An Acad Bras Cienc (2020) 92(1): e20181136 DOI 10.1590/0001-3765202020181136

Anais da Academia Brasileira de Ciências | *Annals of the Brazilian Academy of Sciences*
Printed ISSN 0001-3765 I Online ISSN 1678-2690
www.scielo.br/aabc | www.fb.com/aabcjournal

BIOLOGICAL SCIENCES

Taxonomic revision of the flea genus *Agastopsylla* Jordan & Rothschild 1923 (Siphonaptera: Ctenophthalmidae)

MARIA FERNANDA LÓPEZ-BERRIZBEITIA, JULIANA SANCHEZ, RUBÉN M. BARQUEZ & MÓNICA DÍAZ

Abstract: Fleas of Argentina are receiving renewed systematic interest, but the identification of many species associated with small mammals can be problematic. We review the taxonomy of the flea genus *Agastopsylla* including the re-description of two species and one subspecies, and designate neotype and neallotype for *Agastopsylla hirsutior*, neotype for *Agastopsylla nylota nylota* from the "Colección Mamíferos Lillo Anexos" (CMLA), Universidad Nacional de Tucumán, Argentina, and neotype and neallotype for *Agastopsylla pearsoni* from the Natural History Museum (London, U.K.). Additionally, a key to identification of the species of *Agastopsylla* and a distribution map of the species of the genus are included.

Key words: fleas, systematic, type specimens, rodents, key identification.

INTRODUCTION

The genus *Agastopsylla* Jordan & Rothschild 1923 (family Ctenophthalmidae, subfamily Ctenophthalminae) is characterized by the reduction in size and the coloration of the spines of the genal comb (Hopkins & Rothschild 1966). The distribution of the genus is restricted to Perú, Chile and Argentina (Hopkins & Rothschild 1966, Beaucournu et al. 2014) and the known species are associated mainly to cricetid rodents (Hopkins & Rothschild 1966, Beaucournu et al. 2014, Lareschi et al. 2016).

The genus *Agastopsylla* contains five species and four subspecies: *Agastopsylla boxi boxi* Jordan & Rothschild 1923, *Agastopsylla boxi gibbosa* Beaucournu & Alcover 1990, *Agastopsylla hirsutior* Traub 1952, *Agastopsylla nylota nylota* Traub 1952, *Agastopsylla nylota euneomys* Lewis 1984, *Agastopsylla pearsoni* Traub 1952 and *Agastopsylla guzmani* Beaucournu et al. 2011 (Beaucournu et al. 2014, Lareschi et al. 2016). In Argentina, only two species and two subspecies, *A. b. boxi*, *A. b. gibbosa* and *A. pearsoni* (Lareschi et al. 2016) have been recorded.

There are several issues that hinder the systematic study of the genus *Agastopsylla*. For example the loss of type specimens in reference collections, or the incomplete original descriptions of some species described more than 60 years ago, and the lack of voucher specimens deposited in systematic collections.

We here provide a review of the genus *Agastopsylla*, which includes the re-description of two species and one subspecies. In accordance with Article 75 of the International Code of Zoological Nomenclature (ICZN 1999), we designate neotype and neallotype for *A. hirsutior* and *Agastopsylla pearsoni* and neotype

for *A. n. nylota* and include the first description of the male of *A. hirsutior* and of the female of *A. n. nylota*. Additionally, a key to identification and a distributional map of the species of *Agastopsylla* are also included.

MATERIALS AND METHODS

Fleas were obtained from rodents collected in the provinces of Salta and Tucumán, Argentina. The rodents were captured with Sherman live traps baited with peanut butter and oats. Fleas were removed with forceps and brushes, prepared following conventional techniques for taxonomic identification (Hastriter & Whiting 2003) and photographed with a digital camera AxioCam ERC5S and processed with Microscope Imaging software ZEISS ZEN 2012-Blue edition (Germany). For the identification of the taxa, the original descriptions of the species and the identification keys (Johnson 1957, Hopkins & Rothschild 1966, Beaucournu et al. 2011) were used. Anatomical terms were adapted from Rothschild & Traub (1971) and the classification of Whiting et al. (2008) was followed. Unless otherwise specified, counts of setae represent only one side of the flea. Specimens of *Agastopsylla boxi boxi* [one male holotype (BMNH 1923-615), one female allotype (BMNH 1923-615)] from Argentina and *Agastopsylla pearsoni* [one male paratype (no number), one female paratype (no number)] from Peru, deposited in the Natural History Museum (London, U.K.) were examined.

Neotypes and neallotypes of the species of *Agastopsylla* from Argentina were deposited in the "Colección Mamíferos Lillo Anexos" (CMLA), Universidad Nacional de Tucumán, Argentina. Mammal nomenclature follows Wilson & Reeder (2005), Barquez et al. (2006) and Patton et al. (2015). The host specimens were deposited in the Colección Mamíferos Lillo (CML), Universidad Nacional de Tucumán and in the Sam Noble Oklahoma Museum of Natural History (SNOMNH), University of Oklahoma (Norman, OK).

We used the morphological characters observed in this study as well as the published morphological information for species and subspecies (Jordan & Rothschild 1923, Traub 1952, Beaucournu & Alcover 1990, Sanchez & Lareschi 2014) to formulate supportive illustrations for the characters in the identification key. To illustrate the distribution of the genus *Agastopsylla*, the coordinates of the localities recorded for the species were obtained from the literature and the missing coordinates in the bibliography were determined using Google Earth Pro Version 2018. The map was designed with ArcGis 10.1 program (ESRI 2011). ArcGIS Desktop: Release 10. Redlands, California: Enviromental Systems Research Institute, using the shapefile of Morrone`s (2015) biogeographical regionalization (Lowenberg-Neto 2015).

