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Revision of fleas of the genus *Plocopsylla* belonging to the '*angusticeps–lewisi*' complex in the Andean biogeographic region, with the description of a new species

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Abstract. In Argentina, the Andean biogeographic region accommodates the most diverse population of fleas in the country. The Craneopsyllinae (Siphonaptera: Stephanocircidae) represent one of the most commonly found subfamilies in this region and show some endemism and high diversity. *Plocopsylla* is the most diverse genus of Craneopsyllinae; it includes 10 species mainly distributed in the Patagonian subregion, which parasitize sigmodontine rodents (Rodentia: Cricetidae). We describe and illustrate the morphology of the aedeagus in species of *Plocopsylla* that belong to the '*angusticeps–lewisi*' complex. This character is of diagnostic value in differentiating among species. A new species of this complex, *Plocopsylla (Plocopsylla) linardii* sp. n., is described and identified by the shape and chaetotaxy of the distal arm of sternite IX, as well as by the shape of the median dorsal lobe of the aedeagus. New host associations for this complex and range extensions for most of its species are reported. *Plocopsylla (P.) silewi* is recorded for the first time in Argentina. The southern limits of the distributions of *Plocopsylla (P.) lewisi* and *Plocopsylla (P.) wilesi* are extended to Santa Cruz Province. The *angusticeps–lewisi* complex is found for the first time in San Juan Province. The information may be useful in epidemiological studies of flea-borne diseases.

Key words. Craneopsyllinae, Cricetidae, Sigmodontinae, Siphonaptera, Stephanocircidae, aedeagus, Argentina, Patagonia.

Introduction

Argentina is included within two biogeographic regions, the Neotropical and Andean, between which lies a transition area known as the South American transition zone (Morrone, 2006). In Argentina, the Andean region has the greatest diversity of flea species, some of which extend their distribution towards the South American transition zone, and 60% of flea species and subspecies are represented in the Patagonian subregion (Autino & Lareschi, 1998; Beaucournu & Castro, 2003; Sanchez & Lareschi, 2013, 2014). Within the Andean region, the Stephanocircidae represent one of the most commonly found families of fleas and show high diversity and some endemism (Hopkins & Rothschild, 1956; Beaucournu & Gallardo, 1991, 1992; Beaucournu & Castro, 2003; Bazán-León *et al*., 2013; Sanchez, 2013).

The Stephanocircidae are monophyletic and include two subfamilies. Of these, the Stephanocircinae Wagner, 1928, consist of two genera limited to Australia, and the Craneopsyllinae Wagner, 1939, include seven genera in South America, all

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of which are found in Argentina (Schramn & Lewis, 1988; Beaucournu & Castro, 2003; Colombetti *et al*., 2008; Whiting *et al*., 2008; Lareschi *et al*., 2011; Sanchez, 2013). Stephanocircids are unique among fleas because the forward portion of the head of these fleas shows a division resembling a helmet, which is why species in this family are known as 'helmeted fleas' (Schramn & Lewis, 1988). The helmet serves in a manner similar to that of the prow of a boat as it separates hairs as the flea moves through the pelage of its host (Traub, 1980). Within the Craneopsyllinae, species of the genus *Plocopsylla* Jordan, 1931 demonstrate a helmet that is fully separated from the remainder of the head and two long genal setae that are displaced forward of the cibarial pump. The male clasper bears an apical fringe of very long setae on the fixed process (Jordan, 1931).

Plocopsylla is the most diverse genus of Craneopsyllinae and includes 28 species distributed from Colombia to Argentina and Chile (Schramn & Lewis, 1988). The genus was revised on the basis of male characters by Schramn & Lewis (1988), who separated the species into two groups designated A (four subgroups) and B (two subgroups). Beaucournu *et al.* (2004) called group B subgenus '*Schrammapsylla* Beaucournu & Ménier, 2004', and group A subgenus '*Plocopsylla*'. The subgenera differ in the shape of sternite IX, which is roughly triangular in *Plocopsylla*, but gently curved in *Schrammapsylla*. Within the subgenus *Plocopsylla*, the species *Plocopsylla* (*P.*) *angusticeps* Mahnert, 1982, *Plocopsylla* (*P.*) *lewisi* Beaucournu & Gallardo, 1988, *Plocopsylla* (*P.*) *wilesi* Beaucournu & Kelt, 1990 and *Plocopsylla* (*P.*) *silewi* Beaucournu & Kelt, 1990 comprise the '*angusticeps–lewisi*' complex because of their similarity in the general appearance of tergite IX and the fixed and movable process of the clasper (Beaucournu & Kelt, 1990).

Ten species of *Plocopsylla* have been registered in Argentina, most of which are distributed only in Patagonia, and which parasitize sigmodontine rodents (Cricetidae) (Beaucournu & Castro, 2003; Sanchez, 2013). These species belong to both subgenera *Schrammapsylla* and *Plocopsylla*, and three of them are included in the *angusticeps–lewisi* complex: *P.* (*P.*) *angusticeps*, *P.* (*P.*) *lewisi* and *P.* (*P.*) *wilesi*. Their morphology is known only from their original descriptions and some species have never again been collected. Herein, we revise the *angusticeps–lewisi* complex and provide new morphological characters of diagnostic value in the identification of males of the species. In addition, we describe a new species belonging to this complex. We also report new host associations and range extensions for most species of the complex.

Materials and methods

The collection localities correspond to the provinces of Río Negro, Chubut and Santa Cruz in the Patagonian subregion (Andean region), and San Juan Province in the Prepuna biogeographic area (South American transition zone) (Morrone, 2006) (Fig. 1). The Patagonian subregion extends to southern Argentina, from central Mendoza, widening through Neuquen, Río Negro, Chubut and Santa Cruz, to northern Tierra del Fuego (Morrone, 2006). This subregion presents a temperate to cold-temperate climate, with marked heterogeneity moulded by the combined influences of the latitudinal gradient of temperature, the west–east gradient of precipitation and strong westerly winds (Soriano *et al.*, 1983; Oesterheld *et al.*, 1998; Paruelo *et al.*, 1998). These climatic factors are reflected in the characteristics of soils and vegetation, manifesting aridity as a remarkable peculiarity of the area (Paruelo *et al.*, 1998). Prepuna Province comprises central and northwestern Argentina (Morrone, 2006). This province presents a cold and arid climate with semi-desert vegetation formed by very low arbustive steppe (Cabrera, 1976; Burkart *et al.*, 1999).

Fleas were collected in the field from the pelage of sigmodontine rodents of the following species and stored in 96% ethanol: *Calomys musculinus* (Thomas, 1913); *Eligmodontia morgani* J. A. Allen, 1901; *Phyllotis xanthopygus* (Waterhouse, 1837); *Abrothrix longipilis* (Waterhouse, 1837); *Abrothrix olivacea* (Waterhouse, 1837); *Reithrodon auritus* (Fisher, 1814), and *Euneomys chinchilloides* (Waterhouse, 1839). An individual of *Akodon spegazzini* Thomas, 1897 was captured alive, killed, preserved in an individual nylon bag and examined for fleas in the laboratory.

