). Genal comb with vertical row of 4 spines; genal process with a very small “apical” spinelet. One ocular seta anterior to eye; eye greatly reduced but pigmented. Occipital area with 4 rows of setae: first with 2, second with 3, third with 6, fourth with 7 plus intercalaries.

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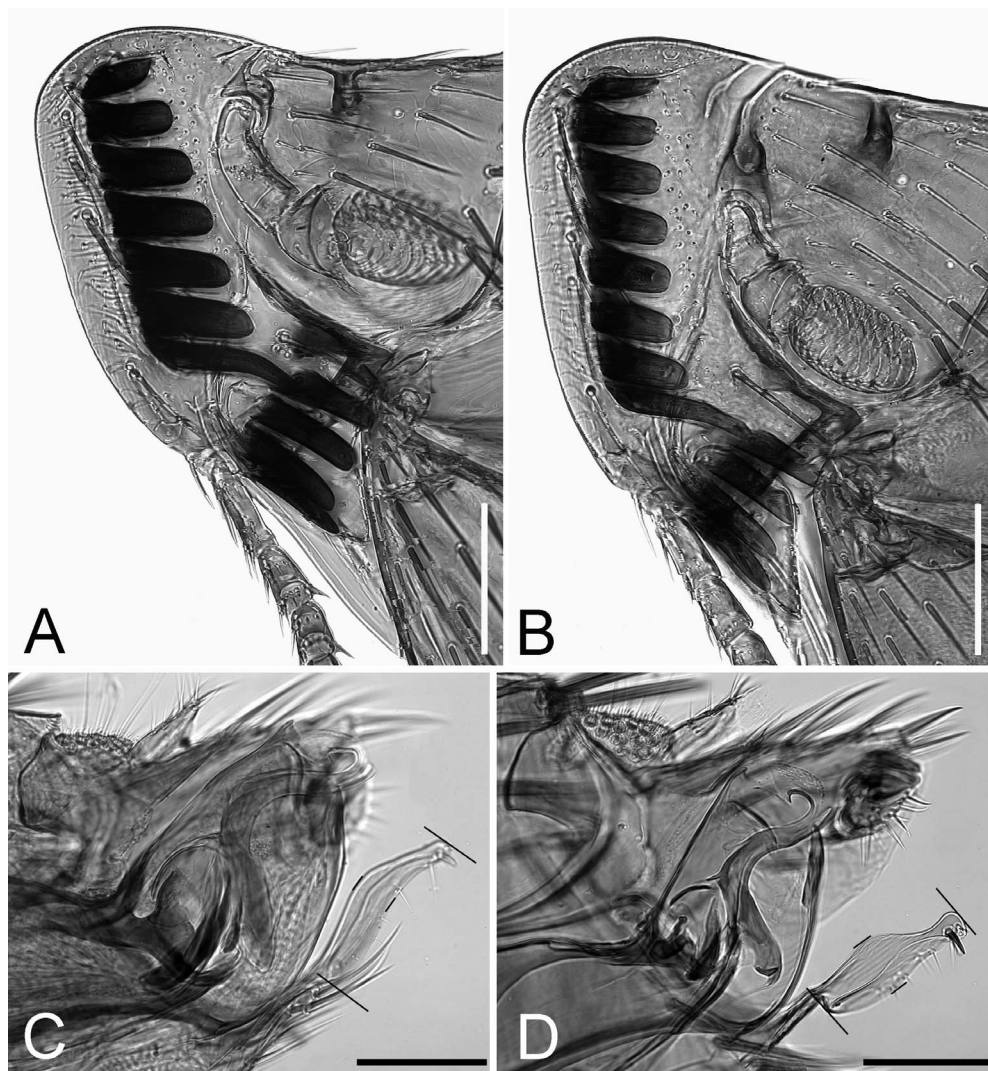


FIGURE 1. *Cleopsysylla barquezi* n. sp. (CMLA-13, 14). (A) Head, male holotype. (B) Head, female allotype. (C) Terminalia, male holotype. (D) *Cleopsysylla townsendi*, (PMH-82) terminalia. Lines on figures C and D indicate landmarks for measuring lengths and widths of distal arm of S-IX. Scale = 100  $\mu$ m.