RESULTS

Systematic

GENUS *AGASTOPSYLLA* JORDAN & ROTHSCHILD 1923

AGASTOPSYLLA BOXI JORDAN & ROTHSCHILD 1923

AGASTOPSYLLA BOXI BOXI JORDAN & ROTHSCHILD 1923

Type host and locality. Abrothrix longipilis (Waterhouse 1837) [originally cited as *Abrothrix suffusus* (Thomas 1903)]; Leleque, Chubut, Argentina (Jordan & Rothschild 1923).

Other known hosts. Abrothrix olivacea (Waterhouse 1837), *Akodon iniscatus* Thomas 1919, *Euneomys chinchilloides* (Waterhouse 1839), *Eligmodontia morgani* J. A. Allen 1901, *Geoxus valdivianus* (Philippi 1858), *Graomys griseoflavus* (Waterhouse 1837), *Loxodontomys micropus* Waterhouse 1837, *Phyllotis xanthopygus* (Waterhouse 1837), *Reithrodon*

auritus (G. Fischer 1814) (Sanchez & Lareschi 2013, 2014, 2018).

Known geographical distribution. Southern Argentina and Chile (Beaucournu et al. 2014, Lareschi et al. 2016, Sanchez & Lareschi 2018) (Fig. 1).

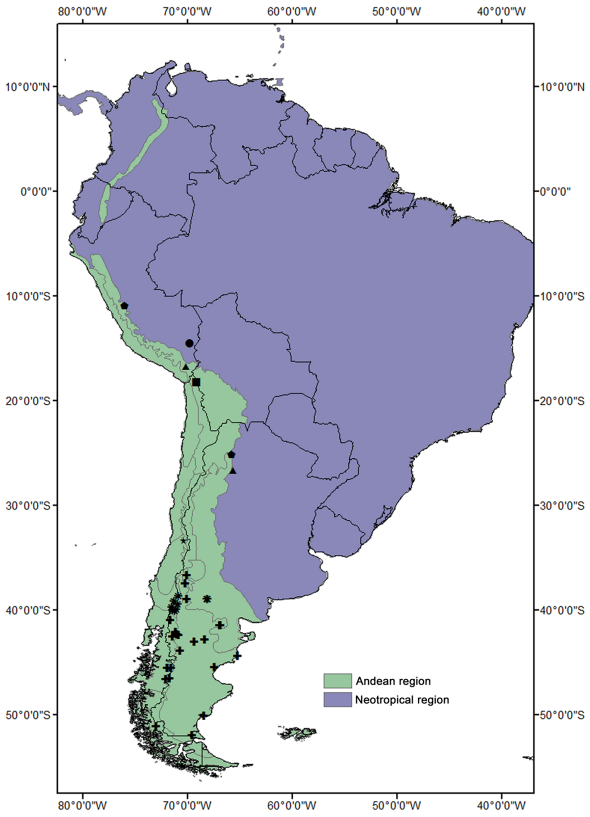

Figure 1. Map illustrating documented Andean distribution of species of *Agastopsylla*.
The localities that follow are listed for each species and subspecies of *Agastopsylla.* The specific localities include country, province and/or department, specific locality, altitudes, and coordinates. Symbols adjacent to each species are listed on map. *Agastopsylla boxi boxi* (+) (Beaucournu et al. 2014, Sanchez & Lareschi, 2013, 2014, 2018). ARGENTINA: Chubut Province: Cabo Raso, 7 m, 44º20'23"S, 65º14'59"W; Pico Salamanca, 542 m, 45º24'32"S, 67º24'58"W; Cañadón de la Madera, Sierra Tepuel, 969 m, 43º52'33"S, 70º42'40"W; Carhué Niyeu, 1,147 m, 42º49'21"S, 68º23'56"W; Establecimiento Gorro Frigio, 361 m, 43º02'26"S, 69º19'55"W; Estancia El Maitén, 702 m, 42º03'34"S, 71º09'48"W; Estancia Leleque, La Potrada, 614 m, 42º19'56"S, 70º59'00"W; Leleque, 600 m, 42º21'54.93"S, 70º51'34.62"W; Cholila, 700m, 42º31'32.90"S, 71º25'22.84"W. Neuquén Province: Km 2 Sendero Pla Quetrihue, PN, 1,091 m, 40º56'58.2"S, 71º39'35.1"W; 1 km aguas abajo puente RN 40 sobre Río Neuquén, Chos Malal, 819 m, 37º24'58.7"S, 70º13'31.6"W; Establecimiento Sorzana, 3 km E RN 22, Zapala, 1,036 m, 38º55'51"S, 70º04'35"W; ANP Domuyo: Aguas Calientes, 1,438 m, 36º40'54.0"S, 70º3'44.2"W. Río Negro Province: Laguna Blanca, Antiplanicie del Somuncurá, 1,413 m, 41º25'36"S, 66º57'20"W; Cerro Corona, Antiplanicie del Somuncurá, 1,354 m, 41º27'11"S, 66º53'49"W. Santa Cruz Province: Pali Aike, 13 m, 50º06'30"S, 68º27'37"W; Puerto Santa Cruz, 118 m, 51º56'09"S, 69º34'26"W. CHILE: XI Region Aysén, Coyhaique Province: El Largo land, Coyhaique Alto, 750 m. 45º29'22.47 "S, 71º35'37.08"W; Coyhaique National Reserve, Municipal Camp Trapananda, 600 m, 45º32'04. 46"S, 71º57'51.95"W; Experimental Plots, 700 m, 45º31'46.35 "S, 71º58'3.11"W; General Carrera Province: General Carrera, El Salto, Puerto Ingeniero Ibañez, 380 m, 46º33'54.49"S, 72º05'38.35"W; Puerto Ingeniero Ibañez, Rocky Bluff, 380 m, 46º33'54.49"S, 72º05'38.35"W; Chile Chico (Aerodrome), 330 m, 46º32'55.92"S, 71º44'30.92"W. XII Region Magallanes, Ultima Esperanza Province: Pudeto ranch, 47 m, 51º04'59.47"S, 72º59'59.87"W.
*** *Agastopsylla boxi gibbosa* (*) (Beaucournu & Alcover 1990, Beaucournu et al. 2014). ARGENTINA: Neuquén Province: Lago Huechulafquen, 1,057 m, 39º42'53.84"S, 71º31'46.90"W; Rio Curruhue, 6 km de Junín de Los Andes, 781 m, 39º57'3.93"S, 71º4'14.52"W; Rio Quilquihue, 821 m, 40º4'39.62"S, 71º11'32.49"W; Cerro Chapelco, 314 m, 38º55'43.07"S, 68º7'1.81"W; Lago Lolog, 918 m, 40º1'48.70"S, 71º25'26.40"W; Lago Curruhue, 314 m, 38º56'17.61"S, 68º5'47.95"W; Lago Norquinco, 1,056 m, 39º8'13.58 "S, 71º17'25.41 "W; Pampa, 265 m, 38º58'5.41"S, 68º3'44.19"W; Rio Alumine, 1,086 m, 39º26'6.32"S, 70º56'33.98"W. CHILE: IX Region Araucania, Malleco Province: Lonquimay, Paso Pino Hachado, 1,730 m, 38º39'00.00 "S, 70º54'00.00 "W. *Agastopsylla guzmani* (■) (Beaucournu et al. 2011). CHILE: I Region Tarapacá, Parinacota Province: Chungará, 4,585 m, 18º15'00.00"S, 69º09'00.00"W. *Agastopsylla hirsutior* (▲) (Traub 1952; this study). ARGENTINA: Tucumán Province, Tafi Viejo Department: Ciénaga Grande, San José de Chasquivil, 2830 m, 26º41'8.74" S, 65º39'30.79"W. PERU: Mariscal Nieto Province, Moquegua Department: Caccachara, 50 miles Southwest of Ilave, elev. 16,000 ft (4,876.8 m), 16º44'57.26 "S, 70º6'59.93"W. *Agastopsylla nylota nylota* (⬟) (Traub 1952; this study). ARGENTINA: Salta Province, Chicoana Department: 15 km W Escoipe, on Provincial road No. 33, 2,680 m, 25º10'25,2"S, 65º49'31,6"W. PERU: Junin Province: Junin Department, Carhuamayo, 14,500 ft. (4,420 m), 10º56'42.55 "S,**

