

Descriptions of two new species of flea of the genus *Plocopsylla* in northwestern Argentina

M. FERNANDA LÓPEZ-BERRIZBEITIA^{1,2}, JULIANA SANCHEZ³,
RUBÉN M. BARQUEZ¹ and M. MÓNICA DÍAZ^{1,2}

¹Programa de Investigaciones de Biodiversidad Argentina (PIDBA), Programa de Conservación de los Murciélagos de Argentina (PCMA), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, Tucumán, Argentina, ²Fundación Miguel Lillo, Tucumán, Argentina and ³Centro de Investigaciones y Transferencia del Noroeste de la Provincia de Buenos Aires (CITNOBA) (CONICET-UNNOBA), Buenos Aires, Argentina

Abstract. Two new species of flea of the genus *Plocopsylla*, subgenus *Plocopsylla*, (Siphonaptera: Stephanocircidae) collected from sigmodontine rodents in northwestern Argentina are described and a key to identification of species of the genus *Plocopsylla*, subgenus *Plocopsylla*, in Argentina is presented. *Plocopsylla* (*P.*) *inti* is cited for the first time in Argentina, extending its distribution ~970 km further south than previously documented. New locality data and flea–host associations are recorded. The contributions of this study are relevant because they increase knowledge of the diversity of flea fauna in northwestern Argentina bordering a plague endemic area and will be useful in the implementation of plague control management plans in the future.

Key words. Craneopsyllinae, plague endemic area, sigmodontine rodents, siphonaptera, stephanocircidae.

Introduction

The family Stephanocircidae includes two subfamilies, Stephanocircinae Wagner, 1928 and Craneopsyllinae Wagner, 1939. The latter is distributed only in South America where its mammal hosts are metatheria and rodents (Whiting *et al.*, 2008). Seven genera are distributed in Argentina and have been documented on the orders Didelphimorphia, Paucituberculata and Rodentia: *Barreropsylla* Jordan, 1953; *Cleopsylla* Rothschild, 1914; *Craneopsylla* Rothschild, 1911; *Plocopsylla* Jordan, 1931; *Nonnapsylla* Wagner, 1938; *Tiarapsylla* Wagner, 1937, and *Sphinctropsylla* Jordan, 1931 (Lareschi *et al.*, 2016; López Berrizbeitia *et al.*, 2016). Five genera and species have been cited as found in the northwestern part of the country: *Cleopsylla barquezi* López-Berrizbeitia, Hastriter & Díaz, 2016; *Craneopsylla minerva* (Rothschild, 1903); *Nonnapsylla rothschildi* Wagner, 1938; *Plocopsylla* sp., and *Tiarapsylla argentina*

Jordan, 1942. Each of these has been found parasitizing cricetid and caviomorph rodents and marsupials (Lareschi *et al.*, 2016).

The genus *Plocopsylla* includes more species than any other genus in the subfamily (Schramm & Lewis, 1988; Sanchez *et al.*, 2015), most of which have been classified based on three characters of males that include the movable process, sternite IX and the mesal process of the clasper. Based on these morphological features, Schramm & Lewis (1988) divided the genus into two groups, of which Group A comprises four subgroups and Group B two subgroups. In line with these two major groups, the genus is divided into two subgenera, *Plocopsylla* Jordan, 1931 comprises species of Group A, and *Schrammap-sylla* Beaucournu & Menier, 2004 comprises species of Group B (Beaucournu *et al.*, 2004). The subgenus *Plocopsylla* includes a complex called ‘*angusticeps-lewisi*’, which in northwestern Argentina was documented in Salta Province and identified as *Plocopsylla* (*P.*) sp. (López Berrizbeitia *et al.*, 2013). Further

Correspondence: Maria Fernanda López-Berrizbeitia, Programa de Investigaciones de Biodiversidad Argentina (PIDBA), Programa de Conservación de los Murciélagos de Argentina (PCMA), CONICET, Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, Miguel Lillo 205, 4000 Tucumán, Argentina. Tel.: + 54 0381 433 0868; E-mail: mflpezberri@hotmail.com

studies of specimens collected in the Province of Catamarca and *Plocopsylla* sp. from Salta Province revealed that it represents a new species. Likewise, specimens collected from La Rioja Province constitute a new species of the genus *Plocopsylla* belonging to subgroup A-3. These two new species are described in this study. Finally, one specimen collected in Catamarca Province and belonging to subgroup A-4 represents a new record for Argentina. Northwestern Argentina borders plague endemic areas. Plague has recently been documented in Ecuador, Bolivia, Brazil and Peru (Bitam *et al.*, 2010). The genus *Plocopsylla* is considered one of the plague vectors (Lewis, 1993); its hosts are mainly sigmodontine rodents (Dubynskiy & Yeszhanov, 2016).

Materials and methods

Fleas were collected from localities in three provinces in northwestern Argentina: Catamarca, La Rioja and Salta (see Appendix 1). The rodents were captured with Sherman live traps baited with peanut butter and oats and subjected to a thorough post-mortem visual examination. Fleas were removed with forceps. Fleas were prepared following conventional techniques for taxonomic identification (Hastriter & Whiting, 2003) and specimens of the new species were drawn using a microscope equipped with a camera lucida and photographed under a microscope. Original descriptions of the species and the keys of Hopkins & Rothschild (1956), Johnson (1957), Schramm & Lewis (1987, 1988), Hastriter *et al.* (2002) and Sanchez *et al.* (2015) were used for comparative purposes. Anatomical terms were adapted from Rothschild & Traub (1971) and the classification given by Whiting *et al.* (2008) was followed. Unless otherwise specified, counts of setae and ctenidia represent only one side of the flea. The landmarks used to measure the fleas are described in Hastriter & Eckerlin (2003).

For comparative purposes, specimens of *Plocopsylla* (*P.*) *silewi* Beaucournu & Kelt, 1990 [one male paratype (KELT-3976), one female paratype (KELT-3976)] from Chile and *Plocopsylla* (*P.*) *lewisi* Beaucournu & Gallardo, 1988 [one male paratype (MHG-852), one female paratype (MHG-852)] from Argentina were examined. These specimens are stored in the flea collection of J. C. Beaucournu and are being catalogued in the Museum of Natural History, Paris, France; the collection numbers designated as KELT and MHG correspond to the initials of the collectors. Other species examined were *Plocopsylla* (*P.*) *pallas* (Rothschild, 1914) [one female lectotype (BNHM 1923-615), one female paralectotype (BNHM 1923-615)] from Peru and *Plocopsylla* (*P.*) *viracocha* (Schramm & Lewis, 1987) [one male paratype (BNHM-17476), one female paratype (BNHM-15327)] from Chile deposited in the British Museum of Natural History (London, U.K.).