**Thorax:** Pronotum with 2 rows of setae, anterior row with 6–7 medium setae, and the main row with 5 long setae plus intercalaries. Pronotal comb of 26 ctenidia (both sides) in the male and 22 in the female. Meso- and metanota with 3 rows of setae, anterior row with 3–4, middle row with 7–8, main row of 5 setae plus intercalaries. Mesosternum with 4 long setae. Mesepimeron with 5–6 long setae. Lateral metanotal area with 1 small seta. Pleural ridge and arch well developed. Metepisternum with 1 long seta at posterior margin. Furca one-third length of pleural ridge. Metepimeron with 2 rows setae; anterior row with 4–6 setae, posterior with 4 setae as *C. townsendi* (Fig. 3A).

**Legs:** Forecoxa with 5 horizontal rows of setae. Meso- and hindcoxa with small setae scattered mainly at anterior margin. Fore femoro-tibial joint with 2 setae equal in length. Meso- and hindfemora with 3 minute lateral setae, and femoro-tibial joint with 1 short lateral seta and 1 long mesal seta. Margin of foretibia with 5 dorsal notches, meso- and hindtibiae with 7 dorsal notches. Mesotibia with 9–11 scattered mesal setae. Notches 4 and 5 of the hind tibia with 3 closely spaced setae per notch, the lateral aspect of hind tibia with 2 vertical rows of setae aligning obliquely with 3 setae of notches 4 and 5 (Fig. 2A).

**Unmodified abdominal segments:** Terga II–VI with 1–3, 2, 1–2, 1–2, 1 apical spinelets in the male, and 2, 2, 2, 2, 1 in the female. Tergites I–VII with 2 rows of bristles, anterior with short bristles, and posterior with long bristles plus intercalaries; T-II–VI with 2 setae below spiracle. Tergite VII with 3 antesensilial bristles; mesal bristle small, barely visible. Sensillum with about 13–14 sensilial pits. Sternites III–VII with a main row of 4 setae

in male; S-III–IV with a main row of 4 setae and S-V–VI with a main row of 5 setae in female.

**Modified abdominal segments:** Male: Dorsal anal lobe with several small setae and ventral anal lobe with 1 long seta. Sternite VIII with 4 long setae at posterior margin. Basimere wide with about 15 long setae of which 3 are at the apical margin. Manubrium similar to other species of the genus, slender and narrow at apex. Telomere without posterior expansion (Fig. 1C) unlike *C. monticola* and *C. townsendi* in which the posterior expansion of telomere is forming a lobe (Fig. 3B, C). Telomere with 8 minute setae along ventral margin; the dorsal basal surface with an accessory lobe short and narrow and tapered at apex. Proximal arm of S-IX with apex rounded on posterior margin and forming a projection on anterior margin (similar to *C. townsendi*); total length of distal arm of S-IX is more than 4 times the length of its swollen portion, with short and stout spines near apex, and a few minute setae on posterior margin (Fig. 1C).

**Aedeagus** (Fig. 1C). Median dorsal lobe with apical projection. Sclerotized inner tube broad and curved with thick lateral sclerotization. Dorsal armature well developed, and ventral armature projects into the aedeagal pouch, apex of the lateral lobe angular. Crescent sclerite long and thin, joined to fulcrum of the apodeme. Fulcrum heavily sclerotized and fulcral latero-ventral lobe long. Aedeagal apodeme broadly spatulate, rounded at apex with conspicuous apical appendage. Penis rods coiled 1 revolution, and virga ventralis is shorter than penis rods.

**Female:** Ventro-caudal margin of T-VIII with 5 long setae. Length of anal stylet 3 times length of width (at base), with a long apical seta and 2 minute setae to each side. The sinus at the caudal margin of the S-VII very