After collection, fleas were cleared and softened in 10% KOH, dehydrated in an increasing series of ethanol (80–100%), further diaphanized in eugenol, and mounted in Canadian balsam for study with a microscope equipped with a drawing tube. Fleas were drawn and photographed.

Voucher specimens will be deposited in the Colección de Entomología del Museo de La Plata (MLP, La Plata, Argentina). Currently, specimens are labelled with field numbers made up of the host field number and an additional number for each flea from the same host, separated by a hyphen (e.g. PPA578-1, LTU673-2). For taxonomic identification, we used original descriptions of the species and followed Schramn & Lewis (1988). Holotypes and paratypes of species of *Plocopsylla* deposited at the Field Museum of Natural History (FMNH), Chicago, IL, U.S.A., and the Muséum d'Histoire Naturelle de Genève (MHNG), Geneva, Switzerland, were examined. Morphology nomenclature followed that of Rothschild & Traub (1971).

Rodents were sampled with Sherman traps. Rodents from San Juan Province were captured by Emiliano Donadío (Department of Zoology and Physiology, University of Wyoming, Laramie, WY, U.S.A.). Rodents from other localities were captured by Ulyses Pardiñas, his collaborators [all from Centro Nacional Patagónico (CENPAT), Argentina] and two of the authors (JS and ML). All the rodents were processed and identified by U. Pardiñas, and deposited at the Colección de Mamíferos del CENPAT (CNP, Puerto Madryn, Argentina). The taxonomy of the rodents followed that of Wilson & Reeder (2005).

The studied fleas (Stephanocircidae; subfamily Craneopsyllinae) are listed below. Numbers of each sex, field numbers, host species and localities are indicated. For all studied species of flea, the aedeagus is described and illustrated and a brief report on diagnostic characters, known host species and geographical distribution is included. A key to the species of the *angusticeps–lewisi* complex is provided.

Fig. 1. Biogeographic areas of South America (Morrone, 2006). Sample sites (x): San Juan Province: (1) Parque Nacional San Guillermo (29°25′S, 69°15′W); Río Negro Province: (2) Puesto Pillahuinco, Estancia La Esperanza (40°25′50″S, 68°40′24″W); (3) Laguna Blanca, Cerro Corona (41°25′36″S, 66°57′20″W); (4) Campamento PNG Somuncurá (41°27′11″S, 66°53′49″W); Chubut Province: (5) Establecimiento La Maroma (42°41′45″S, 68°13′55″W); (6) Carhué Niyeu (42°49′21″S, 68°23′56″W); (7) Lago Fontana, 1 km E RP 57 (44°50′53″S, 71°37′01″W); (8) Alm. Hotel Los Manantiales (45°27′51″S, 69°29′25″W); Santa Cruz Province: (9) Pali Aike (50°06′30″S, 68°27′37″W); (●), known geographical distribution of the *angusticeps–lewisi* complex (Beaucournu & Kelt, 1990).

Plocopsylla (*Plocopsylla*) *angusticeps* Mahnert, 1982

Taxonomic summary

Type host and locality. Abrothrix olivacea (Waterhouse, 1837) (originally reported as *Akodon olivaceus*); Puerto Madryn, Chubut Province, Argentina.

Known geographical distribution. Argentina: Chubut Province (Mahnert, 1982).

Material examined. Holotype ♂ (MHNG): Argentina, Chubut, Puerto Madryn.

Description of aedeagus

Aedeagal apodeme long, reaching 5/6 of total length of aedeagus; proximal margin straight (Fig. 2). Apical appendage reduced. Neck long, located near to middle of apodeme. Middle plate arising from neck region and curving down to almost the same level as the lateral plates. Lateral plates with straight margin. Median dorsal lobe curving below the lateral plates. Lateral lobe forming a right angle. Crescent sclerotization convex, long and arranged around the proximal strut. Sclerotized inner tube apical, long, about four times longer than wide and apically curved; lateral sclerite of inner tube with long ventral sclerotization. Distolateral lobe developed, with lateral margin elongated and extending beyond the apex of sclerotized inner tube. Crochet apical, wider, extending along lateral lobe. Wall of aedeagal pouch extending along the anterior region of the apodeme, above the level of the neck, anteroventral margin strongly sclerotized, forming a right angle, with accessory aedeagal apodemal rod longer than apodeme. Penis rod uncoiled and longer than apodeme.

Length: holotype 2.50 mm

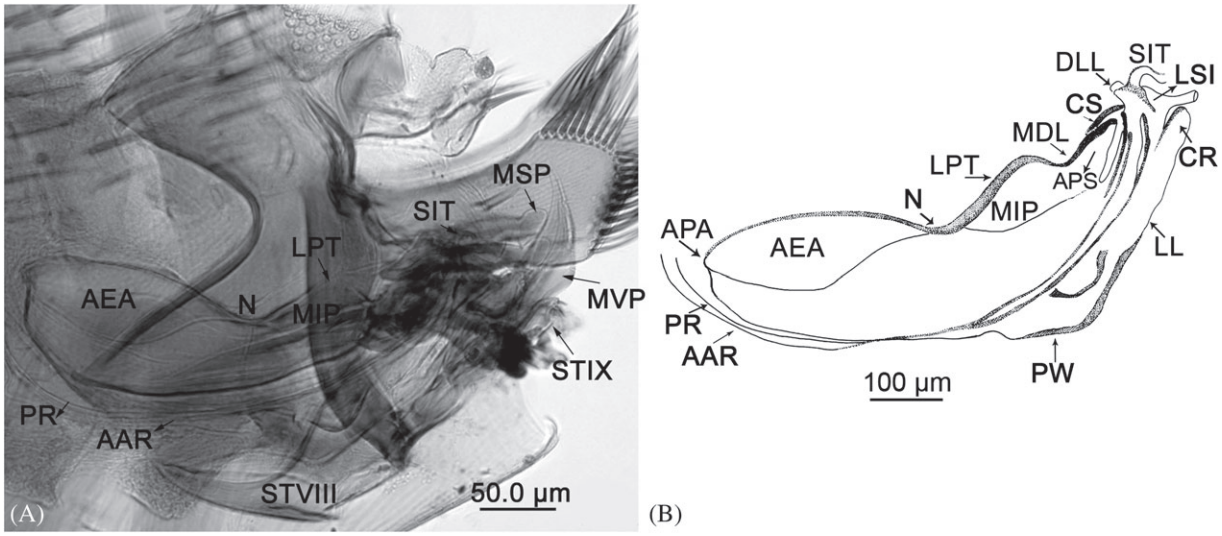

Fig. 2. Genital morphology of male of *Plocopsylla (Plocopsylla) angusticeps* Mahnert, 1982. (A) Modified abdominal segments and aedeagus. (B) Detail of the aedeagus. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; APA, apical appendage; APS, apodemal strut; CR, crochet; CS, crescent sclerite; DLL, distolateral lobe; LL, lateral lobe; LPT, lateral plates; LSI, lateral sclerite of inner tube; MDL, median dorsal lobe; MIP, middle plate; MSP, mesal process of clasper; MVP, movable process; N, neck; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube; STVIII, sternite VIII; STIX, sternite IX.