Holotypes, allotypes and paratypes of the new species of *Plocopsylla* and all fleas listed under 'Other studied specimens' were deposited in the Colección Mamíferos Lillo 'Anexos' (CMLA), Universidad Nacional de Tucumán, Argentina.

Mammal nomenclature follows Barquez *et al.* (2006), Gardner (2008) and Patton *et al.* (2015). The host specimens were deposited at the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán and at the Sam Noble Oklahoma Museum

of Natural History (SNOMNH), University of Oklahoma (Norman, OK, U.S.A.). Some of the host specimens are still being catalogued for the CML and hence the acronyms used in the text correspond to the initials of the collectors: ARG (catalogue of specimens from Argentina at SNOMNH); MIC (María Ines Carma), and RTS (Rocío Tatiana Sánchez). The hosts labelled with the initials of María Ines Carma (MIC) were not available for review and so the species could not be confirmed.

The taxonomic summary of the new species includes *type material* and *other studied specimens* and details the number of each sex of flea, the number and collection or field number of the host species, the date and locality of collection, etymology, diagnosis, description and remarks. The new record includes type host and locality, other known hosts, known geographical distribution, material examined (locality, host species, number and collection or field number of the host species, date, number of each sex of flea, collection number of flea) and remarks.

A distribution map and a key to the identification of species of the genus *Plocopsylla*, subgenus *Plocopsylla*, in Argentina are provided.

Taxonomic summary

Family Stephanocircidae.

Subfamily Stephanocircinae.

Plocopsylla (*Plocopsylla*) *chicoanaensis* López-Berrizbeitia, Sanchez, Barquez & Díaz sp. n.

Type material

Holotype ♂ (CMLA 687) and **allotype** ♀ (CMLA 688), ex *Akodon spegazzinii* Thomas, 1897 (Rodentia: Cricetidae) (SNOMNH 33007), 15 May 1999, Argentina, Salta Province, Chicoana Department: ~15 km west of Escoipe, on provincial road no. 33 (25°10'25.2'' S, 65°49'31.6'' W; 2680 m a.s.l.). **Paratypes**, two ♂ (CMLA 689, 690), one ♀ (CMLA 691), ex *A. spegazzinii*, three specimens (MIC 110, 126, 121), May 2005, Argentina, Catamarca Province, Ambato Department, Las Juntas (28°07'38.4'' S, 65°54'31.7'' W; 1750 m a.s.l.); one ♂ (CMLA 692), one ♀ (CMLA 693), ex *A. spegazzinii*, one (CML 9236), 15 May 1999; two ♂ (CMLA 694, 695), one ♀ (CMLA 696), ex *A. spegazzinii*, one (CML 9240), 17 May 1999, Argentina, Salta Province, Chicoana Department: ~15 km west of Escoipe, on provincial road no. 33 (25°10'25.2'' S, 65°49'31.6'' W; 2680 m a.s.l.).

Other studied specimens. One ♂ (CMLA 697), ex *Akodon caenosus* Thomas, 1918, one (MIC 94), June 2005; one ♀ (CMLA 698), ex *Phyllotis osilae* Allen, 1901 (Rodentia: Cricetidae), one (MIC 79), June 2005; three ♂ (CMLA 699, 700, 701), four ♀ (CMLA 702, 703, 704, 705), ex *A. spegazzinii*, four (MIC 91, 108, 113, 121), May 2005; one ♂ (CMLA 706), ex *Oligoryzomys* sp. (Rodentia: Cricetidae), one (MIC 204), May 2005, Argentina, Catamarca Province, Ambato Department, Las Juntas (28°06'37.9'' S, 65°54'34.6'' W; 1750 m a.s.l.); one ♀ (CMLA 707), ex *Ph. osilae*, one (CML 7234), 23 March 2001, Argentina, Salta Province, Chicoana Department: ~15 km

west of Escoipe, on provincial road no. 33 (25°10'25.2'' S, 65°49'31.6'' W; 2680 m a.s.l.).

Etymology. The species name 'chicoanaensis' refers to the provincial department of origin of the holotype.

Diagnosis

The new species closely resembles *P. silewi* in the following characters: prectenial width of helmet, modified sternites and shape of spermatheca in the female. However, it can be distinguished from *P. silewi* and all other species of the genus *Plocopsylla* by characteristics of the genitalia in the male and tergite VIII in the female. *Plocopsylla (P.) chicoanaensis* n. sp. belongs to the 'angusticeps-lewisi' complex. The male of *P. (P.) chicoanaensis* n. sp. differs from the other species of the 'angusticeps-lewisi' complex by the following characters: (a) the ventral extension of the clasper (manubrium), which has a rounded and narrow nipple-shaped tip; (b) the aedeagal apodeme, which has a narrow apex and a small prominence at the anterodorsal margin; (c) an apical appendage that is raised with a rounded tip, and (d) the anteroventral margin of the wall of the aedeagal pouch, which forms a projection with a large and quadrangular entrance. The female is unique in the shape of tergite VIII, in which the dorsal margin is characterized by a broad shallow sinus subtended by a rounded lobe, and the posteroventral angle of tergite VIII, which is convex, with four setae, the second inferior of which is shortest and spiniform.

Description

Head

The helmet has 11 spines in the male and 12 spines in the female (Fig. 1A, B), with one small seta located at the anteroventral margin of the head, level with the base of the second lower spine. The prectenial width of the helmet is considerably shorter than the length of the longest helmet spine (Fig. 1A, B), similar to *P. silewi*. The genal comb has five spines; the first upper spine is shortest and separated from the rest of the spines by a gap twice its basal width. The genal lobe is rounded. The maxillary palpus has four segments. The labial palp has five segments. The occiput has numerous small setae anteriorly preceding four rows of prominent setae; the posterior row consists of long setae plus intercalaries, similar to the main rows of setae on the thoracic and abdominal tergites. The scape has three to five setae in a row from the dorsal margin to the mesal surface. The pedicel has six to eight setae along the distal margin with some setae reaching the last segment of the clava.

Thorax and abdomen (non-genital segments)

The pronotum has two rows of setae; the pronotal comb has 24–26 spines (both sides) in the male, and 16–20 spines (both sides) in the female. The mesonotum has a small seta anteriorly preceding three rows of setae; the metanotum has three rows of setae.

Legs

The forecoxa has setae scattered over the surface. The fore femorotibial joint has two setae, lateral and mesal, equal in length. The foretibia has one row of five to seven setae on the surface; the margin of the foretibia has six dorsal notches (2, 2, 4, 4, 4, 4). The first two tarsal segments are equal in length; the third is half the length of the fifth; the fifth segment is longest and the fourth segment is shortest.