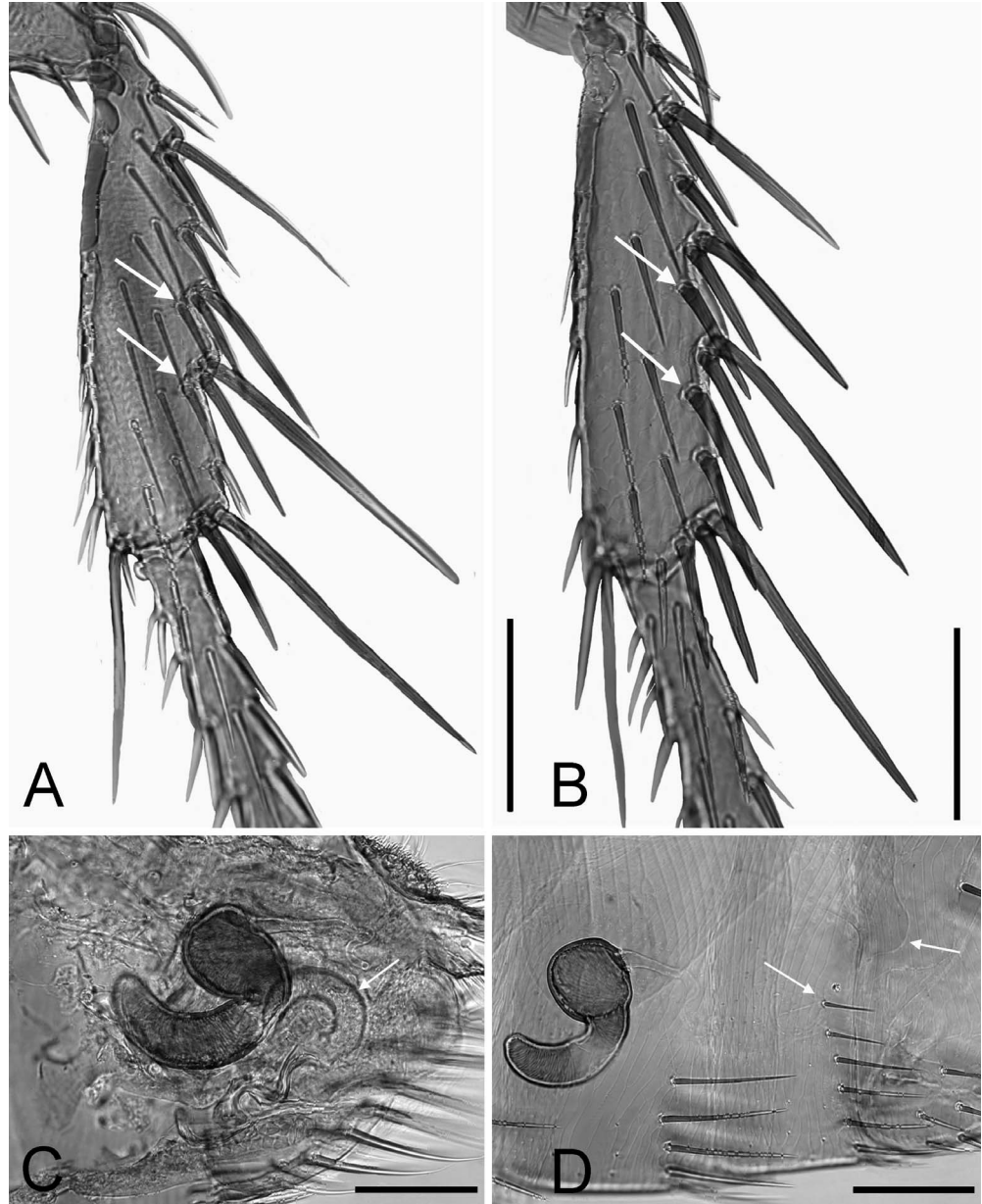


FIGURE 2. (A) *Cleopsylla barquezi* n. sp., male (CMLA-13), hind tibia. (B) *Cleopsylla monticola*, male (V-21836), hind tibia. (C) *Cleopsylla barquezi* n. sp., (CMLA-14), female spermatheca, bursa copulatrix, and pars dilatata (white arrow). (D) *Cleopsylla townsendi*, female (PMH-64), spermatheca and arrows indicating lobe and uppermost seta on S-VII. Scale = 100  $\mu$ m.

short, one-third the total length of the sternite. The caudal margin of S-VII with 8 long, main setae: 4 setae above the lower margin of the lobe of the caudal margin of the sternite VII and 4 setae at sinus level (Fig. 3D). Spermatheca internally grooved, hilla twice length of bulga, not protruding into bulga, bulga subglobular. Juncture of hilla and bulga constricted, without marked sclerotization. Bursa copulatrix is sclerotized with a hyaline perula that expands into a long dilated portion (pars dilatata) of the duct of the spermatheca (Fig. 2C).

**Dimensions:** Holotype: 2.00 mm. Males, mean: 1.96 mm (n = 7); range: 1.72–2.15 mm. Allotype: 2.23 mm. Females, mean: 2.25 mm (n = 10); range: 2.15–2.43 mm.