Diagnosis

Plocopsylla (*P.*) *angusticeps* is unique in the shape of its helmet (very narrow with a concave anterior margin), and in the shape and chaetotaxy of the distal arm of sternite IX (which has a triangular apex, bearing three pigmented setae and one large unpigmented seta in the middle) (Mahnert, 1982; Schramn & Lewis, 1988). Moreover, *P.* (*P.*) *angusticeps* is similar to *P.* (*P.*) *silewi*, but differs from the other species of the *angusticeps–lewisi* complex by the combination of the following characters: (a) of the mesal process of the clasper is rounded and directed upwards (Fig. 2A); (b) the movable process of the clasper shows a dorsal apex that is prominent, triangular, highly elongated and narrow, with three equidistant thin setae along the distal margin (Fig. 2A); (c) sternite VIII is narrow, with an anteroventral angle and a long retrograde prolongation (Fig. 2A); (d) the apical appendage is reduced (Fig.2B), and (e) the wall of the aedeagal pouch shows an anteroventral margin, is strongly sclerotized and forms a right angle (Fig. 2B).

Remarks

Plocopsylla (*P.*) *angusticeps* is known only by the holotype, and is appropriately named for its extremely narrow helmet. This character has been suggested as an individual deformation of the helmet (Mahnert, 1982; Beaucournu & Kelt, 1990). It should be noticed that in the last 7 years one of the authors (JS) made numerous samplings at the type locality of *P.* (*P.*) *angusticeps* (Puerto Madryn, Chubut Province) and in nearby localities, but found no specimens of this species. In this study, on the basis of the holotype, we describe the morphology of the aedeagus of *P.* (*P.*) *angusticeps*, which was previously unknown, and is now included as a character of diagnostic value.

Plocopsylla (*Plocopsylla*) *lewisi* Beaucournu & Gallardo, 1988

Taxonomic summary

Type host and locality. Abrothrix longipilis (Waterhouse, 1837) (originally reported as *Akodon longipilis*); Estación Perito Moreno, Río Negro Province, Argentina.

Other known hosts. Abrothrix olivacea, *Oligoryzomys longicaudatus* Bennett, 1832, *Phyllotis xanthopygus*, *Reithrodon physodes* Olfers, 1818 (Schramn & Lewis, 1988; Beaucournu & Kelt, 1990).

Known geographical distribution. Argentina: Río Negro and Chubut Provinces (Beaucournu & Gallardo, 1988; Schramn & Lewis, 1988); Chile (Beaucournu & Kelt, 1990).

Material examined. **Chubut:** Lago Fontana, 1 km E RP 57 (44°50′52.9″S, 71°37′1″W; 1069 m a.s.l.), ex *A. olivacea*, U. Pardiñas, M. Lareschi, A. Formoso and J. Sanchez collectors, IV/2013, 1 ♂ (PPA977), **Santa Cruz:** Pali Aike (50°06′30″S, 68°27′37″W; 24 m a.s.l.), ex *A. olivacea* U. Pardiñas, D. Udrizar Sauthier, A. Formoso, D. Podestá and J. Sanchez collectors, XII/2009, 2 ♂ (LTU668, 673-1); ♀ (LTU673-2).

Description of aedeagus

Aedeagal apodeme long, reaching 5/6 of total length of aedeagus; proximal margin straight (Fig. 3A, B). Apical appendage

short and triangular. Neck long, located near to the middle of apodeme. Middle plate arising from neck region and curving down to almost the same level as lateral plates. Lateral plates form a right angle. Median dorsal lobe curves below lateral plates. Margin of lateral lobe is straight. Crescent sclerotization convex, long and arranged around the proximal strut. Sclerotized inner tube apical, long, about four times longer than wide and apically curved; lateral sclerite of inner tube with long ventral sclerotization. Distolateral lobe developed, with lateral margin elongated and extending beyond the apex of sclerotized inner tube. Crochet apical, wider, extending along lateral lobe. Wall of aedeagal pouch extending along the anterior region of the apodeme, above the level of the neck; anteroventral margin mildly sclerotized, forming a convex lobe, with accessory aedeagal apodemal rod, longer than aedeagal apodeme. Penis rod uncoiled and longer than aedeagal apodeme.

Length: male 2.50–3.00 mm; female 3.00 mm.

Diagnosis

Plocopsylla (*P.*) *lewisi* is unique in the combination of the following characters: (a) the apex of the mesal process of the clasper forms a triangle (Fig. 3A); (b) the movable process of the clasper shows a dorsal apex that is triangular, short and narrow, and the distal margin is straight with thin setae mainly located in the middle (Fig. 3A); (c) the apex of the distal arm of sternite IX is rounded with two large unpigmented setae and numerous small setae (Fig. 3A, C); (d) sternite VIII is narrow, long and angled anteroventrally and shows a small retrograde prolongation (Fig. 3A); (e) the apical appendage is short and triangular (Fig. 3B), and (f) the wall of the aedeagal pouch shows an anteroventral margin that is mildly sclerotized and forms a convex lobe (Fig. 3A, B).

Remarks

Plocopsylla (*P.*) *lewisi* is distributed in southern Argentina and Chile (Beaucournu & Gallardo, 1988; Schramn & Lewis, 1988). In Argentina, this species was found in the provinces of Río Negro (type material: Beaucournu & Gallardo, 1988) and Chubut, and was identified by Mahnert (1982) as *Plocopsylla* (*P.*) *chiris* and subsequently re-identified by Schramn & Lewis (1988) as *P.* (*P.*) *lewisi*. The present record of *P.* (*P.*) *lewisi* in Pali Aike, Santa Cruz Province, is the first for this province and establishes the southern limit of this species' range.

Plocopsylla (*Plocopsylla*) *wilesi* Beaucournu & Kelt, 1990

Taxonomic summary

Type host and locality. Abrothrix olivacea (Waterhouse, 1837) (originally reported as *Akodon xanthorhinus*); Aisén, Chile.

Other known hosts. Abrothrix longipilis; *Euneomys* sp.; *P. xanthopygus* (Beaucournu & Kelt, 1990; Sanchez & Lareschi, 2013).

Known geographical distribution. Argentina: Neuquen and Río Negro Provinces (Sanchez & Lareschi, 2013); Chile (Beaucournu & Kelt, 1990).

Material examined. Paratype ♂ (FMNH): Chile, Aisén, Chile Chico.

