



# New records of Culicidae (Diptera) in agricultural oases of San Juan province, Argentina

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## Abstract

We report eight new Culicidae records from San Juan province, Argentina: *Anopheles argyritarsis* Robineau-Desvoidy, 1827; *Anopheles neomaculipalpus* Curry, 1931; *Culex acharistus* Root, 1927; *Culex apicinus* Philippi, 1965; *Culex maxi* Dyar, 1928; *Culex quinquefasciatus* Say, 1823; *Culex saltanensis* Dyar, 1928; and *Haemagogus spegazzinii* Brethes, 1912. The geographic distribution of *Aedes aegypti* (Linnaeus, 1762), *Aedes albifasciatus* (Macquart, 1838), *Anopheles pseudopunctipennis* Theobald, 1901, *Culex pipiens* Linnaeus, 1758, *Culex tramazayguesi* Duret, 1954, and *Psorophora cyanescens* (Coquillett, 1902) is extended. Data on collection localities, types of breeding sites and health importance are also presented.

## Keywords

Diversity, irrigated areas, mosquitoes.

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## Introduction

Factors associated with human behavior such as changes in the environment for productive purposes, transport and commercial activities, may impact on the distribution of insect species and, in particular, Culicidae (Stein et al. 2016b). Some regions, where annual precipitations are low (<150 mm), mainly depend on an irrigation system that enables a proper hydration of the crops grown there. Poor management of these systems, such as the overflow or obstruction of the irrigation channels, cause shallow water bodies that provide resources for the

development of immature stages of Culicidae (DAEUA 1970).

San Juan is a province located in the Central-West region of Argentina, with low rainfall rate (110 mm annually), and that concentrates human activity in agricultural oases under artificial irrigation, mostly located in the phytogeographic province of Monte (Neiman and Quaranta 2013) and isolated by deserted areas. Mosquito populations associated with these systems have historically caused discomfort to locals and workers of urban

and rural areas (Murúa et al. 2018). In 2011, 11 human cases of Saint Louis encephalitis were reported in this province, two of which were mortal (Fabbri et al. 2011; MSN 2011).

Previous papers, some older than 60 years, reported eight species of mosquitoes in San Juan with specific collection localities: *Anopheles pseudopunctipennis* Theobald, 1901 (Mazza and Basualdo 1938), *Aedes albifasciatus* (Macquart, 1838) (Duret 1954b), *Culex tramazayguesi* Duret, 1954 (Duret 1954a; Bachmann and Casal 1962), *Psorophora cyanescens* (Coquillett, 1902), *P. discrucians* (Walker, 1856) (Duret 1954b), *Cx. pipiens* Linnaeus, 1758 (Mitchell et al. 1984), *Cx. cuyanus* Duret, 1968 (Duret 1968), and *Ae. aegypti* (Linnaeus, 1762) (Carrizo Páez et al. 2016). Finally, Murúa et al. (2005) and Rossi (2015) also mentioned the occurrence of *Cx. apicinus* Philippi, 1965 and *Cx. saltanensis* Dyar, 1928 in the province, but did not provide the specific locality or any other reference data.

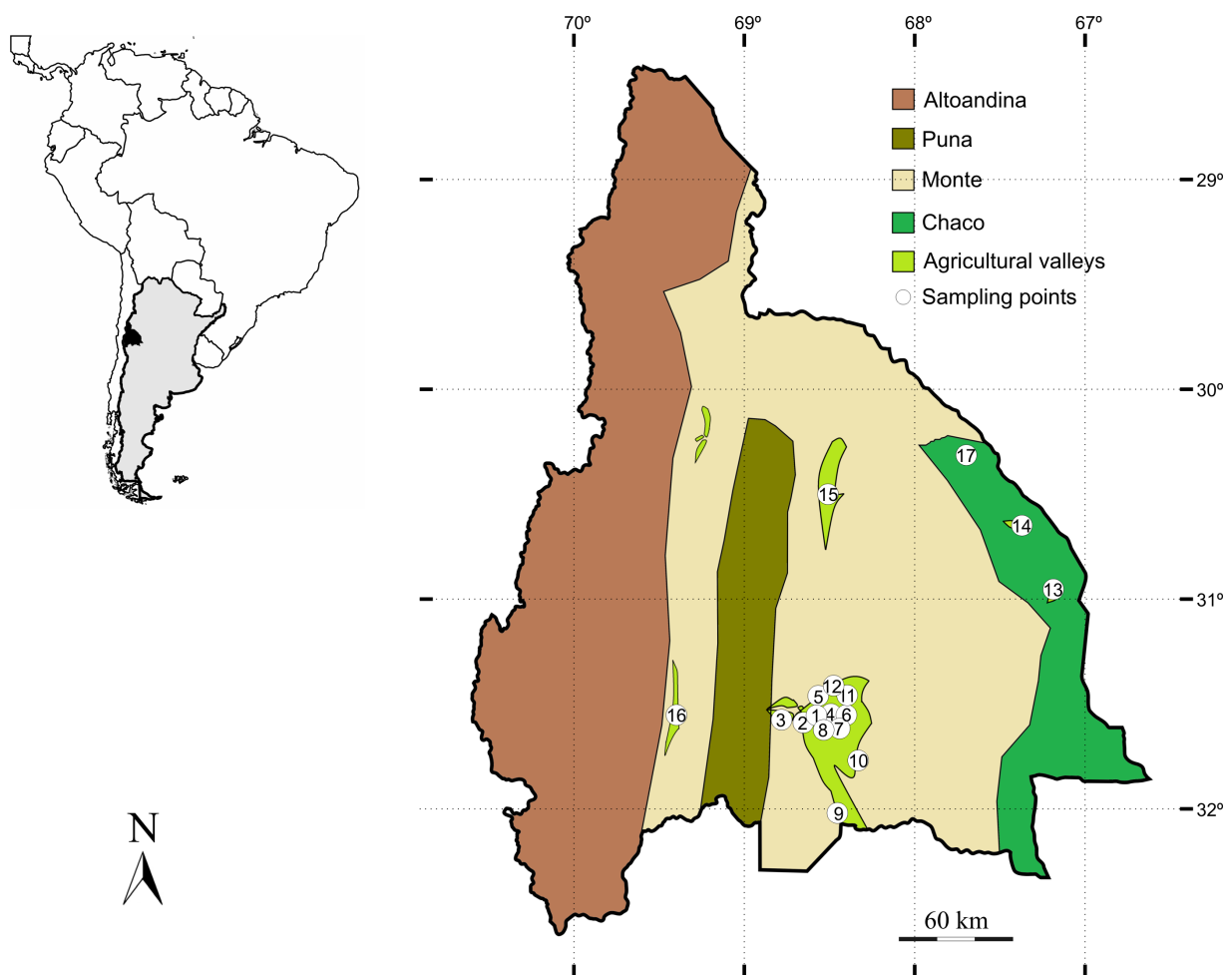
The present work aims to improve the knowledge of the Culicidae from San Juan, Argentina, including new records of species, additional data on the collection localities and types of breeding sites.