The mesocoxa is without setae. The mesofemur has a row of five setae restricted to the ventral and distal portions. The mesofemorotibial joint has one short lateral and one long mesal seta. The mesotibia has nine to 13 scattered setae on the surface and margin of the mesotibia with seven dorsal notches in the following arrangement: 2, 2, 3, 4, 4, 4, 4. The first tarsal segment is longest and is twice the length of the second; the second and fifth segments are twice the length of the third, and the fourth is shortest.

The hind coxa has a row of small and thick setae near the proximal and ventral margin, with some scattered setae on the surface anteriorly. The hind femur has a row of five setae restricted to the ventral and distal portions. The hind femorotibial joint has one short lateral seta and one long mesal seta. The hind tibia has 11–14 scattered setae on the surface and margin with seven dorsal notches (2, 2, 2–3, 3–4, 3, 4, 4). The first tarsal segment is twice the length of the second; the second is twice the length of the third; the third and fifth are twice the length of the fourth, and the fourth is shortest.

Abdomen

The abdominal tergites have two rows of bristles; the anterior row consists of small bristles and the posterior row of long bristles plus intercalaries. Tergites II–V show apical spinelets 3–5, 3–6, 1–3 and 0–3 in males and 3–5, 3–5, 1–3 and 0–1 in females. There is one elongate antesensilial bristle per side in males and two antesensilial bristles per side in females.

Modified abdominal segments: male

The basimere (the fixed process of the clasper) is triangular with 20 large setae (Figs 2 and 3A). The apex of the mesal process of the clasper is spatulate, with a straight distal margin (Fig. 3A). The telomere (the movable process of the clasper) has a markedly triangular and narrow apex with a thin seta and several thin scattered setae on the surface; it is a horizontal and narrow process with a modified, heavily pigmented, modified spiniform seta (Fig. 3B). The ventral extension of the clasper (manubrium) has a rounded and narrow nipple-shaped tip (Fig. 2). The posterior margin of sternite VIII forms a right angle with the ventral margin. The proximal arm of sternite IX has a concave dorsal margin and convex ventral margin (Fig. 3C). The distal arm of sternite IX narrows to an apex and has three small pigmented setae; near to these pigmented setae and to the caudal margin are four or five small and thin setae, and below these are two large non-pigmented setae (Fig. 3C).



Fig. 1. *Plocopsylla (Plocopsylla) chicoanaensis* n. sp. (CMLA 687, 688). (A) Male holotype. (B) Female allotype. Scale bar: 500 μ m.

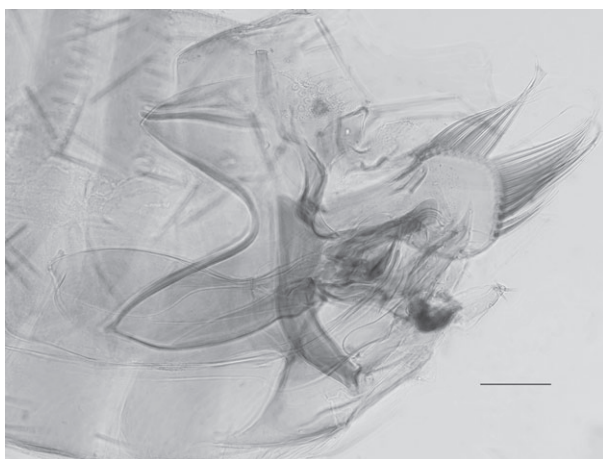


Fig. 2. Genital morphology of male of *Plocopsylla (Plocopsylla) chicoanaensis* n. sp., showing modified abdominal segments and aedeagus. Scale bar: 100 μ m.

Aedeagus

The aedeagal apodeme is broad, reaching two-thirds of the total length of the aedeagus; the apex has a small prominence at the anterodorsal margin (Fig. 3D). The apical appendage is raised with a rounded tip. The distal margin is almost curved with two long fulcral medial and lateroventral lobes. The middle plate is wider than the neck and curves down at almost the same level as the fulcrum. The lateral plates are convex and sclerotized. The dorsal median lobes are membranous with a straight dorsal margin. The lateral lobes are convex with a shallow sinus in the middle (similar to *P. lewisi*). The crescent sclerite is convex, housed inside fulcral sclerites. The sclerotized inner tube is about four times longer than wide and

curved ventrally. The distolateral lobes have a sclerotized lateral margin. The crochets are sclerotized, flanking the sclerotized inner tube. The wall of the aedeagal pouch extends along the caudal region of the apodeme at the same level of the neck, has a markedly sclerotized ventral margin and forms an anterior and ventral projection with a large and quadrangular entrance. The penis rods are longer than the aedeagal apodeme and the aedeagal apodemal rod is longer than the apodeme.

Modified abdominal segments: female

The spiracle of tergite VIII is large (Fig. 4). Tergite VIII has a dorsal margin characterized by a rounded lobe and a wide concavity below. The posteroventral angle of tergite VIII is convex, with four setae; the second inferior seta is the shortest and is spiniform. The anal stylet is 2.5 times longer than wide. The dorsocaudal margin of sternite VII is convex; the lower margin is straight (similar to *P. silewi*).

Spermatheca

The bulga has a concave ventral margin. The hilla extends into the bulga to form a sclerotized area. The bursa copulatrix is striated, sinuous and sclerotized.

Dimensions

Holotype: 1.9 mm. Males ($n = 11$): mean = 2.1 mm (range: 1.9–2.5 mm). Allotype: 2.7 mm. Females ($n = 10$): mean = 2.3 mm (range: 2.0–2.7 mm).