Río Negro: Laguna Blanca, Cerro Corona (41°25′36″S, 66°57′20″W; 1330 m a.s.l.), U. Pardiñas and D. Udrizar Sauthier collectors, 2005, ex *E. chinchilloides*, 1 ♂ (UP875-1); 1 ♀ (UP875-2); ex *A. longipilis*, 3 ♂ (UP869-1, 872, 873); 3 ♀ (UP869-2, 872-1,2); Campamento PNG Somuncurá (41°27′11″S, 66°53′49″W; 1395 m a.s.l.), U. Pardiñas and D. Udrizar Sauthier collectors, ex *A. longipilis* 1 ♀ (UP881). **Chubut:** Carhué Niyeu (42°49′21″S, 68°23′56″W; 1158 m a.s.l.), U. Pardiñas collector, 2012, ex *A. longipilis*, 1 ♂ (PPA 286); ex *A. olivacea*, 1 ♂ (PPA281); ex *P. xanthopygus*, 2 ♀ (PPA 272, 274); ex *E. morgani*, 1 ♀ (PPA 270); Establecimiento La Maroma (42°41′45″S, 68°13′55″W; 1162 m a.s.l.), U. Pardiñas collector, 2012, ex *A. longipilis*, 3 ♂ (PPA251-1,2,3); ex *E. morgani*, 1 ♂ (PPA336); ex *P. xanthopygus*, 1 ♂ (PPA246); Alm. Hotel Los Manantiales (45°27′51″S, 69°29′25″W; 661 m a.s.l.), U. Pardiñas collector, 2012, ex *P. xanthopygus*, 3 ♂ (PPA948, PPA968-1,2), 2 ♀ (PPA968-3,4). **Santa Cruz:** Pali Aike (50°06′30″S, 68°27′37″W; 24 m a.s.l.), U. Pardiñas, D. Udrizar Sauthier, A. Formoso, D. Podestá and J. Sanchez collectors, XII/2009, ex *A. olivacea*, 2 ♂ (LTU663, 678-1); 1 ♀ (LTU678-2).

Description of aedeagus

Aedeagal apodeme long, reaching 5/6 of total length of aedeagus, proximal margin straight; with two long apodemal cone-shaped struts, proximal strut wider and shorter than distal strut (Fig. 4). Apical appendage somewhat reduced, button-shaped. Middle plate arising from neck region and curving down to almost the same level as lateral plates. Lateral plates strongly sclerotized. Neck long, strongly sclerotized, located near to the 2/3 of total length of apodeme. Median dorsal lobe curving below the lateral plates and forming a straight margin. Margin of lateral lobe straight. Crescent sclerotization convex, long and arranged around the proximal strut. Sclerotized inner tube apical, long, about four times longer than wide and apically curved; lateral sclerite of inner tube with long ventral sclerotization. Distolateral lobe developed, with lateral margin elongated and extending beyond the apex of sclerotized inner tube. Crochet apical, wider, extending along lateral lobe. Wall of aedeagal pouch extending along the anterior region of the apodeme, above the level of the neck; anteroventral margin strongly sclerotized and forming a long projection, with accessory aedeagal apodemal rod, longer than apodeme. Penis rod longer than apodeme and with tip slightly curved upwardly.

Length: male 2.50–2.80 mm; female 2.75–3.00 mm.

Diagnosis

The male of *P.* (*P.*) *wilesi* is distinguished from males of the other species of the *angusticeps–lewisi* complex by the

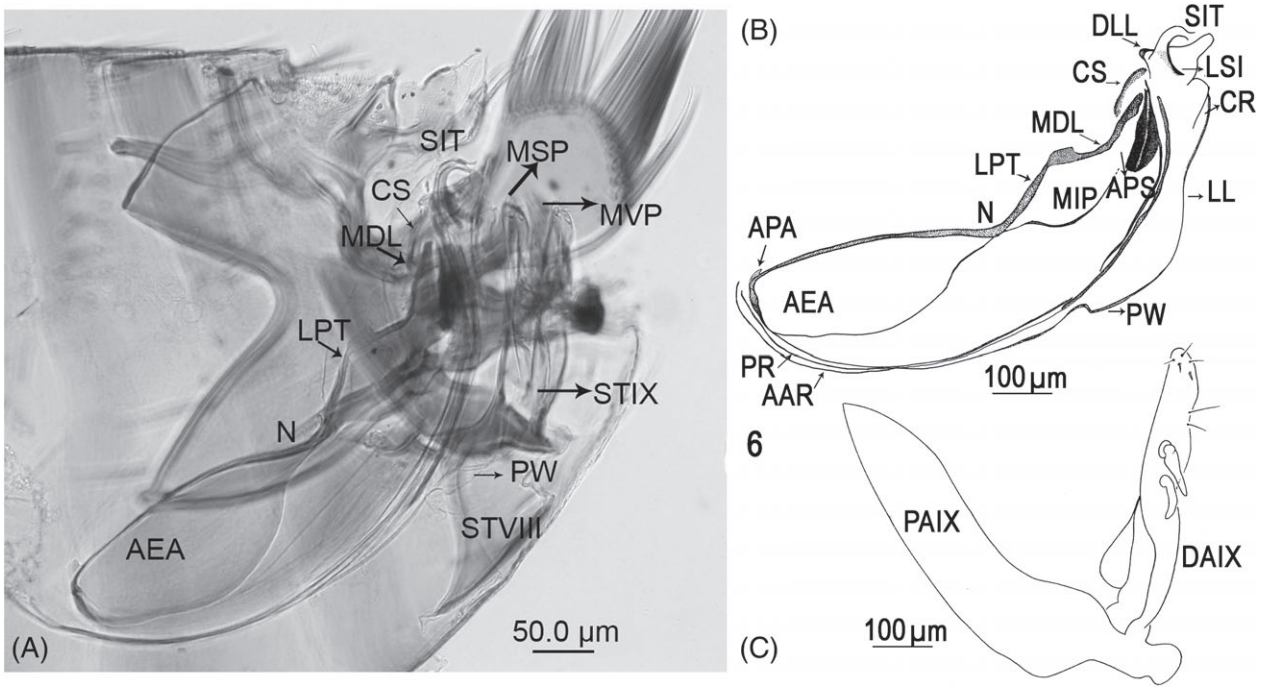

Fig. 3. Genital morphology of male of *Plocopsylla (Plocopsylla) lewisi* Beaucournu & Gallardo, 1988. (A) Modified abdominal segments and aedeagus. (B) Detail of the aedeagus. (C) Detail of sternite IX. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; APA, apical appendage; APS, apodemal strut; CR, crochet; CS, crescent sclerite; DAIX, distal arm of sternite IX; DLL, distolateral lobe; LL, lateral lobe; LPT, lateral plates; LSI, lateral sclerite of inner tube; MDL, median dorsal lobe; MIP, middle plate; MSP, mesal process of clasper; MVP, movable process; N, neck; PAIX, proximal arm of sternite IX; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube; STVIII, sternite VIII; STIX, sternite IX.

combination of the following characters: (a) the apex of the mesal process of the clasper is spatulate (Fig. 4A); (b) the movable process of the clasper shows a dorsal apex that is triangular, short and wide; the distal margin is straight with thin setae mainly located in the apex (Fig. 4A); (c) the apex of the distal arm of sternite IX is straight with five or six pigmented setae and two large unpigmented setae (Fig. 4A, C); (d) sternite VIII is massive (Fig. 4A); (e) the apical appendage is somewhat reduced and button-shaped (Fig. 4B), and (f) the wall of the aedeagal pouch shows an anteroventral margin that is strongly sclerotized and forms a long projection (Fig. 4B).