**Taxonomic summary:** *Type material* Holotype  $\delta$  (CMLA-13) and allotype  $\delta$  (CMLA-14), Argentina, Tucuman Province: Tafi del Valle Department, Santa Cruz, 10 km S Tafi del Valle (26°53'34.90"S, 65°45'52.28"W), 2,278 meters (m), ex *Phyllotis osilae* J. A. Allen, 1901 (OMNH 30102), 28 November 1998. Paratypes, Argentina, Salta Province: ~15 km W Escoipe, on Provincial road No. 33, (25°10'25.2"S,

65°49'31.6"W), 2,680 m, 1  $\delta$  (CMLA-15), 3  $\delta$  (CMLA-17, 18, 19) ex *Akodon spegazzinii* Thomas, 1897 (CML 9236, OMNH 33007), 15 May 1999; Catamarca Province: Ambato Department; Cumbre de Humaya (27°56'12.08"S, 65°56'46.30"W), 1,900 m, 1  $\delta$  (CMLA-26) ex *A. spegazzinii* (MIC 302), 27 May 2006, 1  $\delta$  (CMLA- 29) ex *A. spegazzinii* (MIC 312), 28 May 2006.

**Additional specimens examined:** Argentina, Salta Province: ~15 km W Escoipe, on Provincial road No. 33, (25°10'25.2"S, 65°49'31.6"W), 2,680 m, 2  $\delta$  (CMLA-16,20), 1  $\delta$  (CMLA-21) ex *A. spegazzinii* (CML 9236), 15.v.1999; Catamarca Province: Ambato Department, Las Juntas (28°06'S, 65°55'W), 1,750 m, 1  $\delta$  (CMLA-22), 2  $\delta$  (CMLA-23, 24) ex *P. osilae* (MIC 79), 1  $\delta$  (CMLA-25) ex *A. spegazzinii* (MIC 85), 22 June 2005; Cumbre de Humaya (27°56'12.08"S, 65°56'46.30"W), 1,900 m, 1  $\delta$  (CMLA-27), 1  $\delta$  (CMLA-28) ex *A. spegazzinii* (MIC 263, 266), 26 May 2006, 1  $\delta$  (CMLA-30), 1  $\delta$  (CMLA-31) ex *A. spegazzinii* (MIC 311), 28 May 2006.