76º2'9.15"W. ***Agastopsylla nylota euneomys*** **(★) (Lewis & Spotorno, 1984) CHILE: RM Region Metropolitana: Farellones, 2,800 m, 33º21'00.00"S, 70º20'00.00"W.** ***Agastopsylla pearsoni*** **(●) (Traub 1952). PERU: Puno Department, San Antonio de Putina Province: Picotani 4,537 m, 14º32'59.67 "S, 69º48'0.02"W.**

Material examined. **Holotype** ♂ (BMNH 1923-615), ex *A. longipilis* (no number), **Argentina**, Chubut Province: Leleque. **Neallotype** ♀ (BMNH 1923-615), ex *Ctenomys haigi* Thomas 1919 (no number), 23.VI.1920, **Argentina**, Chubut Province: Cholila (Fig. 1)

Remarks. Sanchez & Lareschi (2014) redescribed this subspecies based on the morphology of the aedeagus, unknown until that moment. *Agastopsylla boxi boxi* is known from the Argentine and Chilean Patagonia, mainly restricted to the Andean-Patagonian forests (Beaucournu et al. 2014, Sanchez & Lareschi 2018). This subspecies parasitizes mainly rodents of the genus *Abrothrix* (Beaucournu et al. 2014, Lareschi et al. 2016). *Abrothrix longipilis* has harbored this flea most frequently (Hopkins & Rothschild 1966, Sanchez & Lareschi 2013).

AGASTOPSYLLA BOXI GIBBOSA BEAUCOURNU & ALCOVER 1990

Type host and locality. Abrothrix longipilis; Lago Huechulafquen, Neuquén, Argentina (Beaucournu & Alcover 1990).

Other known hosts. A. olivacea, L. micropus, Oligoryzomys longicaudatus (Bennett 1832) (Beaucournu & Alcover 1990).

Known geographical distribution. Only Neuquén province: Cerro Chapelco, Lago Norquinco, Río Alumine, Río Curruhue, Río Quilquihue, Argentina (Beaucournu & Alcover 1990) and Lonquimay, Malleco, Chile (ccournu & Gallardo 1991) (Fig. 1).

Material examined. None.

Remarks. Sanchez & Lareschi (2014) suggested that *A. boxi gibbosa* and *A. boxi boxi* are synonyms because they occur in sympatry. Morphologically, *A. boxi gibbosa* is only known by the shape of sternite IX of the male, and females of the two subspecies are indistinguishable (Beaucournu & Alcover 1990).

AGASTOPSYLLA HIRSUTIOR TRAUB 1952

Type host and locality. *Abrothrix jelskii* (Thomas 1894) [originally cited as *Akodon* (*Chroeomys*) *pulcherrimus* (Thomas 1897)]; Caccachara, Dep. Puno, Peru (Traub 1952).

Other known hosts. None.

Known geographical distribution. Peru (Hopkins & Rothschild 1966) (Fig. 1).

Material examined. **Neotype** ♂ (CMLA 795) and **Neallotype** ♀ (CMLA 794) ex *Akodon spegazzinii* Thomas 1897 (CML 7478), 29.I.2005, **Argentina**, Tucumán Province: Ciénaga Grande, San José de Chasquivil (Fig. 1).

Emended diagnosis

Agastopsylla hirsutior is unique by the following combination of characters: lateral surface of the hind tibia densely covered by 22–24 setae (Figs. 2a, b), the male telomere notably short; lateral margins converge towards the apex (Fig. 2c). Female spermatheca with a globular bulga which bears a small dorsal pump (Fig. 2d).