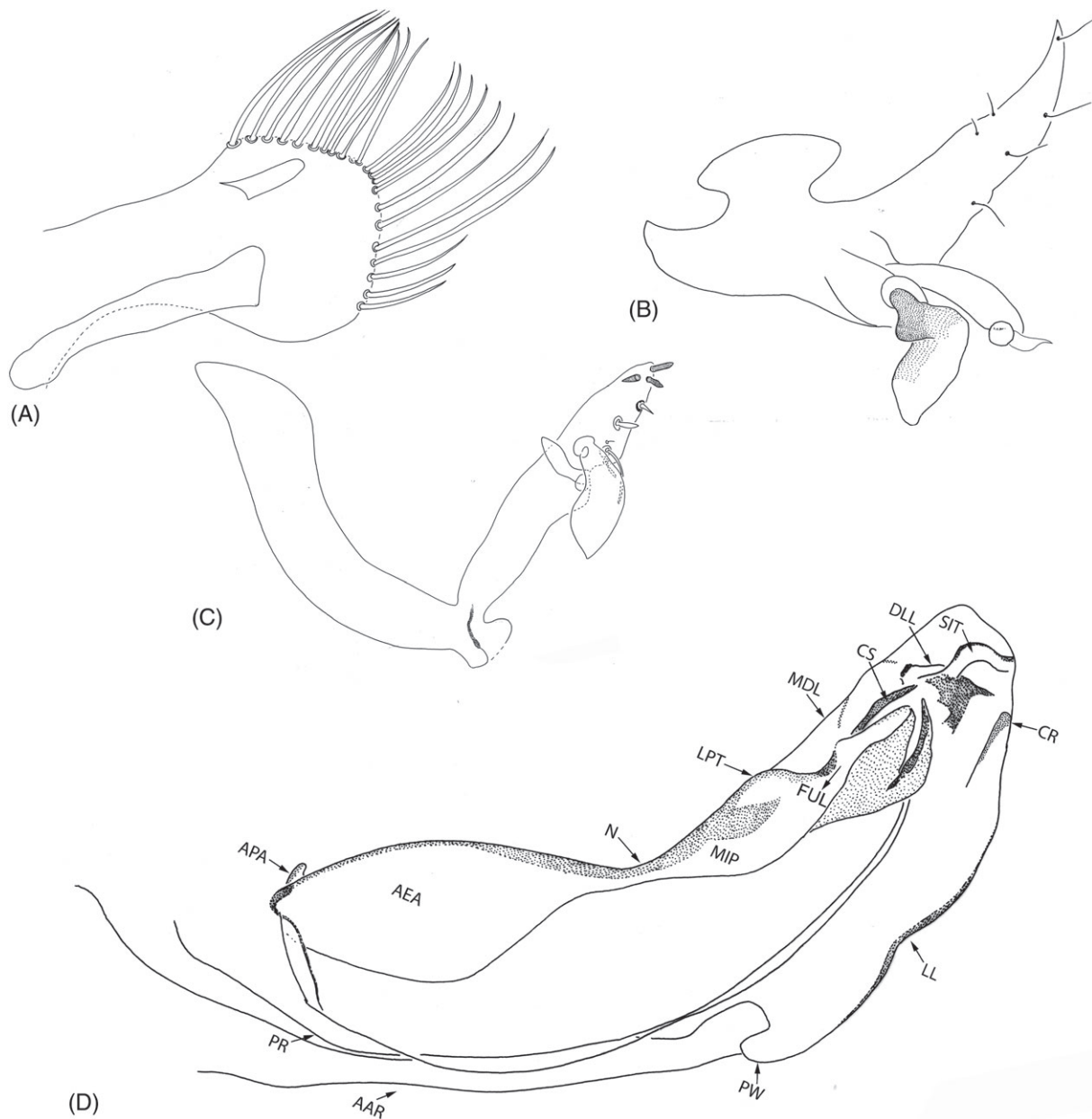


Fig. 3. *Plocopsylla (Plocopsylla) chicoanaensis*, male. (A) Basimere (fixed process of the clasper). (B) Telomere (movable process of the clasper). (C) Detail of sternite IX. (D) Aedeagus. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; APA, apical appendage; CR, crochet; CS, crescent sclerite; DLL, developed distolateral lobes; FUL, fulcrum; LL, lateral lobe; LPT, lateral plates; MDL, median dorsal lobes; MIP, middle plate; N, neck; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube.

Remarks

The type locality of *P. (P.) chicoanaensis* corresponds to the Monte Desert of Mountains and Isolated Valleys Ecoregion (Burkart *et al.*, 1999), where the vegetation is characterized by small and medium-sized shrubs and cacti called ‘cardones’ (*Trichocereus atacamensis*). Also present but scattered are some typical trees of the ecoregion, the ‘algarrobos’ (*Prosopis alba*). The habitat in which the paratypes were collected corresponds to the Montane Forest stratum of the Yungas Forest ecoregion. It

is a temperate and humid area with winter frosts and features tree species such as the ‘aliso’ (*Alnus acuminata*), ‘pino del cerro’ (*Podocarpus parlatorei*) and ‘nogal’ (*Juglans australis*) (Burkart *et al.*, 1999). The hosts recorded for *P. (P.) chicoanaensis* belong to different tribes of rodent, including the Akodontini represented by *A. caenosus* and *A. spegazzinii*, the Phyllotini represented by *Ph. osilae* and the Oryzomyini represented by *Oligoryzomys* sp. (Pardiñas *et al.*, 2015; Steppan & Ramirez, 2015; Weksler & Bonvicino, 2015).

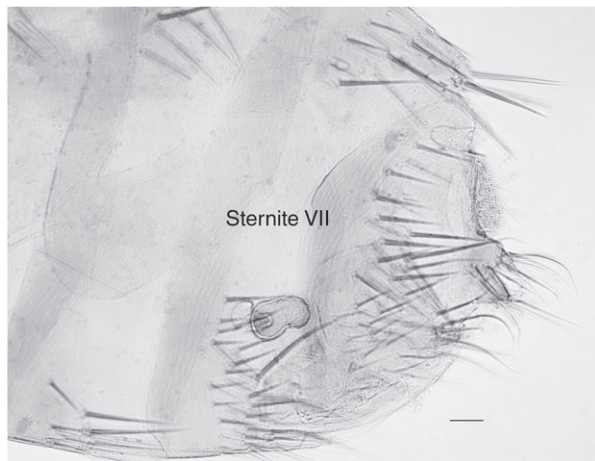


Fig. 4. Genital morphology of female of *Plocopsylla* (*Plocopsylla*) *chicoanaensis* n. sp. Scale bar: 50 μ m.

***Plocopsylla* (*Plocopsylla*) *hastriteri* López-Berrizbeitia, Sanchez, Barquez & Díaz sp. n.**

Type material

Holotype ♂ (CMLA 708), **paratype** ♂ (CMLA 709), ex *Ph. osilae*, one (RTS 38), 6 November 2013, Argentina, La Rioja Province, Famatina Department: 8 km northeast of Cañón del Ocre (28°57'37.3" S, 67°41'26.3" W; 3127 m a.s.l.).

Etymology

This species is named '*hastriteri*' in honour of Michael W. Hastriter (Brigham Young University, Provo, UT, U.S.A.), an outstanding entomologist dedicated to the study of Siphonaptera whose knowledge of global flea fauna represents an enormous contribution to the systematics of fleas. He has been a mentor to one of the authors (MFL-B) and provided her with assistance to develop the present and other investigations.

Diagnosis

The new species most closely resembles *P. (P.) viracocha* in the prectenidial width of the helmet, the shape of sternite IX and the telomere, but can be distinguished from it and all other species of the genus *Plocopsylla* by the shape of the basimere and the characteristics of the aedeagus. *Plocopsylla* (*Plocopsylla*) *hastriteri* belongs to subgroup A-3 as the male exhibits features involving the movable process (telomere) (Schramm & Lewis, 1988). The male of *P. (P.) hastriteri* differs from other species by the following combination of characters: (a) the basimere of the clasper is wider in all of its extension and shows a convex margin with seven or eight setae and a concave margin with four setae, and (b) the aedeagus has membranous median dorsal lobes, the tips of which project upward to form a conical apex.