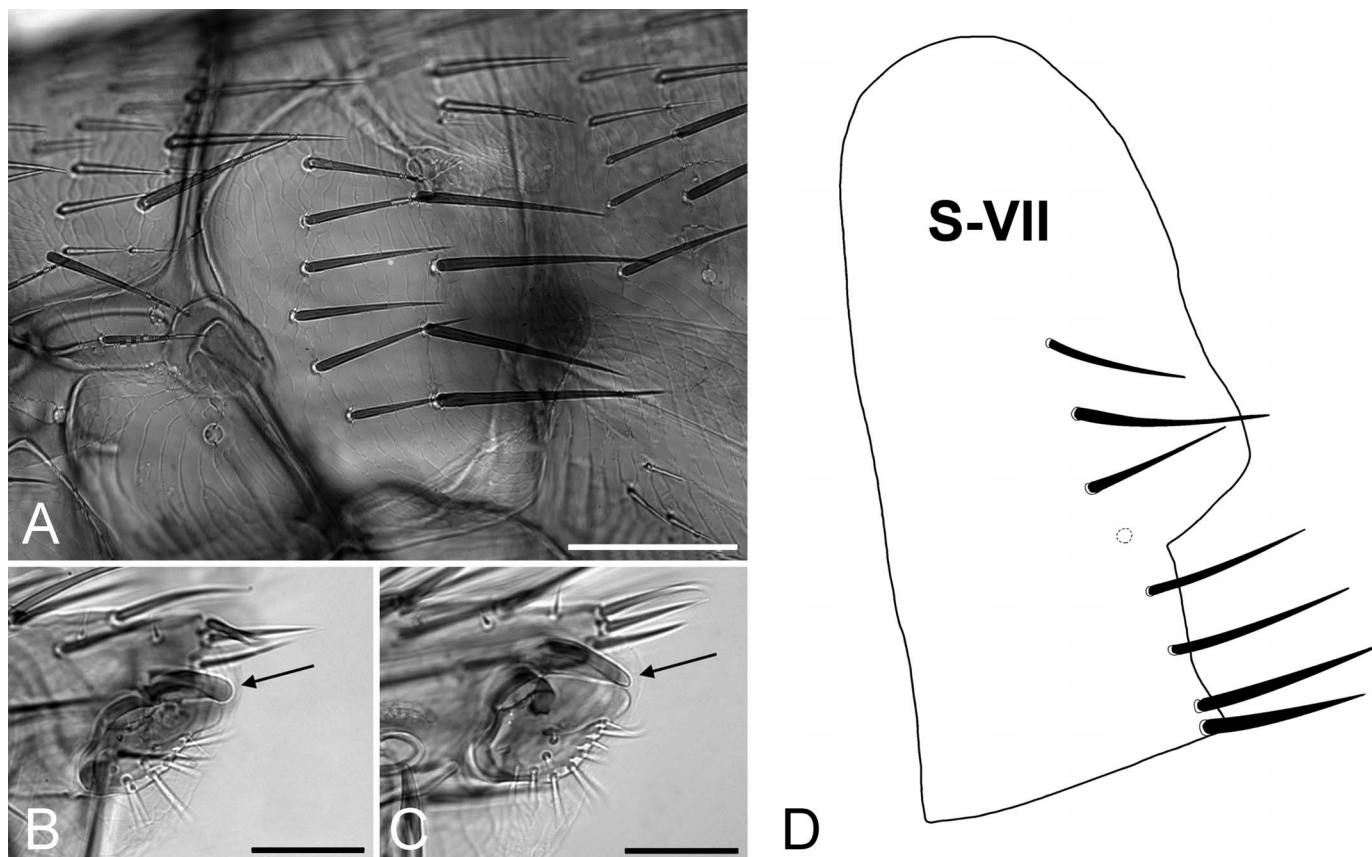


FIGURE 3. (A) *Cleopस्या townsendi* female (PMH-64), metepimeron. (B) *Cleopस्या monticola*, male (V-21884), telomere (arrow to accessory lobe). (C) *Cleopस्या townsendi*, male (PMH-82), telomere (arrow to accessory lobe). (D) *Cleopस्या barquezi* n. sp., female (CMLA-14), S-VII illustrating position of setae relative to caudal lobe and sinus. Scale, Fig. A = 100  $\mu$ m; B–C = 50  $\mu$ m.

*Etymology:* *Cleopस्या barquezi* is named in honor of Dr. Rubén Barquez, internationally recognized Argentine mammalogist, who has dedicated his life to the study of several aspects of the small mammals, especially in northwestern Argentina, and one of these aspects is the relationship between mammal hosts and their parasites. He is particularly noted for mentoring many students in research of ectoparasites of small mammals.

## DISCUSSION

The distribution of the genus *Cleopस्या* seems to be mainly Andean (Fig. 4). The maximum altitude recorded for *C. monticola* in Ecuador (Chimborazo) was 6,000 m (Smit, 1953). The lowest elevation was recorded by Beaucournu et al. (2014) for *C. townsendi* at 1,000 m at Putaendo, San Felipe, Chile. According to the amount of specimens examined, this last locality could be defined as “atypical,” since it is at a much lower altitude than the remaining localities recorded for the genus. This locality, as well as the type locality of *C. vidua*, are the southernmost limits cited for this genus (Fig. 4).

The elevation for hosts and specimens of the new species of flea was similar between the localities, with a range of 1,750–2,680 m. The type locality of *C. barquezi* corresponds to highland pastures (2,278 m), the last stratum of the eco-region Yungas Forests. This stratum is cold temperate and subhumid, and the vegetation is characterized by patches of Montane Forest alternating with shrubs, and at higher altitudes herbaceous communities dominate

(Burkart et al., 1999). This habitat is considered to be threatened by anthropogenic pressure manifested by cattle raising (Sala et al., 1986; Prado, 1995). Paratypes from localities from Catamarca, also correspond to the eco-region Yungas Forests, but from a different stratum, the Montane Forest. It is temperate, with winter frosts, and humid; there are trees as “aliso” (*Alnus acuminata*), “pino del cerro” (*Podocarpus parlatorei*), and “nogal” (*Juglans australis*) (Burkart et al., 1999). The locality from Salta corresponds to the eco-region Monte Desert of Mountains and Isolated Valleys, where the vegetation is characterized by small and medium shrubs and cacti called “cardones” (*Trichocereus atacamensis*); also, some scattered trees typical of the ecoregions “algarrobos” (*Prosopis alba*) are present (Burkart et al., 1999; López Berrizbeitia et al., 2015).