Redescription

Head. Front margin convex with two placoid pits and one row of four short setae. Behind this row and on the surface of the gena, several short setae are distributed; ventral margin of the gena with two long setae. Antennal scape with six setae, pedicel with one row of seven short setae on posterior margin and male clave slightly larger than that of female; border of fossa antennal with one row of 5-6 small setae. One seta anterior to eye. Eye reduced but pigmented. Genal comb pale with five spines, first spine most ventrally located, very small and poorly visible. Maxilla fusiform, labial palpus with five

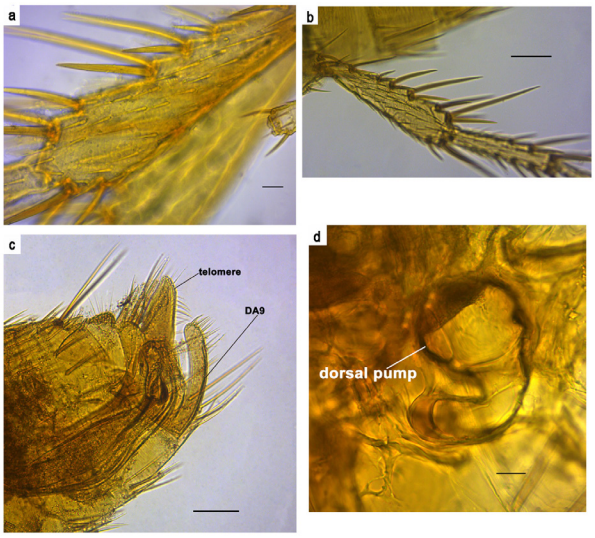

Figure 2. *Agastopsylla hirsutior*. **a, Hind tibia, male neotype (CMLA 795) Scale =10 µm. b, Hind tibia, female neallotype (CMLA 794) Scale =50 µm. c, Modified abdominal segments, male neotype (CMLA 795). Scale =50 µm. d, Spermatheca, female neallotype (CMLA 794). Scale =10 µm.**

segments extending to the base of the forecoxa. Occiput with three rows of setae, first and second rows with four short setae and third with six long setae plus intercalaries; additionally, there are two long setae near antennal fossa.

Thorax. Pronotum with two rows of setae: an anterior with six short setae and main row with five long setae plus intercalaries, and between these two rows a small seta. Pronotal comb with eight spines. Mesonotum with three rows of setae: first with three short setae, second with six short setae and main row with five long setae plus intercalaries. Metanotum with four rows of setae: first three rows with short setae and fourth with one row of seven setae plus intercalaries. Mesepisternum with an anterior group of small setae and two long posterior setae. Mesepimeron with five setae, two thin and three thicker; lateral metanotal area with one long seta; pleural arch and ridge well developed. Metepisternum with one long seta and four short setae. Metepimeron with nine setae scattered over the surface, seven thin and short and three thick and long.

Legs. Forecoxa with 40–45 setae scattered over surface and one seta on posterior margin; mesocoxa and hindcoxa with setae scattered only on the posterior margin. Forefemur with two small setae on the dorso-posterior side and one seta on the ventro-posterior margin. Mesofemur with two small setae on ventro-posterior margin; and hind femora with two small subventral setae on anterior side and two setae on ventro-posterior margin. Foretibia with six dorsal notches; mesotibia and hind tibia with seven dorsal notches. The number of setae on each notch are as follows: foretibia: 2; 2; 2; 2; 1; 2, mesotibia: 2; 2; 2; 2; 2; 2; 2 and hindtibia: 2; 2; 2; 2; 2; 1–2; 2. The only species of the genus with the outer side of hindtibia densely covered by 22–24 setae (Figs. 2a, b).

Abdomen. Tergites without spinelets. Tergites I–V with three rows of setae: first and second rows with short setae and the third row with long setae. Tergites VI–VII with two rows of setae, anterior with short setae and the posterior with long setae. Tergite VII (T–VII) with one antesensilial bristle. Sensilium with 13 sensilial pits. Sternites III–VII with one main row of three setae in the male, and four setae in the female.

Modified abdominal segments, male (Fig. 2c): Sternite VIII (S–VIII) with three long setae and five short setae on the posterior region. Basimere dorsally rounded with posterior margin slightly convex and dorsal margin with three long thick setae and four thin setae; telomere with anterior and posterior margins convergent towards the apex with posterior margin with several setae. The manubrium is narrow and noticeably sharp at apex. Proximal arm of sternite IX (S–IX) narrow in the base and widened at the apex. Distal arm of S–IX (DA9) uniformly narrow with apex strongly rounded,

posterior margin convex with some setae, and a few setae over surface close to apex.

Aedeagus. Median dorsal lobe dorsally convex. Sclerotized inner tube very short. Crochet short and posteriorly sharp. Fulcrum well developed with elongated medial and latero-ventral lobes; latero-ventral lobe strongly sclerotized. Crescent sclerite slightly sclerotized, narrow and long, subequal in length than the fulcral latero-ventral lobe. The dorsal extension of median lamina of aedeagal apodeme strongly sclerotized. Penis rods extended beyond the apex of aedeagal apodeme and uncoiled

Modified abdominal segments, female: Tergite VIII (T–VIII) with 13 setae scattered over surface. Length of anal stylet four times the length of its width (at base); with a long apical seta. Ventral portion of S–VII convex. Dorsal and ventral anal lobes triangular shape, both with one long seta at the apex. Hilla of spermatheca longer than bulga; bulga globular with a small dorsal pump; cribriform area noticeably sclerotized; duct of spermatheca expands into a bursa copulatrix, which bears a hyaline perula and a visible duct (Fig. 2d).

Remarks. Previous to our study, *A. hirsutior* was known only by the single female holotype deposited in the Field Museum of Natural History, Chicago. The holotype could not be found and is considered lost. The newly acquired male and female were collected from the highland pasture (2830 m) in the last stratum of the eco-region Yungas Forests. The species was recorded for the first time on *A. jelskii* from Peru; in the present study a male and a female were documented from *A. spegazzinii*, constituting a new distribution and flea-host association.