Description

Head

The helmet has 15 spatulate spines, without notched bases. The prectenidial width of the helmet is more than 1.5 times the length of the longest helmet spine (Fig. 5A). There are minute marginal setae along the anterior margin of the helmet, and one long seta near the base of the second ventral helmet spine. Two placoid pits are seen on the dorsal margin of the helmet. The gena has a line of nine or 10 minute setae on the anterior margin. The genal comb has six spatulate spines [as in *Plocopsylla* (*P.*) *enderleini*, *P. (P.) pallas* and *P. (P.) viracocha*]; the most dorsal spine is less than half the length of the adjacent spine. The genal lobe extends beyond the most dorsal spine of the comb. The maxillary palpus has four segments. The maxilla has a rounded dorsal margin and a straight ventral margin. The labial palp has five segments. The post-antennal region has a group of five minute setae and 15 long setae on the anterior margin, behind which are four rows of setae (4, 5, 6, 8); the posterior row has intercalaries. The antennal scape has four short setae; the pedicel has 10 long setae, extending beyond the base of the clava [as in *P. (P.) viracocha*].

Thorax

The pronotum has three rows of setae (4, 7, 6); the comb has 10 spines. The mesonotum has an anterior group of approximately 15 setae, irregularly distributed rows of six setae and seven setae, and a row of four long setae plus intercalaries. The mesosternum has three long setae; the mesepimeron has four long setae and three short setae on the pleural rod. The metanotum has four rows of setae, the first with two small setae, the second with three, the third with seven, and the fourth with five plus intercalaries. The lateral metanotal area has three long setae and two short setae. The pleural arch is well developed. The metepisternum has a single long seta. The metasternum has an anteroventral projection. The metepimeron has four anterior and three posterior setae.

Legs

The forecoxa has numerous setae over the surface. The meso- and hind coxa are without setae. The fore and mesofemur have seven setae arranged over the surface and on the ventral margin. The fore femorotibial joint has two setae equal in length. The meso- and hind femorotibial joints have one short lateral seta and one long mesal seta. The hind femur has 13 setae arranged over the surface and on the ventral margin. The foretibia has eight lateral setae, a margin with five dorsal notches (2, 2, 3, 3, 3) and an apical false comb of eight setae. The margin of the mesotibia has six dorsal notches (2, 2, 3, 3, 3, 3) and an apical false comb of eight setae. The hind tibia has 16 lateral setae, a margin with seven dorsal notches (2, 2, 3, 3, 3, 3, 4) and interrupted apical setae that do not form a false comb. The fifth segment of the fore, meso- and hind tarsi has four pairs of lateral plantar bristles, and a pair of proximal bristles displaced to the middle of the plantar surface.

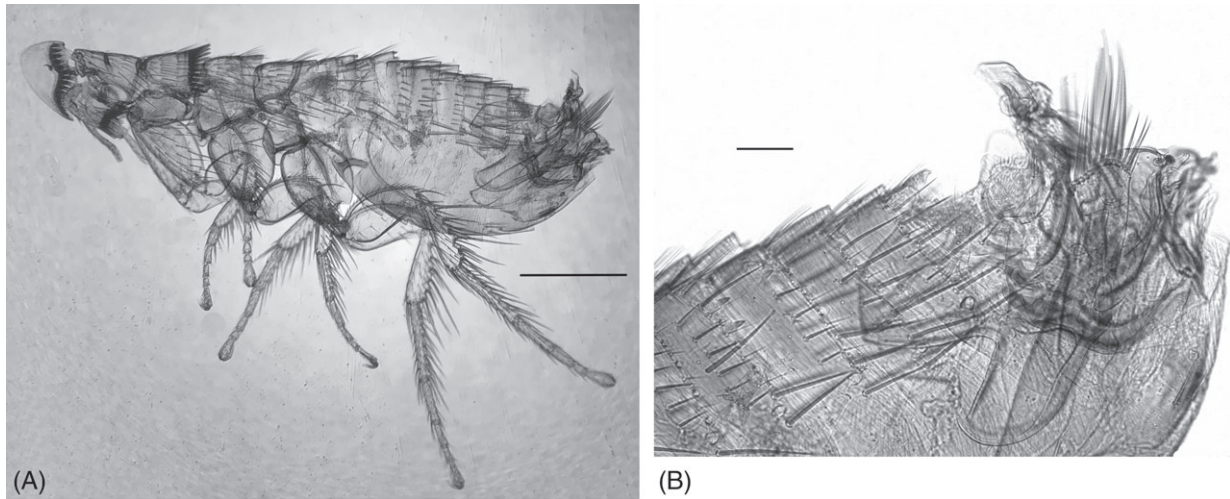


Fig. 5. *Plocopsylla (Plocopsylla) hastriteri* n. sp. (CMLA 708). (A) Male holotype. Scale bar: 500 μm . (B) Genital morphology of male *Plocopsylla (P.) hastriteri* n. sp. showing modified abdominal segments and aedeagus. Scale bar: 100 μm .

Unmodified abdominal segments

Tergites I–V have 2–4, 3–4, 4, 2 and 0–1 apical spinelets. Tergites I–VII have two rows of setae, anterior short setae and posterior long setae plus intercalaries. Anterior setae are lacking. Sternites III–VII have a main row of two setae. Sclerotized apodemes are seen on basal sternite II.

Modified abdominal segments

As in *P. pallas*, tergite VIII is greatly expanded into wing-like processes that extend dorsally between tergite VII and the sensillum (Fig. 5B), with spicules over the surface. The sensillum has 19 sensillial pits. The basimere of the clasper has an asymmetrical apex, similarly to *P. viracocha*, but the new species shows a wider structure in all its extension, a convex margin with seven or eight setae and a concave margin with four setae (Fig. 5B). The mesal process of the basimere is uniformly broad without setae (two setae in *P. pallas*). The telomere (the movable process of the clasper) is similar to that in *P. viracocha*; the apex of the telomere has a group of minute setae over the surface and a large pinhead-shaped seta (spiniform in *P. pallas*) on the apical–posterior margin (Fig. 5B). The proximal arm of sternite IX is curved in the middle (as in *P. viracocha*) with a pointed apex; the distal arm has a curved apex and one minute bristle on the apex; the posterior margin of the distal arm has one small bristle and two highly modified spiniform bristles (Fig. 5B).

Aedeagus

The median dorsal lobes are membranous with tips that project upward to form a conical apex (Fig. 6). The distolateral lobes are ovate and flank a portion of the median dorsal lobes. The crochets are well developed and lobed. The sclerotized inner tube is curved and the dorsal armature well developed. The

crescent sclerite is visible and sclerotized. The fulcrum of the median lamina of the apodeme has a strongly sclerotized fulcral lateroventral lobe. The aedeagal pouch is noticeably convex, similar to that in *P. (P.) viracocha*. The apodemal rod of the endophallus is curved and longer than the penis rods.