Remarks

Plocopsylla (*P.*) *wilesi* is recorded in the provinces of Chubut and Santa Cruz for the first time. Prior to this study, this species was found in the provinces of Neuquen and Río Negro (Sanchez & Lareschi, 2013). The record in Pali Aike, Santa Cruz Province, establishes the southern limit of its range (600 km south of its earlier known distribution). *Plocopsylla* (*P.*) *wilesi* parasitizes only sigmodontine rodents; *Abrothrix* spp. are the most frequent hosts (Beaucournu & Kelt, 1990; Sanchez & Lareschi, 2013). *Eligmodontia morgani* represents a new host for this species of flea.

Plocopsylla (*Plocopsylla*) *silewi* Beaucournu & Kelt, 1990

Taxonomic summary

Type host and locality. Abrothrix olivacea (Waterhouse, 1837) (originally reported as *Akodon xanthorhinus*); Aisén, Chile.

Known geographical distribution. Chile (Beaucournu & Kelt, 1990).

Material examined. Paratype ♂ (FMNH): Chile, Aisén, Chile Chico.

Río Negro: Puesto Pillahuinco, Estancia La Esperanza (40°25′50″S, 68°40′24″W; 1201 m a.s.l.), U. Pardiñas collector, 2012, ex *E. morgani*, 1 ♀ (PPA579); *P. xanthopygus*, 2 ♀ (PPA578-1,2). **Chubut:** Carhué Niyeu (42°49′21″S, 68°23′56″W; 1158 m a.s.l.), U. Pardiñas collector, 2012, ex *A. olivacea*, 1 ♂ (PPA 284-1); 3 ♀ (PPA 278, 280, 281, 284-2), ex *E. morgani*, 3 ♂ (PPA 270, 271-1, 2); 2 ♀ (PPA 270-3, 287), Establecimiento La Maroma (42°41′45″S, 68°13′55″W; 1162 m a.s.l.), U. Pardiñas collector, 2012, ex *A. olivacea*, 1 ♂ (PPA306); 4 ♀ (PPA304, 313, 328-1,2); ex *E. morgani*, 4 ♀ (PPA 299, 302, 316, 338).

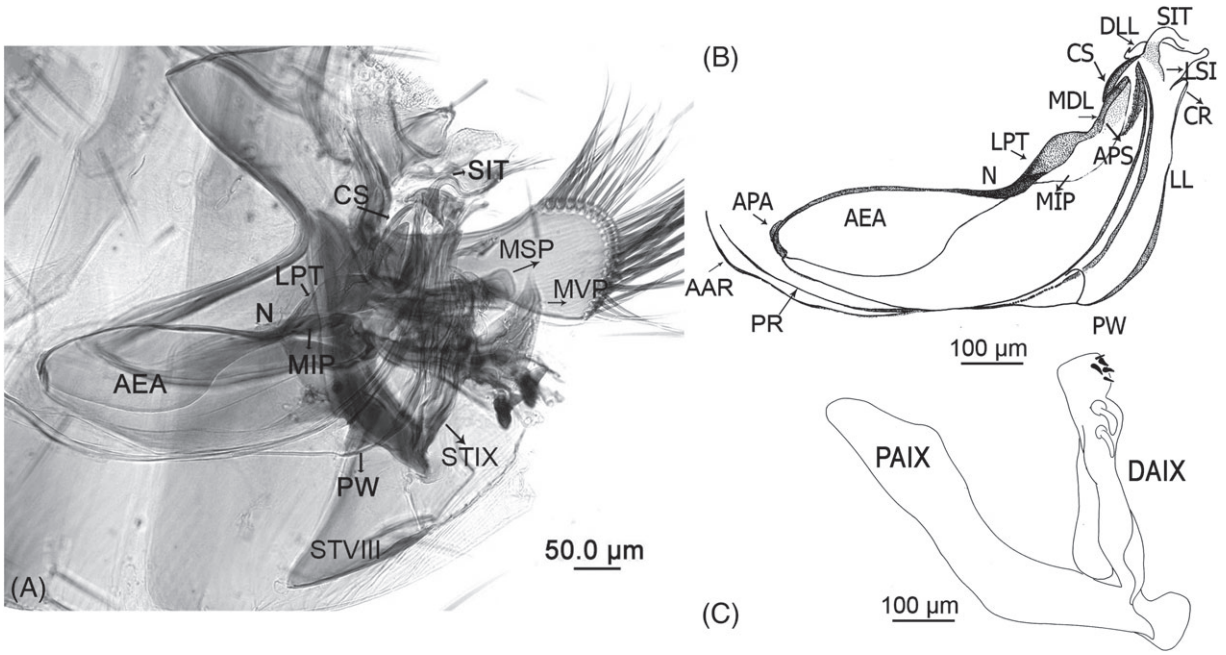

Fig. 4. Genital morphology of male of *Plocopsylla (Plocopsylla) wilesi* Beaucournu & Kelt, 1990. (A) Modified abdominal segments and aedeagus. (B) Detail of the aedeagus. (C) Detail of sternite IX. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; APA, apical appendage; APS, apodemal strut; CR, crochet; CS, crescent sclerite; DAIX, distal arm of sternite IX; DLL, distolateral lobe; LL, lateral lobe; LPT, lateral plates; LSI, lateral sclerite of inner tube; MDL, median dorsal lobe; MIP, middle plate; MSP, mesal process of clasper; MVP, movable process; N, neck; PAIX, proximal arm of sternite IX; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube; STVIII, sternite VIII; STIX, sternite IX.

Description of aedeagus

Aedeagal apodeme long, reaching 5/6 of total length of aedeagus; proximal margin straight (Fig. 5A, B). Apical appendage reduced. Neck long, located near to the middle of apodeme. Middle plate arising from neck region and curving down to almost the same level as lateral plates. Lateral plates with straight margin. Median dorsal lobe curving below the lateral plates. Lateral lobe forming a right angle. Crescent sclerotization convex, long and arranged around the proximal strut. Sclerotized inner tube apical, long, about four times longer than wide and apically curved; lateral sclerite of inner tube with long ventral sclerotization. Distolateral lobe developed, with lateral margin elongated and extending beyond the apex of sclerotized inner tube. Crochet apical, wider, extending along lateral lobe. Wall of aedeagal pouch extending along anterior region of the apodeme, above the level of the neck, anteroventral margin strongly sclerotized, forming a right angle, with accessory aedeagal apodemal rod, longer than apodeme. Penis rod uncoiled and longer than apodeme.