We designate herein the male as the neotype and the female as the neallotype. Each is described above and an emended diagnosis is provided. The accompanying female associated with the neotype is conspecific to the description and illustrations of the Peruvian female holotype. The male provides a more distinctive morphological representation of the species than the female and is therefore designated as the neotype.

AGASTOPSYLLA NYLOTA TRAUB 1952

AGASTOPSYLLA NYLOTA NYLOTA TRAUB 1952

Type host locality. *Eligmodontia* sp., *A. jelskii* or *Phyllotis darwini* (Waterhouse 1837); Carhuamyo, Dep. Junin, Peru (Traub 1952).

Other known hosts. None.

Known geographical distribution. Peru (Hopkins & Rothschild 1966) (Fig. 1).

Material examined. **Neotype** ♂ (CMLA 796), 2 ♂ (CMLA 797, 798), 1 ♀ (CMLA 799), ex *Phyllotis osilae* Allen 1901 (CML 8044), 17.V.1999, **Argentina**, Salta Province: ~15 km W Escoipe, on Provincial road No. 33. (Fig. 1).

Redescription

Head. Front convex with two placoid pits and micro-punctuations scattered over surface. In male, front with one row of five setae and behind this, on the surface of the gena, several short setae; in female front with several minute setae, but not row of setae. Antennal scape larger in the male and both sexes with six setae; pedicel with one row of 10 short setae on posterior margin and clava slightly larger in male; border of antennal fossa with one row of 12 small setae in male, and eight small setae in female. One seta anterior to eye. Eye reduced but pigmented. Genal comb pale with four or five spines in male and four in female, the first most ventral very small. Ventral margin of gena with two long setae. Maxilla fusiform; the labial palpus with five segments, extending to the base of the forecoxa. Occiput with micro-punctuations scattered over surface and three rows of setae, first and second rows with four short setae and third row with six

long setae plus intercalaries; additionally two long setae near the antennal fossa.

Thorax. Pronotum with one main row of 5–6 setae plus intercalaries. Pronotal comb with 10 spines in male and eight in female. Mesonotum with three rows of setae: first row with three short setae, second with six short setae and main row with five long setae plus intercalaries. Metanotum with three rows of setae in male, the first two with short setae and the third with one row of six setae plus intercalaries. Female with two rows of setae, first row with eight setae and second with six setae plus intercalaries. Mesepisternum with an anterior group of small setae and two long posterior setae. Mesepimeron with seven setae, two short and five long. Lateral metanotal area with one long seta and two small setae next to well developed pleural arch; pleural ridge well developed. Metepisternum with long seta and five short setae in posterior region. Metepimeron with two rows of setae, anterior with four setae and posterior with 3–4 setae.

Legs. Forecoxa with 34–35 setae scattered over the surface; mesocoxa and hindcoxa with scattered setae only on the posterior margin. Forefemur with two small setae on dorso-posterior side and one seta on ventro-posterior margin. Mesofemur and hind femora with one small seta on ventro-anterior margin and two setae on ventro-posterior margin. Foretibia, mesotibia and hindtibia with six dorsal notches; the number of setae in each notch is 1–2, 2, 1–2, 2, 1–2, 1-2. Unlike *A. hirsutior*, the lateral surface of hindtibia has a few setae, between 14–15, restricted to the dorsal margin (Figs. 3a, b).

Abdomen. Tergites without spinelets. Tergites I–VII with three rows of setae; first row with 3–4 short setae, the second with 6–8 short setae and the third with seven long setae plus intercalaries. Tergite VII with one antesensilial bristle. Sensilium with 11–12 sensilial pits.

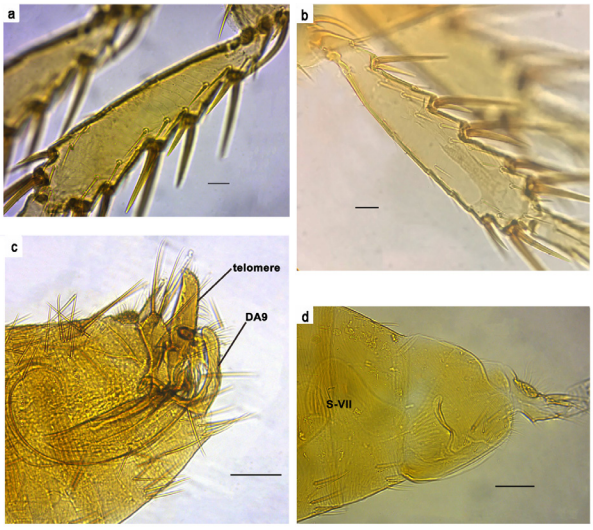

Figure 3. *Agastopsylla nylota nylota*. **a, Hind tibia, male neotype (CMLA 796) Scale=10 µm. b, Hind tibia, female (CMLA 799) Scale=10 µm. c, Modified abdominal segments, male neotype (CMLA 796) Scale =50 µm. d, Modified abdominal segments, female (CMLA 799) Scale =50 µm.**

Sternites III–VII with one main row of three setae in male, and four in female.

Modified abdominal segments, male: Sternite VIII with 8–10 long setae next to the posterior region. Basimere narrows at apex with two long setae near apex, posterior margin convex with a long seta and three small thin setae below. Telomere noticeably longer than that of *A. hirsutior* and anterior and posterior margins are parallel (Fig. 3c) with several setae near apex and ventro-posterior margin. The manubrium is narrow and noticeably sharp at the apex. Distal arm of S–IX as in *A. hirsutior* but with a thicker sclerotization in the lower portion of the posterior margin.

Aedeagus. Median dorsal lobe dorsally convex with a sharp dorso-posterior projection and an undulating anterior margin. Sclerotized inner tube very short. Crochet longer than in *A. hirsutior*. Lateral lobe with a convex portion in the middle. Fulcrum well developed. Aedeagal

apodeme sharp in the apex. Penis rods long and uncoiled.