Dimensions

Holotype: 2.4 mm. Males ($n = 2$): mean = 2.4 mm (range: 2.4–2.5 mm).

Remarks

The type locality of *P. (P.) hastriteri* corresponds to the Puna Ecoregion where the vegetation is dominated by shrub steppe, characterized by scattered shrubs and stony or saline soils covered by sparse vegetation (Burkart *et al.*, 1999). This new species was recorded on *Ph. osilae*, a rodent that occurs from southern Peru to northwestern Argentina, along the eastern Altiplano and Andean slopes, at altitudes ranging from 2700–4000 m a.s.l. in the north to 500 m a.s.l. in the south (Salazar-Bravo, 2015).

Plocopsylla (Plocopsylla) inti Johnson, 1957

Type host and locality

Phyllotis (Phyllotis) magister Thomas, 1912; 2 km north of Tarata (17°27'55" S, 70°01'55" W; 3140 m a.s.l.), Tacna Department, Peru (Johnson, 1957).

Other known hosts

Phyllotis xanthopygus (Waterhouse, 1837) [originally reported as *Phyllotis (Phyllotis) darwini* ssp. by Johnson (1957)].

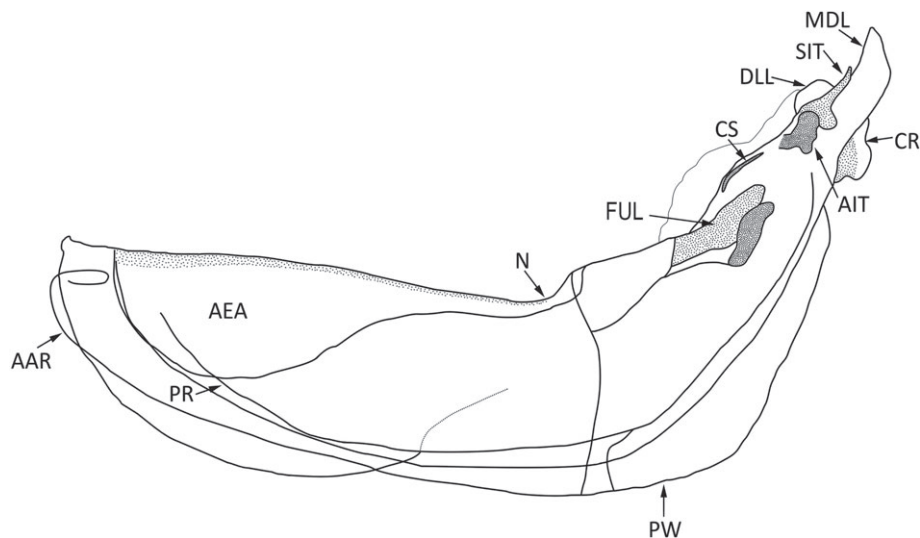


Fig. 6. *Plocopsylla (Plocopsylla) hastriteri* aedeagus. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; AIT, armature of sclerotized inner tube; CR, crochet; CS, crescent sclerite; DLL, developed distolateral lobes; FUL, fulcrum; MDL, median dorsal lobes; N, neck; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube.

Known geographical distribution

Peru: Tacna Department.

Material examined

Argentina: Catamarca Province, Antofagasta de la Sierra Department, Paycuqui (25°54'53'' S, 67°21'15'' W; ~3664 m a.s.l.), 27 March 2001, one ♀ (CMLA 710), ex *Abrothrix andina* (Philippi, 1858) (Rodentia: Cricetidae), one (CML 9218).

Remarks

Plocopsylla (Plocopsylla) inti differs from all other members of the genus in having seven genal spines (Johnson, 1957). The present unique record is represented by one female (Fig. 7). The female is characterized by a hilla noticeably shorter than the bulga, which penetrates deep into the bulga (Fig. 7) (Schramm & Lewis, 1988). This species constitutes a new record for Argentina and its finding in this country extends the species' known distribution by Σ 970 km southward. The locality in which this species was collected corresponds to the Puna Ecoregion; the species was found parasitizing *Abrothrix andina*, a rodent with a basically Andean distribution (Barquez *et al.*, 2016). *Plocopsylla (P.) inti* infesting *Abrothrix andina* constitutes a new flea–host association.

Discussion

Until now five different genera and five species belonging to the family Stephanocircidae and subfamily Craneopsyllinae had been recorded in the study area. The present study describes



Fig. 7. (A) *Plocopsylla (Plocopsylla) inti* (CMLA 710), female. Scale bar: 500 μ m. (B) Spermatheca. Scale bar: 100 μ m.

two new species of *Plocopsylla* and adds a new species for Argentina, increasing the diversity of the flea fauna in north-western Argentina. The genus *Plocopsylla* Jordan, 1931 is distributed from Colombia to Argentina and Chile (Schramm & Lewis, 1988). In Argentina, *Plocopsylla* had been represented by 12 species, of which five belong to the subgenus *Plocopsylla* and seven to the subgenus *Schrammapsylla*, parasitizing mainly rodents of the subfamily Sigmodontinae (Lareschi *et al.*, 2016). The results of this study increase the number of species within the subgenus *Plocopsylla* distributed in Argentina to eight. Within Argentina, these species are distributed in the Andean biogeographic region (Fig. 8, Appendix 1), which is in agreement with other records of the subgenus in South America (Schramm & Lewis, 1988). *Plocopsylla (P.) chicoanaensis* belongs to the complex 'angusticeps-lewisi', which represents species that share similarities in the general appearance of sternite IX and the fixed and movable processes of the clasper (Beaucournu & Kelt, 1990). The complex also comprises