During the literature review, errors in recorded localities were noted. Hastriter et al. (2002) indicated the same coordinates (10°03'48"S, 77°19'27"W) in 2 provinces (Chiquian and Recuay); this coordinate occurs only in Recuay Province. Johnson (1957) located the localities Pampa de Capazo and Pampa de Ancamarca in the Junin Department, but these correspond to Puno Department; and Caccachara in Puno Department corresponds to Moquegua Department. Beaucournu and Gallardo (1991) erroneously indicated the coordinates (18°12'S, 69°16'W) to Lago Chungara, but the precise coordinates are 18°13'31"S, 69°9'21"W, and also the coordinates 40°42'S, 71°57'W for Lagos, Puyehue, but the corresponding ones are 40°41'8"S, 72°36'9"W.



FIGURE 4. Map illustrating documented distribution of species of *Cleopsylla*. The localities that follow are listed by latitude from north to south for each species of *Cleopsylla*. The specific localities (in parentheses) include country, department and/or province, specific locality, altitudes, and coordinates. Symbols adjacent to each species are listed on map (Fig. 4) with associated locality number.

***Cleopsylla monticola*** (●) Venezuela: Federal Trujillo Department: not specific locality (1); Merida Department: not specific locality (2); Tachira Department: not specific locality (3). The locality point was placed in the center of the department. Colombia: Cundinamarca, Bogota District: San Cristóbal, 2,718 meters (m), 4°33'35.69"N, 74°05'29.44"W (4). Ecuador: Pichincha Province: Pichincha, 16,000 ft. (4,877 m), 0°10'38"S, 78°35'56"W (5). Cotopaxi Province: Iliniza, ±17,500 ft (±5,334 m), 0°39'46"S, 78°42'54"W (6). Chimborazo Province: Chimborazo, 20,500 ft (6,248 m), 1°28'9"S, 78°49'3"W (7).

***Cleopsylla townsendi*** (■) Peru: Ancash Department, Huaylas Province: Parque Nacional Huascarán, 3,630 m, 9°30'04"S, 77°25'31"W (8); Parque Nacional Huascarán, 3,935 m, 9°30'27"S, 77°26'13"W (9); Parque Nacional Huascarán, 3,475 m, 9°30'39"S, 77°27'69"W (10); Parque Nacional Huascarán, 3,630 m, 9°30'04"S, 77°25'31"W (11). Huaraz Province: Pariacota, 3,715 m, 9°33'10"S, 77°35'69"W (12). Recuay Province: 4.6 km W Recuay, 3,660 m, 9°43'36"S, 77°27'55"W (13); 19 km W Recuay, 4,420 m, 9°44'6"S, 77°30'03"W (14); N of Santos River, 4,180 m, 10°03'48"S, 77°19'27"W (15). Chiquian Province: E of Chiquian, 4,180 m, 10°06'07"S, 77°11'07"W (16); E of Chiquian, 3,995 m, 10°08'06"S, 77°10'22"W (17); E of Chiquian, 3,990 m, 10°09'14"S, 77°19'17"W (18). Junin Department, Junin Province: Carhuamayo, 14,500 ft. (4,420 m), 10°56'42.55"S, 76°02'09.15"W (19). Jauja Province: Pachacayo, 12,000 ft. (3,658 m), 11°44'42.63"S, 75°43'53.41"W (20). Cuzco Department, Calca Province: Hacienda Urco, 3,134 m, 13°41'08.97"S, 71°37'21.96"W (21). Puno Department, San Antonio de Putina Province: Picotani, 4,537 m, 14°32'59.67"S, 69°48'0.02"W (22). El Collao Province: Pampa de Ancomarca, 13,700 ft. (4,176 m), 17°12'53"S, 69°39'4"W (23). El Collao Province: Pampa de Capazo, 14,300 ft. (4,359 m), 17°10'30"S, 69°44'53"W (24). Moquegua Department: Mariscal Nieto Province: Caccachara, 50 miles Southwest of Ilave, elev. 16,000 ft (4,876.8 m) 16°44'57.26"S, 70°6'59.93"W (25). Tacna Department, Tarata Province: 20k NE Tarata, 14,600 ft. (4,450 m), 17°22'30.14"S,