Modified abdominal segments, female: Tergite VIII with two setae (one greatly reduced) below the spiracle and 18 setae scattered over surface, with setae next to ventral margin smaller than the remaining. Length of anal stylet is one-third the total length of its apical seta. Sternite VII convex in middle (Fig. 3d). Dorsal and ventral anal lobes triangular shape, both with one long seta at the apex. The spermatheca was missing.

Remarks. The male holotype was deposited in the Field Museum of Natural History, Chicago, and could not be located. The female of *A. nylota nylota* was unknown prior the single female collected in our study. Although the spermatheca is missing, its occurrence with three males from the same host (CML 8044), presence of the same number of setae on the dorsal margin of the hind tibia, similar chaetotaxy to the male, and the presence of four genal spines are evidence that the female and males are of the same taxon.

One of the specimens examined (male) was previously identified as *Agastopsylla pearsoni* by López-Berrizbeitia et al. (2013) but further studies and comparisons with specimens deposited in collections allowed us to re-identification of the specimens as *A. n. nylota*. When *A. nylota nylota* was recorded for the first time in Peru, the hosts were not identified and in the original description the authors suggested three possible hosts (see in type host and locality); it is necessary to emphasize that the distribution *P. darwini* is restricted to Chile (Steppan & Ramírez 2015). Thus, this second record of *A. nylota nylota* in the present study represents the first confirmed association with *P. osilae*. The subspecies was collected in the Monte Desert of Mountains and Isolated Valleys eco-region (2680 m).

AGASTOPSYLLA NYLOTA EUNEOMYS LEWIS & SPOTORNO 1984

Type host and locality. *Euneomys mordax* Thomas 1912 (originally cited as *Euneomys noei* Mann 1944); Farellones, Chile (Lewis & Spotorno 1984).

Other known hosts. None.

Known geographical distribution. Chile (Beaucournu et al. 2014) (Fig. 1).

Remarks. This subspecies is only known by the holotype male deposited in the U.S. National Museum, Washington, D.C. *Agastopsylla nylota euneomys* differs mainly of the nominate subspecies in the following characters: genal comb of 3 pale spines, labial palpus extending well beyond apex of forecoxa and telomere shorter and wider (Lewis & Spotorno 1984).

AGASTOPSYLLA PEARSONI TRAUB 1952

Type host and locality. *Chinchillula sahamae* Thomas 1898, *A. jelskii* (originally cited as *Akodon pulcherrimus cruceri* Thomas 1901) or *Auslicomys pictus* (Thomas 1884) (originally cited as *Phyllotis pictus* Hershkovitz 1962); Picotani, Dep. Puno, Peru (Traub 1952).

Other known hosts. *Abrothrix longipilis* (Beaucournu et al. 2014).

Known geographical distribution. Chile and Peru (Hopkins & Rothschild 1966, Beaucournu et al. 2014) (Fig. 1).

Material examined. **Paratypes** ♂ and ♀ (BMNH), ex *C. sahamae*, *A. jelskii* or *A. pictus* (no number), 15.IX.1941, **Peru**, Puno Dep., San Antonio de Putina Province: Picotani (Fig. 1).

Remarks. The holotype male and allotype female, deposited in the Field Museum of Natural History (Chicago) could not be found and are considered lost. Therefore, we designate herein the paratype male as the neotype and the paratype female as the neallotype. These paratypes are deposited in the Natural History Museum (London, U.K.).

DISCUSSION

In the present revision of the genus *Agastopsylla* for Argentina, we add *A. hirsutior* and *A. n. nylota,* and remove *A. pearsoni* from the fauna of the country. Hopkins & Rothschild (1966), who realized a complete revision of the genus, at that time, were unable to review specimens of *A. hirsutior* and *A. nylota nylota*. Although two of our designated neotypes are not from the type localities of the original, their designation is important and necessary to maintain nomenclatural stability and to solve problems of doubtful and confusing identities in the future. The finding of *A. hirsutior* in Tucumán Province extends its geographic distribution~ 1700 km southward, and the record for *A. n. nylota* in Salta Province also extends its distribution ~ 2700 km southward, from the records previously documented by Traub (1952) in Peru (Caccachara, Dep. Puno and Carhuamyo, Dep. Junin, respectively). These results are consistent with what was expressed by Lewis & Spotorno (1984), who assumed that the species of *Agastopsylla* range much wider than indicated by collection records considering mainly the large numbers of small cricetids rodents having Andean distributions.

In Argentina, *A. hirsutior* and *A. n. nylota* are restricted to the northwestern Argentina, in highland pastures, the last stratum of Yungas Forests and the Monte Desert of Mountains and Isolated Valleys eco-region (see Results), whereas, *A. b. boxi* and *A. b. gibbosa* are distributed in the Patagonia, in the eco-regions of the Steppe and the Forest (Lareschi et al. 2016). Our records, as well as other already published for the genus (Hopkins & Rothschild 1966, Beaucournu et al. 2014, Sanchez & Lareschi 2014), confirm that it is mainly distributed in the Andean biogeographic region (as defined by Morrone 2015) (see Fig. 1), as do several species of the flea fauna of northwestern Argentina, among those *Neotyphloceras crassispina*, *Nonnapsylla rothschildi*, *Plocopsylla hastriteri* and *Tiarapsylla argentina* (Lareschi et al. 2011, López-Berrizbeitia et al. 2015, 2018).