Length: male 2.50–2.75 mm; female 2.50–3.00 mm.

Diagnosis

The male of *P.* (*P.*) *silewi* is similar to that of *P.* (*P.*) *angusticeps*, and differs from males of the other species of the *angusticeps–lewisi* complex by the combination of the following characters: (a) the apex of the mesal process of the clasper is rounded and directed upwards (Fig. 5A); (b) the movable process of the clasper shows a dorsal apex that is prominent, triangular, highly elongated and narrow; three equidistant thin setae lie along the distal margin (Fig. 5A); (c) sternite VIII is narrow, lies at an anteroventral angle and shows a long retrograde prolongation (Fig. 5A); (d) the apical appendage is reduced (Fig. 5B), and (e) the wall of the aedeagal pouch shows an anteroventral margin that is strongly sclerotized and forms a right angle (Fig. 5B). *Plocopsylla* (*P.*) *silewi* is unique in the shape and chaetotaxy of the distal arm of sternite IX, which shows a triangular apex and two heavily pigmented and three unpigmented setae (Fig. 5A, C).

Remarks

Plocopsylla (*P.*) *silewi* is very similar to *P.* (*P.*) *angusticeps*, but its characters differ from those given in drawings and descriptions of the shape and chaetotaxy of sternite IX of *P.* (*P.*) *angusticeps* by Mahnert (1982) and Schramn and Lewis (1988). However, we were unable to observe these characters in the holotype of *P.* (*P.*) *angusticeps* because they are hidden behind other structures. The large number of similarities between *P.* (*P.*) *silewi* and *P.* (*P.*) *angusticeps*, other than the apex of sternite IX mentioned in the literature (see above), allow us to hypothesize that these species may be synonymous. However, new findings of *P.* (*P.*) *angusticeps* are necessary in order to examine sternite IX and investigate our postulation.

Present records of *P.* (*P.*) *silewi* in the provinces of Río Negro and Chubut represent the first observations of this species in

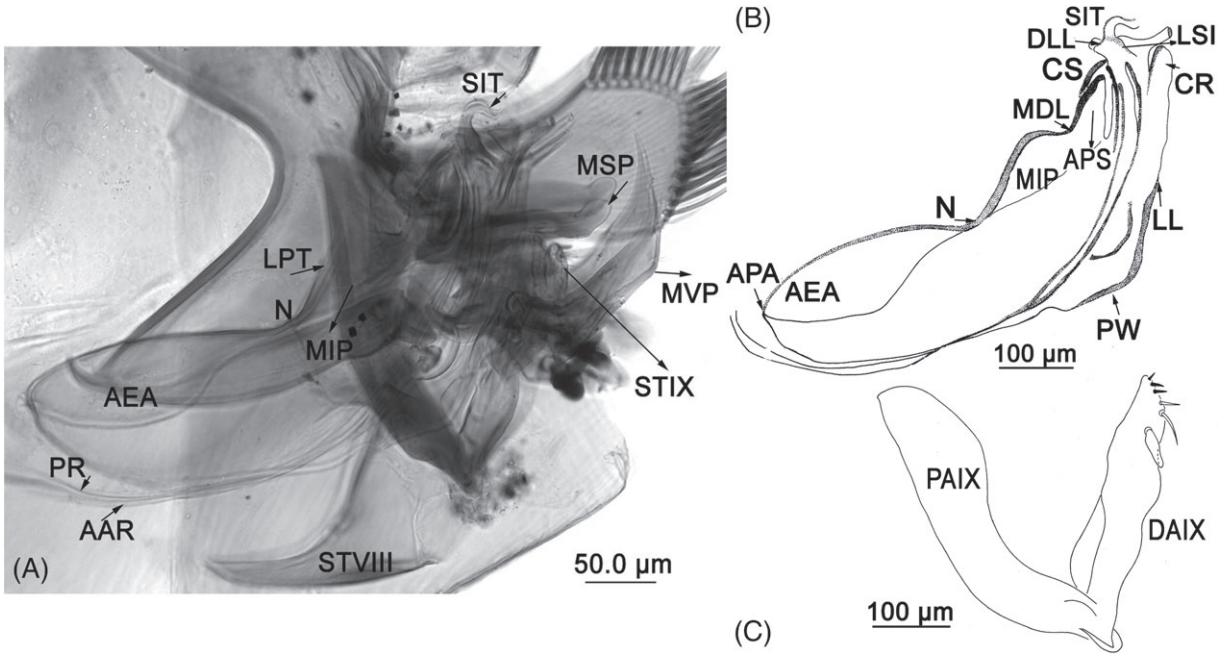

Fig. 5. Genital morphology of male of *Plocopsylla (Plocopsylla) silewi* Beaucournu & Kelt, 1990. (A) Modified abdominal segments and aedeagus. (B) Detail of the aedeagus. (C) Detail of sternite IX. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; APA, apical appendage; APS, apodemal strut; CR, crochet; CS, crescent sclerite; DAIX, distal arm of sternite IX; DLL, distolateral lobe; LL, lateral lobe; LPT, lateral plates; LSI, lateral sclerite of inner tube; MDL, median dorsal lobe; MIP, middle plate; MSP, mesal process of clasper; MVP, movable process; N, neck; PAIX, proximal arm of sternite IX; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube; STVIII, sternite VIII; STIX, sternite IX.

Argentina. Prior to this study, *P.* (*P.*) *silewi* was recorded only at the type locality (Aisén, Chile). The present report considerably extends the geographical distribution of the species. *Phyllotis xanthopygus* and *E. morgani* represent new hosts for *P.* (*P.*) *silewi.*

Plocopsylla (*Plocopsylla*) *linardii* Sanchez, Beaucournu & Lareschi, sp. n.

Taxonomic summary

Type material. Holotype male ex *Akodon spegazzini* Thomas (SJ5), Argentina, San Juan Province, Parque Nacional San Guillermo (29°25′ S, 69°15′ W; 3287 m a.s.l.), E. Donadío Collector, 2011.

Deposition of type. The holotype male will be deposited in the Colección de Entomología del Museo de La Plata (MLP).

Etymology. This species is named in honour of Pedro Marcos Linardi (Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil) in recognition of his valuable contributions to knowledge of ectoparasites from South America, particularly fleas, as well as for acting as advisor to the last author in her post-doctoral studies.