Jordan (1931) proposed that "helmet fleas" were originally parasites of marsupials and secondarily evolved on rodents. *Cleopsylla monticola* and *C. vidua* were indeed collected on marsupials (Beaucournu and Gallardo, 1991); however, our new species *C. barquezi* was collected on the sigmodontine rodent hosts (*Akodon spegazzinii* and *Phyllotis osilae*), and *C. townsendi* was collected on the octodontid rodent *Octodon lunatus* Osgood, 1943 (Beaucournu et al., 2014). Other stephanocircid fleas of South America (*Plocopsylla*, *Craneopsylla*, *Sphinctopsylla*, etc.) follow similar original patterns of evolving on marsupial host lineages with more recent radiation to a myriad of rodent hosts (both sigmodontids and octodontids).

The discovery of this new species and our most recent description of *Ctenidiosomus austrinus* (López Berrizbeitia et al., 2015) support the assumption that the flea fauna of the region of northwestern Argentina is largely unexplored and requires additional field investigations to elucidate yet undescribed flea taxa. Colombetti et al. (2008) misidentified our new species of *C. barquezi* referring to it as *C. townsendi*. We examined all available fleas except 2 that are missing and compared them with specimens from Tucuman and Salta provinces. All specimens examined shared the diagnostic characters presented in this study. The hosts reported by Colombetti et al. (2008) were not available for our review; therefore, we could not verify their identity. We highlight the importance of deposition of scientific material to systematic collections, ensuring the proper preservation thereof over time; this will allow timely study and review by researchers.

**Key to species of *Cleopsylla***

1. Pronotal ctenidia with narrow and triangular apex. Hind tibia, with a single vertical lateral row setae. Hilla appearing to protrude into bulga, as the base of the bulga envelops hilla (male unknown). . . . . *C. vidua*
- 1'. Pronotal ctenidia with sharpened and not triangular apex (Fig. 1A, B). Hind tibia with 2 vertical lateral row setae (Fig. 2A, B). Hilla not protruding into bulga. . . . . 2
2. Ventral seta in notches 4 and 5 of hind tibia in line with the other 2 setae, without a false comb (Fig. 2A). Hilla distinctly longer than bulga. . . . . 3
- 2'. Ventral seta in notches 4 and 5 of hind tibia shifted farther below middle seta, at a distance near midway between adjacent notches thus causing the tibia to appear as a false comb (Fig. 2B). Hilla much shorter, only slightly longer than bulga. . . . . *C. monticola*

69°57'4.39"W (26). Chile: XV Region Arica and Parinacota: Parinacota Province; Lago Chungará, 4,000 m, 18°13'31"S, 69°9'21"W (27). Región V Valparaíso: San Felipe de Aconcagua, Putaendo, 816 m, 32°37'42.37"S, 70°43'03.91"W (28).

***Cleopsylla vidua*** (★) Chile: X Region Los Lagos: Osorno Province, Entre Lagos, Puyehue, 1,400 m, 40°41'8"S, 72°36'9"W (29).

***Cleopsylla barquezi* n. sp** (▲) Argentina: Salta Province, Cachi Department: 15 km W Escoipe, on Provincial road No. 33, 2,680 m, 25°10'25.2"S, 65°49'31.6"W (30). Tucumán Province, Tafi del Valle Department: Santa Cruz, 10 km S Tafi del Valle, 2,278 m, 26°53'34.90"S, 65°45'52.28"W (31). Catamarca Province, Ambato Department, Cumbre de Humaya, 1,900 m, 27°56'12.08"S, 65°56'46.30"W (32); Las Juntas, 1,750 m, 28°06'S, 65°55'W (33).

3. Total length of distal arm of S-IX is more than 4 times the length of its swollen portion (Fig. 1C). Main row of 8 setae on margin of S-VII of female distributed in approximately even numbers above and below upper apex of sinus (Fig. 3D)..... *C. barquezi* n. sp.
- 3'. Total length of distal arm of S-IX is less than 3 times the length of its swollen portions (Fig. 1D). Setae in main row of S-VII situated below dorsal lobe or 1 seta above lowest level of dorsal (Fig. 2D). ..... *C. townsendi*

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