In order to morphologically distinguish the species the flea specialists, have mainly and traditionally used the number of setae in the outer side of the hind tibia, and characters of the genitalia; among these, the shape of telomere in the males and the shape of spermatheca in females (Traub 1952, Beaucournu & Alcover 1990, Beaucournu et al. 2011). Additionally the aedeagus, in the male, has been considered as one of the most important diagnostic characters (Lewis & Spotorno 1984, Sanchez & Lareschi 2014). In this study, we used mainly these characters to distinguish species and subspecies. More collecting and studies of these fleas are needed to define the morphological characters of the female of *A. n. nylota* and, complementary, comparisons with materials deposited in collections are required to identify the species with confidence. Specimens of genus *Agastopsylla* are hard to find and therefore are poorly represented in collections. Several authors have suggested that they are nest-fleas (Traub 1952, Johnson 1957, Hopkins & Rothschild 1966), so they have developed certain morphological adaptations as are the partial fusion of the metepimeron with the metanotum, reduction of the eyes, and the elongated labial palpus and mouthparts. These characters are all shared with other genera known to be nest-fleas (Lewis & Spotorno 1984). It is important to increase the sampling efforts as well as to implement complementary collecting methods such as searching in nests and shelters, and depositing the voucher specimens in systematic collections, to ensure their proper study and preservation.

This study provides information that favors the knowledge of this genus and can provide tools for a more comprehensive review, referring to the entire area of distribution of all *Agastopsylla* species.

Key to species and subspecies of the genus *Agastopsylla* modified from Beaucournu *et al.* (2011).

- Hind tibia densely covered by 22-24 setae (Figs. 2a, b)..... ***Agastopsylla hirsutior***
- 1´.Hind tibia covered for 15 or fewer setae (Figs. 3a, b).....2
- ♂.....3
- 2´.♀ (Unknown in *A. guzmani*, *A. nylota euneomys* and *A. boxi gibbosa*).....8
- Terguite VII with dense cluster of small setae locate dorsally.....4
- 3´.Terguite VII without dense cluster of small setae.....6
- Antepygidial bristle locate in the middle of the cluster of small bristles; sternite IX thick..... ***Agastopsylla boxi***...5
- 4´.Antepygidial bristle locate behind of the cluster of small bristles; sternite IX thin.
- ..... ***Agastopsylla guzmani***
- The apex of sternite IX moderately convex and dorsal part covered with small setae..... ***Agastopsylla boxi boxi***
- 5´.The apex of sternite IX strongly convex and dorsal part covered with small spiniform setae..... ***Agastopsylla boxi gibbosa.***
- Telomere with apical margin slightly oblique..... ***Agastopsylla pearsoni***
- 6´.Telomere with apical margin strongly oblique..... ***Agastopsylla nylota...7***
- Genal comb of 4-5 spines, labial palpus extending to apex of forecoxa, total length of telomere more than 3 times the length of its wide (Fig. 3c)..... ..... ***Agastopsylla nylota nylota***
- 7´. Genal comb of 3 spines, labial palpus extending beyond apex of forecoxa, total length of telomere less than 3 times the length of its wide..... ***Agastopsylla nylota euneomys***
- Anal stylet length one-third of the total length of the apical seta.....9
- 8´.Anal stylet length sub-equal of the total length of the apical seta..... .....***Agastopsylla pearsoni***
- Terguite VIII with two setae (one greatly reduced) below the spiracle..... .....***Agastopsylla nylota nylota***
- 9´.Terguite VIII with three setae (two greatly reduced) below the spiracle..... ***Agastopsylla boxi boxi***

Acknowledgments

The authors thank the members of the Programa de Investigaciones de Biodiversidad Argentina (PIDBA) for their help during the entirety of this study and are especially grateful to Ignacio Ferro for the collection of some specimens. The authors are grateful to Erica McAlister, curator at the British Museum of Natural History, London, for her support during a visit by MFL-B to the museum. Field trips were funded by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina. We want to thank the anonymous reviewer for the valuable comments and suggestions. The authors declare no conflicts of interest.

REFERENCES

BARQUEZ RM, DÍAZ MM & OJEDA RA. 2006. Mamíferos de Argentina. Sistemática y distribución. Sociedad Argentina para el Estudio de los Mamíferos (SAREM), Mendoza, 356 p.

BEAUCOURNU JC & ALCOVER JA. 1990. Puces récoltées dans la province de Neuquén (Argentine); description de 4 nouveaux taxa (Insecta: Siphonaptera). Ann Parasit Hum Comp 64: 489-505.

BEAUCOURNU JC & GALLARDO MH. 1991. Catalogue provisoire des puces du Chili (Insecta: Siphonaptera) (1er partie). Bull Soc Fr Parasitol 9: 237-270.

BEAUCOURNU JC, MORENO L & GONZALEZ-ACUÑA D. 2011. Deux espèces nouvelles de puces (Siphonaptera: Ctenophthalmidae and Rhopalopsyllidae) du Chili. Parasite 18: 241-246.

BEAUCOURNU JC, MORENO L & GONZALEZ-ACUÑA D. 2014. Fleas (Insecta-Siphonaptera) of Chile: a review. Zootaxa 2: 151-203.

ESRI. 2011. ArcGIS Desktop: Release 10. Redlands, California: Enviromental Systems Research Institute.

HASTRITER MW & WHITING, MF. 2003. Siphonaptera (fleas). In: Resh VH & Carde R (Eds), Encyclopedia of Insects. Academic Press, San Diego, CA, p. 1040-1044.

HERSHKOVITZ P. 1962. Evolution of Neotropical cricetine rodents (Muridae) with special reference to the phyllotine group. Fieldiana Zool 46: 1-524.

HOPKINS GH & ROTHSCHILD M. 1966. An illustrated catalogue of the Rothschild Collection of fleas (Siphonaptera) in the British Museum (Natural History). Volume IV. Hystricopsyllidae. British Museum (NH), London, 449 p.

ICZN - INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. 1999. International code of zoological nomenclature, The International Trust for Zoological Nomenclature, London, 4th ed., XXIX, 306 p.

JOHNSON PT. 1957. A classification of the Siphonaptera of South America. Memoir Entomol Soc Wash 3: 1-298.