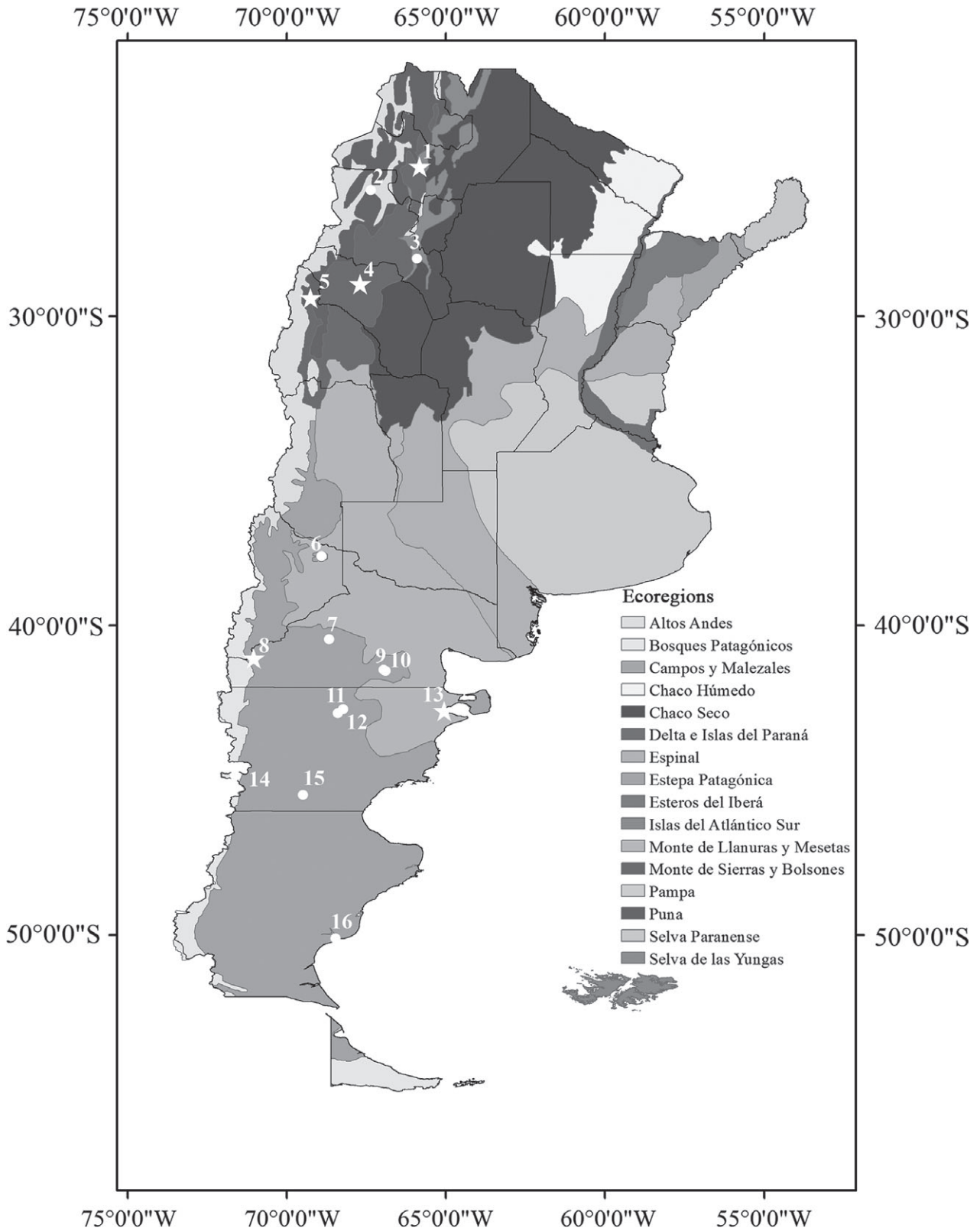


Fig. 8. Geographical distribution of species of the genus *Plocopsylla*, subgenus *Plocopsylla*, in Argentina (see Appendix 1 for details).

Plocopsylla (*P.*) *angusticeps* Mahnert, 1982, *P.* (*P.*) *lewisi*, *Plocopsylla* (*P.*) *wilesi* (Beaucournu & Kelt, 1990), *P.* (*P.*) *silewi* and *Plocopsylla* (*P.*) *linardii* (Sanchez *et al.*, 2015). All these species have been recorded in Argentina. *Plocopsylla* (*P.*) *linardii*, recently described in San Juan Province, Argentina (Sanchez *et al.*, 2015), is closest geographically to *P.* (*P.*) *chicoanaensis* n. sp. (Fig. 8).

Plocopsylla (*P.*) *hastriteri* belongs to subgroup A-3, which also contains *P.* (*P.*) *enderleini* Wagner, 1933 (recorded in Bolivia, Chile and Peru), *P.* (*P.*) *viracocha* (recorded in Chile and Peru), and *P.* (*P.*) *pallas* (recorded only in Peru). These species share similarities in the general appearance of the movable process. This structure is broadly triangular, the dorsal apex either abruptly tapered or rounded and the posterior margin mostly convex, and bears extremely long bristles on the mesal surface, among other features (Schramm & Lewis, 1988).

Plocopsylla (*P.*) *inti* is unique within subgroup A-4 because it is the only species to present seven genal spines (Schramm & Lewis, 1988). Johnson (1957) described *P.* (*P.*) *inti* from Tacna (Peru) from *Ph. magister* and *Ph. xanthopygus*; the present authors' collection of one female 60 years later represents the second record of this species.

It is necessary to emphasize the importance of the aedeagus as a diagnostic character for the two species newly described in the present study. This structure was long neglected by many specialists because of its complexity (Sanchez & Lareschi, 2014), but it reflects true diversity among species because its morphology determines compatibility during copulation and it is thus a naturally isolating mechanism that facilitates speciation (Hastriter & Bush, 2014; Hastriter, 2016; M. W. Hastriter, personal communication 2017).

It is important to study insects of the order Siphonaptera from not only a taxonomic but also an epidemiological point of view because their function as vectors of pathogens provides a natural avenue for pathogen dispersal (Bitam *et al.*, 2010). Fleas are capable of transmitting pathogenic organisms to wild and domestic animals and even to humans (Bonvicino *et al.*, 2015). Plague is the most notorious flea-borne disease known to man and is a re-emerging public health issue, particularly in Africa and South America (in Bolivia, Brazil, Ecuador and Peru) (Eisen & Gage, 2012; Pan American Health Organization, 2012). In Bolivia and Peru, plague is endemic in the Andean region and several rodents (Sigmodontinae and Murinae) have been identified as reservoirs (Ruiz, 2001; Álvaro *et al.*, 2013; Schneider *et al.*, 2014). Within the subgenus *Plocopsylla*, *Plocopsylla* (*P.*) *hector* is reportedly a vector of plague in Ecuador (Lewis, 1993), parasitizing rodents of the genus *Thomasomys* belonging to the subfamily Sigmodontinae (Dubyanskiy & Yeszhanov, 2016). In the present study, all species identified as hosts of the new flea species are sigmodontine rodents.

The species in the current research were not studied in relation to epidemiology or in regard to their potential as vectors of diseases. Given their geographical distributions in the Andean region bordering plague endemic areas, further studies are needed to confirm the roles of pathogens transmitted by these species. Likewise, reports of new flea–rodent associations are important because rodents are the main hosts of fleas (Bonvicino *et al.*, 2015), accommodating 74% of known flea species (Krasnov *et al.*, 2004).

Accordingly, the present authors consider it relevant to constantly update information on flea diversity in the study area and to insist on the correct identification of hosts and ectoparasites.