Description

Head: prectenidial width of helmet similar to length of longest helmet spine (Fig. 6A). Helmet widest at fifth dorsal spine. Helmet comb with 11 spines on left side and 12 on right; one small seta located on anteroventral margin of the head, level with basis of inferior spine. Anterior margin of gena convex, with 11 closely spaced submarginal setae that extend linearly from dorsal to ventral margins of gena, and seven smaller setae between two long genal bristles. Genal comb with five spines, the first shortened and separated from adjacent spine by a gap similar to basal width of genal spine. Genal lobe rounded. Occiput with numerous small setae preceding four rows of prominent setae, with posterior row consisting of long setae plus intercalaries, similar to main setal rows on thoracic and abdominal tergites. First antennal segment with four setae in row from dorsal margin to mesal surface. Second segment with seven setae along the distal margin extending beyond apex of clava.

Abdomen (non-genital segments) and thorax: pronotum with two rows of setae. Pronotal comb of 22 spines (Fig. 6A), with narrow lobe below ventral-most spine, much shorter than pronotal spines. Mesonotum and metanotum each with three rows of setae. Tergites with two rows of setae, with anterior row of intermediate-length setae, posterior of alternating long setae and intercalaries. One elongate antepygidial seta per side.

Legs: dorsoapical setae of hind tibia with the following arrangement: 3, 2, 2–3, 4, 4, 4, 4. Lateral surface of hind tibia with a single row of setae.

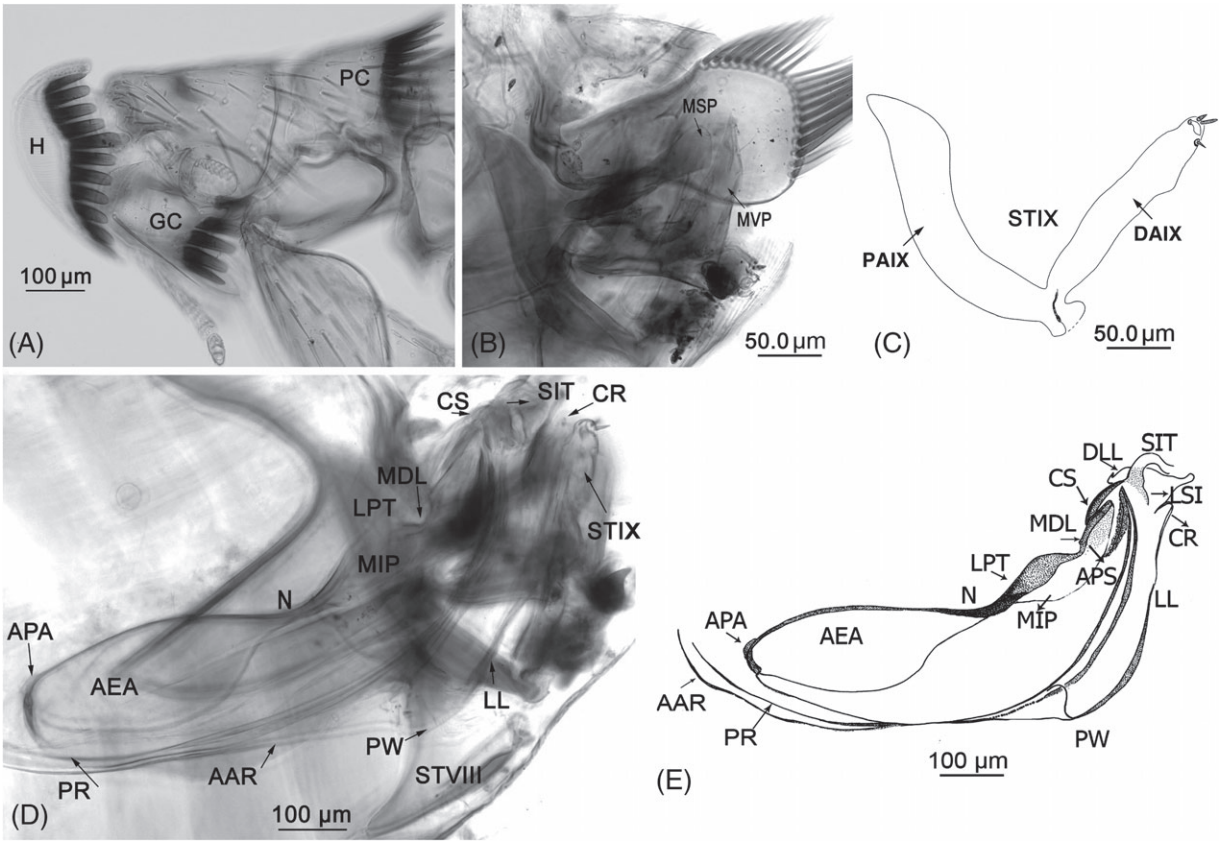

Fig. 6. *Plocopsylla (Plocopsylla) linardii* sp. n. (A) Head and prothorax. (B) Mesal process and movable process of clasper. (C) Detail of sternite IX. (D) Aedeagus and sternite IX. (E) Detail of the aedeagus. AAR, aedeagal apodemal rod; AEA, aedeagal apodeme; APA, apical appendage; APS, apodemal strut; CR, crochet; CS, crescent sclerite; DAIX, distal arm of sternite IX; DLL, distolateral lobe; GC, genal comb; H, helmet; LL, lateral lobe; LPT, lateral plates; LSI, lateral sclerite of inner tube; MDL, median dorsal lobe; MIP, middle plate; MSP, mesal process of clasper; MVP, movable process; N, neck; PAIX, proximal arm of sternite IX; PC, pronotal comb; PR, penis rod; PW, wall of aedeagal pouch; SIT, sclerotized inner tube; STVIII, sternite VIII; STIX, sternite IX.

Modified abdominal segments: fringe on fixed process of clasper with 20 large setae (Fig. 6B). Apex of the mesal process of clasper is spatula-shaped (Fig. 6B). Movable process of clasper with dorsal apex triangular, short and wide; distal margin straight with thin setae mainly located in apex (Fig. 6B). Tergite VIII with rounded and narrow apodeme. Sternite VIII massive (Fig. 6D). Proximal arm of sternite IX with distal margin convex, apex narrow and slightly curved. Distal arm of sternite IX with apex narrow and rounded, three small heavily pigmented setae and one large unpigmented seta (Fig. 6C).

Description of aedeagus

Aedeagal apodeme long, reaching 5/6 of total length of aedeagus, proximal margin straight; with two long apodemal, cone-shaped struts, proximal strut wider and shorter than distal strut (Fig. 6D, E). Apical appendage somewhat reduced, button-shaped. Middle plate arising from neck region and curving down to almost the same level as lateral plates. Lateral plates strongly sclerotized. Neck long, strongly sclerotized, located near to the 2/3 of total length of apodeme. Median dorsal lobe curving below lateral plates and markedly concave. Margin of lateral lobe straight. Crescent sclerotized and convex, long and arranged around the proximal strut. Sclerotized inner tube apical, long, about four times longer than wide and apically curved, with long ventral sclerotization. Distolateral lobe developed, with lateral margin elongated and extending beyond the apex of sclerotized inner tube. Crochet apical, wider, extending along lateral lobe. Wall of aedeagal pouch extending along the anterior region of the apodeme, above the level of the neck; anteroventral margin strongly sclerotized and forming a long projection, with accessory aedeagal apodemal rod longer than apodeme. Penis rod longer than apodeme and with lightly upwardly curved tip.