JORDAN K & ROTHSCHILD NC .1923. On the genera *Rhopalopsyllus* and *Parapsyllus*. Ectoparasites 1: 320-370.

LARESCHI M, AUTINO AG, DÍAZ MM & BARQUEZ RM. 2011. Taxonomy and Distribution of *Nonnapsylla* Wagner, 1938 (Siphonaptera, Stephanocircidae, Craneopsyllinae). J Parasitol 97: 954-955.

LARESCHI M, SANCHEZ JP & AUTINO AG. 2016. A review of the fleas (Insecta: Siphonaptera) from Argentina. Zootaxa 4103: 239-258.

LEWIS RE & SPOTRONO AE. 1984. A new subspecies of *Agastopsylla nylota* (Siphonaptera: Hystrichopsyllidae) from Chile, with a key to the known taxa. J Med Entomol 4: 392-394

LÓPEZ-BERRIZBEITIA MF, DÍAZ MM, BARQUEZ RM & LARESCHI M. 2013. Pulgas (Siphonaptera) parásitas de roedores (Rodentia: Cricetidae) de la provincia de Salta, Argentina: nuevos registros de distribución. Rev Soc Entomol Arg 72:141-146.

LÓPEZ-BERRIZBEITIA MF, SANCHEZ JP, DÍAZ MM, BARQUEZ RM & LARESCHI M. 2015. Redescription of *Neotyphloceras crassispina hemisus* Jordan (Siphonaptera: Ctenophthalmidae: Neotyphloceratini). J Parasitol 101: 145-149.

LÓPEZ-BERRIZBEITIA MF, SANCHEZ JP, BARQUEZ RM & DÍAZ MM. 2018. Descriptions of two new species of flea of the genus *Plocopsylla* in northwestern Argentina. Med Vet Entomol 32:334-345.

LÖWENBERG-NETO P. 2015. Andean region: A shapefile of Morrone's (2015) biogeographical regionalization. Zootaxa 3985: 600.

MORRONE JJ. 2015. Biogeographical regionalisation of the Andean region. Zootaxa 3936: 207-236.

PATTON JL, PARDIÑAS UFJ & D'ELÍA G. 2015. MAMMALS of South America. Volume 2. Rodents. The University of Chicago Press, Chicago, 1336 p.

ROTHSCHILD M & TRAUB R. 1971. A Revised Glossary of Terms used in the Taxonomy and Morphology of Fleas. An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History), Vol. V. British Museum (NH), London.

SANCHEZ JP & LARESCHI M. 2013. The fleas (Insecta: Siphonaptera) parasites of sigmodontine rodents (Cricetidae) from Northern Patagonia, Argentina. Comp Parasitol 80: 110-117.

SANCHEZ JP & LARESCHI M. 2014. New records of fleas (Siphonaptera: Ctenophthalmidae, Rhopalopsyllidae and Stephanocircidae) from Argentinean Patagonia with remarks on the morphology of *Agastopsylla boxi* and *Tiarapsylla argentina*. Rev Mex Biodivers 85: 383-390.

SANCHEZ JP & LARESCHI M. 2018. Diversity, distribution and parasitism rates of fleas (Insecta: Siphonaptera) on Sigmodontine rodents (Cricetidae) from Argentinian Patagonia. Bull Entomol Res 1: 72-83.

STEPPAN SJ & RAMIREZ O. 2015. Genus *Phyllotis* Mammals of South America. In: Patton JL, Pardiñas UFJ & D'Elia G (Eds), Rodents Vol. 2., University of Chicago Press, Chicago, IL, p. 535-554.

TRAUB R. 1952. Records and descriptions of fleas from Peru. Proc Ent Soc of Wash 54: 1-22

WHITING MF, WHITING AS, HASTRITER, MW & DITTMAR K. 2008. A molecular phylogeny of fleas (Insecta: Siphonaptera): origins and host associations. Cladistics 24: 1-31.

WILSON DE & REEDER DM. 2005. Mammal Species of the World. A Taxonomic and Geographic Reference (3rd ed), Johns Hopkins University Press, Maryland, USA, 2142 p.

How to cite

LÓPEZ-BERRIZBEITIA MF, SANCHEZ J, BARQUEZ RM & DÍAZ M. 2020.

Taxonomic revision of the flea genus *Agastopsylla* Jordan & Rothschild 1923 (Siphonaptera: Ctenophthalmidae). An Acad Bras Cienc 92: e20181136. DOI. 10.1590/0001-3765202020181136

Manuscript received on October 29, 2018; accepted for publication on December 27, 2018

MARIA FERNANDA LÓPEZ-BERRIZBEITIA[1,2]
https://orcid.org/0000-0001-5320-4793

JULIANA SANCHEZ[3]
https://orcid.org/0000-0003-4366-9073

RUBEN MARCOS BARQUEZ[1]
https://orcid.org/0000-0002-7027-4950

MÓNICA DÍAZ[1,2]
https://orcid.org/0000-0001-9519-6461

[1]Programa 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, Miguel Lillo 205, San Miguel de Tucumán 4000, Tucumán, Argentina

[2]Fundación Miguel Lillo, Miguel Lillo 251, San Miguel de Tucumán 4000, Tucumán, Argentina

[3]Centro de Investigaciones y Transferencia del Noroeste de la Provincia de Buenos Aires (CITNOBA) (CONICET-UNNOBA), Ruta Provincial 32 Km 3.5, 2700 Pergamino, Buenos Aires, Argentina

Correspondence to: **María Fernanda López-Berrizbeitia**
E-mail: mflopezberri@hotmail.com

Author contributions

López-Berrizbeitia MF developed the study, redescribed the species and subspecies, processed the data, interpreted the results and worked on the manuscript. Sanchez JP verified redescriptions and organized the plates with figures. Barquez RM interpreted the results and revised the English in the entire manuscript. Diaz MM supervised the findings of this research. All authors discussed the results and contributed to revisions and final manuscript.