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Key to species of the genus *Plocopsylla*, subgenus *Plocopsylla*, in Argentina [modified from Schramm & Lewis (1988) and Sanchez *et al.* (2015)]

1 Seven spines in the genal comb → *Plocopsylla* (*P.*) *inti*

1' Five or six spines in the genal comb → 2

2 Six spines in the genal comb; male with telomere broadly triangular; aedeagus with membranous median dorsal lobes and

tip projected upward to form a conical apex (female unknown) → *Plocopsylla (P.) hastriteri* n. sp.

2' Five spines in the genal comb; male with telomere markedly triangular at the apex; aedeagus with median dorsal lobes not projected at the apex → 3

3' Helmet extremely narrow (broadest portion of prectenidial area less than half the length of longest helmet spine), with a concave anterior margin; male with apex of distal arm of sternite IX with three pigmented setae; one large unpigmented seta in the middle (female unknown) → *Plocopsylla (P.) angusticeps*

3' Helmet developed, with convex anterior margin; male with apex of distal arm of sternite IX with none to six pigmented setae; one to three unpigmented setae not in the middle → 4

4' Prectenidial width of helmet considerably shorter, reaching three-quarters of the length of the longest helmet spine; apex of distal arm of sternite IX triangular and with two pigmented setae, and below them two or three unpigmented setae → 5

4' Prectenidial width of helmet similar to length of longest helmet spine; apex of distal arm of sternite IX straight or rounded, without setae, or with three, five or six pigmented setae, and below them one or two unpigmented setae → 6

5' Males: apex of distal arm of sternite IX with two pigmented setae and three unpigmented setae; ventral extension of the clasper (manubrium) ending in a prolongation; aedeagal apodeme with anterodorsal margin straight, apical appendage reduced; anteroventral margin of wall of aedeagal pouch forming a right angle; females: posteroventral angle of tergite VIII with three setae → *Plocopsylla (P.) silewi*

5' Males: apex of distal arm of sternite IX with three pigmented setae and two unpigmented setae; ventral extension of the clasper (manubrium) with a rounded and narrow nipple-shaped tip; aedeagal apodeme with a small prominence at anterodorsal margin, apical appendage raised with rounded tip; anteroventral margin of wall of aedeagal pouch forming a projection with a large and quadrangular entrance; females: posteroventral angle of tergite VIII with four setae → *Plocopsylla (P.) chicoanaensis* n. sp.

6' Males: apex of distal arm of sternite IX rounded without pigmented setae and with two unpigmented setae; aedeagal apodeme with apical appendage short and triangular; females: caudal margin of sternite VII with median lobe; large spiracle; anal stylet large, length three times its basal width → *Plocopsylla (P.) lewisi*

6' Males: apex of distal arm of sternite IX straight or rounded with three, five or six pigmented setae and one or two unpigmented setae; aedeagal apodeme with apical appendage almost reduced and button-shaped; females only known in one species (see *P. (P.) wilesi*) → 7

7' Males with distal arm of sternite IX with narrow and rounded apex with three pigmented setae and one large unpigmented setae (female unknown) → *Plocopsylla (P.) linardii*

7' Males with distal arm of sternite IX with straight apex with five or six pigmented setae and two large unpigmented setae; females with caudal margin of sternite VII slightly straight; short spiracle; anal stylet short, length twice its basal width → *Plocopsylla (P.) wilesi*

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Appendix 1

The localities (in parentheses) include province, department, specific locality, coordinates and altitudes. Star symbols correspond to type localities and circles to remaining localities; all localities are numbered.

***Plocopsylla (Plocopsylla) chicoanaensis* n. sp.** (1) Salta Province, Chicoana Department: ~ 15 km west of Escoipe, on provincial road no. 33 (25°10'25.2'' S, 65°49'31.6'' W; 2680 m a.s.l.) (type locality); (3) Catamarca Province, Ambato Department, Las Juntas (28°07'38.4'' S, 65°54'31.7'' W; 1750 m a.s.l.).

Plocopsylla (Plocopsylla) inti (2) Catamarca Province, Antofagasta de la Sierra Department, Paycuqui (25°54'53'' S, 67°21'15'' W; 3664 m a.s.l.).

***Plocopsylla (Plocopsylla) hastriteri* n. sp.** (4) La Rioja Province, Famatina Department: 8 km northeast of Cañón del Ocre (28°57'37.3'' S, 67°41'26.3'' W; 3127 m a.s.l.) (type locality).

Plocopsylla (Plocopsylla) linardii (5) San Juan Province, Parque Nacional San Guillermo (29°25' S, 69°15' W; 3287 m a.s.l.) (type locality).

Plocopsylla (Plocopsylla) wilesi (6) Neuquen Province, Aca Mahuida (37°45'04'' S, 68°54'11.8'' W; 1846 m a.s.l.); (9) Río Negro Province, Laguna Blanca, Cerro Corona (41°25'36'' S, 66°57'20'' W; 1330 m a.s.l.); (10) Campamento PNG Somuncurá (41°27'11'' S, 66°53'49'' W; 1395 m a.s.l.); (11) Chubut Province, Carhué Niyeu (42°49'21'' S, 68°23'56'' W; 1158 m a.s.l.); (12) Establecimiento La Maroma (42°41'45'' S, 68°13'55'' W; 1162 m a.s.l.); (15) Alm Hotel Los Manantiales (45°27'51'' S, 69°29'25'' W; 661 m a.s.l.); (16) Santa Cruz Province, Pali Aike (50°06'30'' S, 68°27'37'' W; 24 m a.s.l.).

Plocopsylla (Plocopsylla) silewi (7) Río Negro Province, Puesto Pillahuinco, Estancia La Esperanza (40°25'50'' S, 68°40'24'' W; 1201 m a.s.l.); (11) Chubut Province, Carhué Niyeu (42°49'21'' S, 68°23'56'' W; 1158 m a.s.l.); (12) Establecimiento La Maroma (42°41'45'' S, 68°13'55'' W; 1162 m a.s.l.).

Plocopsylla (Plocopsylla) angusticeps (13) Chubut Province, Puerto Madryn (42°46' S, 65°03' W; 8 m a.s.l.) (type locality).

Plocopsylla (Plocopsylla) lewisi (14) Chubut Province, Lago Fontana, 1 km east on provincial road no. 57 (44°50'52.9'' S, 71°37'01'' W; 1069 m a.s.l.); (13) Puerto Madryn (42°46' S, 65°03' W; 8 m a.s.l.); (8) Río Negro Province, Cerro Microondas, 5 km south-southeast of Estación Perito Moreno (41°04' S, 71°02' W; 1379 m a.s.l.) (type locality); (16) Santa Cruz Province, Pali Aike (50°06'30'' S, 68°27'37'' W; 24 m a.s.l.).