Length: 2.37 mm.

Diagnosis

The male of *Plocopsylla* (*P.*) *linardii* n. sp. is similar to that of *P.* (*P.*) *wilesi* and differs from males of the other species of the *angusticeps–lewisi* complex in the combination of the following characters: (a) the apex of the mesal process of the clasper is spatulate (Fig. 6B); (b) the movable process of the

clasper shows a dorsal apex that is triangular, short and wide, and the distal margin is straight and shows thin setae mainly located in the apex (Fig. 6B); (c) sternite VIII is massive (Fig. 6D); (d) the apical appendage is somewhat reduced and button-shaped (Fig. 6D, E), and (e) the wall of the aedeagal pouch shows an anteroventral margin that is strongly sclerotized and forms a long projection (Fig. 6D, E). *Plocopsylla* (*P.*) *linardii* sp. n. is unique in: (a) the shape and chaetotaxy of the distal arm of sternite IX, which has a narrow and rounded apex, and three small heavily pigmented setae and one large unpigmented seta (Fig. 6C), and (b) the median dorsal lobe of the aedeagus is markedly concave (Fig. 6D, E).

Remarks

The general morphology of *P.* (*P.*) *linardii* sp. n is consistent with that of the subgenus *Plocopsylla* and the *angusticeps–lewisi* complex. Although it would be desirable to collect paratypes and the allotype of *P.* (*P.*) *linardii* sp. n., a close species, *P.* (*P.*) *angusticeps*, was also described on the basis of only one male specimen. In addition, other species of *Plocopsylla*, such as *Plocopsylla* (*P.*) *phyllisae* Smit, 1953 and *Plocopsylla* (*S.*) *muruai* Beaucournu and Gallardo 2004, were also described on the bases of single male specimens. Moreover, as intraspecific variation in the morphology and chaetotaxy of sternite IX and the aedeagus, characters diagnostic of the *angusticeps–lewisi* complex, is unusual among fleas of this complex, we consider our evidence to be sufficient to support the designation of a new species, *P.* (*P.*) *linardii* sp. n.

The present study represents the first findings of species of the *angusticeps–lewisi* complex, including *P.* (*P.*) *linardii* sp. n., in San Juan Province. Although species of this complex are distributed mainly in the Andean region (Schramn & Lewis, 1988; Beaucournu & Kelt, 1990; Sanchez & Lareschi, 2013), this record in San Juan Province and the recent record in Salta Province (López Berrizbeitia *et al.*, 2013) confirm that the distribution range of the *angusticeps–lewisi* complex extends to the South American transition zone (Morrone, 2006).

Key to males of species of the *angusticeps–lewisi* complex

1. The movable process of the clasper shows a dorsal apex that is prominent, triangular, highly elongated and narrow, and a distal margin with three equidistant setae; sternite VIII is narrow, with an anteroventral angle and a long retrograde prolongation ... 2

1′ The movable process of the clasper shows a dorsal apex that is triangular, short and narrow or wide, with a distal margin with setae mainly located in the middle or in the apex; sternite VIII is either massive or narrow and shows an anteroventral angle and a small retrograde prolongation 3

2 The distal arm of sternite IX shows a triangular apex and bears three pigmented setae and one large unpigmented seta in the middle [Mahnert, 1982 (Fig. 3); Schramn & Lewis, 1988 (Fig. 7)] ..... *Plocopsylla* (*P.*) *angusticeps*

2′ The distal arm of sternite IX shows a triangular apex, with two heavily pigmented and three unpigmented setae (Fig. 5C) ..... *Plocopsylla* (*P.*) *silewi*

3 Sternite VIII is narrow, with a small retrograde anteroventral prolongation (Fig. 3A); the aedeagus shows an apical appendage that is short and triangular (Fig. 3B); the wall of the aedeagal pouch shows an anteroventral margin that is mildly sclerotized and forms a convex lobe (Fig. 3B) ..... *Plocopsylla* (*P.*) *lewisi*

3′ Sternite VIII is massive; the aedeagus shows an apical appendage that is somewhat reduced and button-shaped; the wall of the aedeagal pouch shows an anteroventral margin that is strongly sclerotized and forms a long projection 4

4 The median dorsal lobe of the aedeagus curves below the lateral plates and is markedly concave (Fig. 6E); the distal arm of sternite IX shows a narrow and rounded apex, with three small heavily pigmented setae and one large unpigmented seta (Fig. 6C) ..... *Plocopsylla* (*P.*) *linardii* sp. n.

4′ The median dorsal lobe of the aedeagus curves below the lateral plates to form a straight margin (Fig. 4B); the distal arm of sternite IX shows a straight apex with five or six pigmented setae and two more large unpigmented setae (Fig. 4C) ..... *Plocopsylla* (*P.*) *wilesi*

Discussion

In this study, we provide new characters of the male genitalia which can be used to distinguish each species included in the *angusticeps–lewisi* complex within the genus *Plocopsylla*. On the basis of these diagnostic characters, we describe a new species of this complex, *P.* (*P.*) *linardii* sp. n., and raise the hypothesis that *P.* (*P.*) *angusticeps* may be a senior synonym of *P.* (*P.*) *silewi*. Our results extend the geographic and host distributions of most of the fleas studied; *P.* (*P.*) *silewi* is reported from Argentina for the first time, and the southern limits of the distributions of *P.* (*P.*) *lewisi* and *P.* (*P.*) *wilesi* are established in Santa Cruz Province, thereby extending the known geographic range of both species 600 km to the south. In addition, the *angusticeps–lewisi* complex is registered for the first time in San Juan Province.

Some species of flea are able to transmit several infectious diseases to birds, rodents and other species of mammal, including domestic animals and humans (Linardi & Guimarães, 2000; Krasnov, 2008). Epidemiological studies have revealed that fleas in Argentina may be vectors of bubonic plague and murine typhus (Soria & Rossi de Capri, 1960; Boero, 1967; Nava *et al.*, 2008; Venzal & Nava, 2011).

The flea population of Argentina shows high diversity and includes around 120 species and subspecies, most of which are parasites of rodents (Autino & Lareschi, 1998; Beaucournu & Castro, 2003; Sanchez & Lareschi, 2013, 2014). Given that rodents are reservoirs of several zoonotic pathogens transmitted by fleas (Marshall, 1981; Linardi & Guimarães, 2000), the information provided in this study on the geographic and host distributions of fleas may be useful in epidemiological studies.

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