## Methods

The study area included 12 departments of the center and south of San Juan, located in the phytogeographic province of Monte, and one department of the east, located in the phytogeographic province of Chaco (Morello 1958; Márquez et al. 2014) (Fig. 1). San Juan has a desert climate, an average annual temperature of 17.2 °C, 110–400 mm of annual rainfall concentrated in the summer season and winds prevailing from the south (annually) and, to a lesser extent, from the north (July to September) (Poblete and Minetti 1999).

Immature stages of Culicidae were collected with a plastic dipper of 300 ml with handle, in natural and artificial, indoor and outdoor, permanent and transitory water bodies. First-instar larvae (L) were held in plastic trays of 500 ml with dechlorinated water until they reached the fourth larval instar. They were purged during 24 h, killed with water at 60 °C and kept in 70% ethanol for subsequent identification.

Adult specimens were obtained through occasional collections using manual suction tubes, and from individually reared immature stages. Adults were mounted



**Figure 1.** Study area and details of the main phytogeographic provinces of San Juan, Argentina (adapted from Márquez et al. 2016 and Arana et al. 2017). Main agricultural valleys and sampling points: 1, Capital; 2, Rivadavia; 3, Zonda; 4, Santa Lucía; 5, Chimbas; 6, San Martín; 7, 9 de Julio; 8, Pocito; 9, Sarmiento; 10, Caucete; 11, Angaco; 12, Albardón; 13, Las Tumanas; 14, Valle Fértil; 15, Jáchal; 16, Calingasta; and 17, Ischigualasto.

for subsequent identification. The voucher specimens are deposited in the entomological collection of the Cátedra de Diversidad de Invertebrados of the Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de San Juan, Argentina (CuUNSJ).

Specific identification was based on the keys of Dar- sie (1985), Forattini (1965), Lane (1953a, 1953b), and Rossi et al. (2002). Current descriptions were used for *Culex apicinus*, and *Cx. saltanensis* (Laurito et al. 2008; Rossi et al. 2008). In order to determine the members of the Pipiens complex, male genitalia (MG) were prepared and identified following Harbach (2012). Fourth-instar larval specimens were considered members of this complex due to the difficulty in differentiating species at this stage of development. Reinert (2009) was followed for genus and subgenus abbreviations.

## Results

Based on the morphological identification of the captured specimens, eight new records are reported from San Juan, including two species of *Anopheles* Meigen, 1818, five of *Culex* Linnaeus, 1758, and one of *Haemagogus* Williston, 1826. The geographic distribution of two species of *Aedes* Meigen, 1818, one of *Anopheles*, two of *Culex* and one of *Psorophora* Robineau-Desvoidy,

1827 is extended. Table 1 summarizes the new records presented in this work.

### *Anopheles argyritarsis* Robineau-Desvoidy, 1827

Figure 2A

**New records.** ARGENTINA • 3 L; San Juan province, Las Tumanas; 30°51'30"S, 067°19'40"W; 750 m a.s.l.; 18 Dec. 2016; F. Cano leg.; CuUNSJ001. • 9 ♀; San Juan province, Valle Fértil; 30°38'26"S, 067°29'56"W; 925 m a.s.l.; 08 Mar. 2018; L.M. Díaz Nieto, F. Cano, M. Miranda leg.; CuUNSJ002. • 3 L, 3 ♀; San Juan province, Valle Fértil; 30°40'43"S, 067°30'32"W; 961 m a.s.l.; 30 Mar. 2018; L.M. Díaz Nieto, F. Cano, M. Miranda leg.; CuUNSJ003, CuUNSJ004.

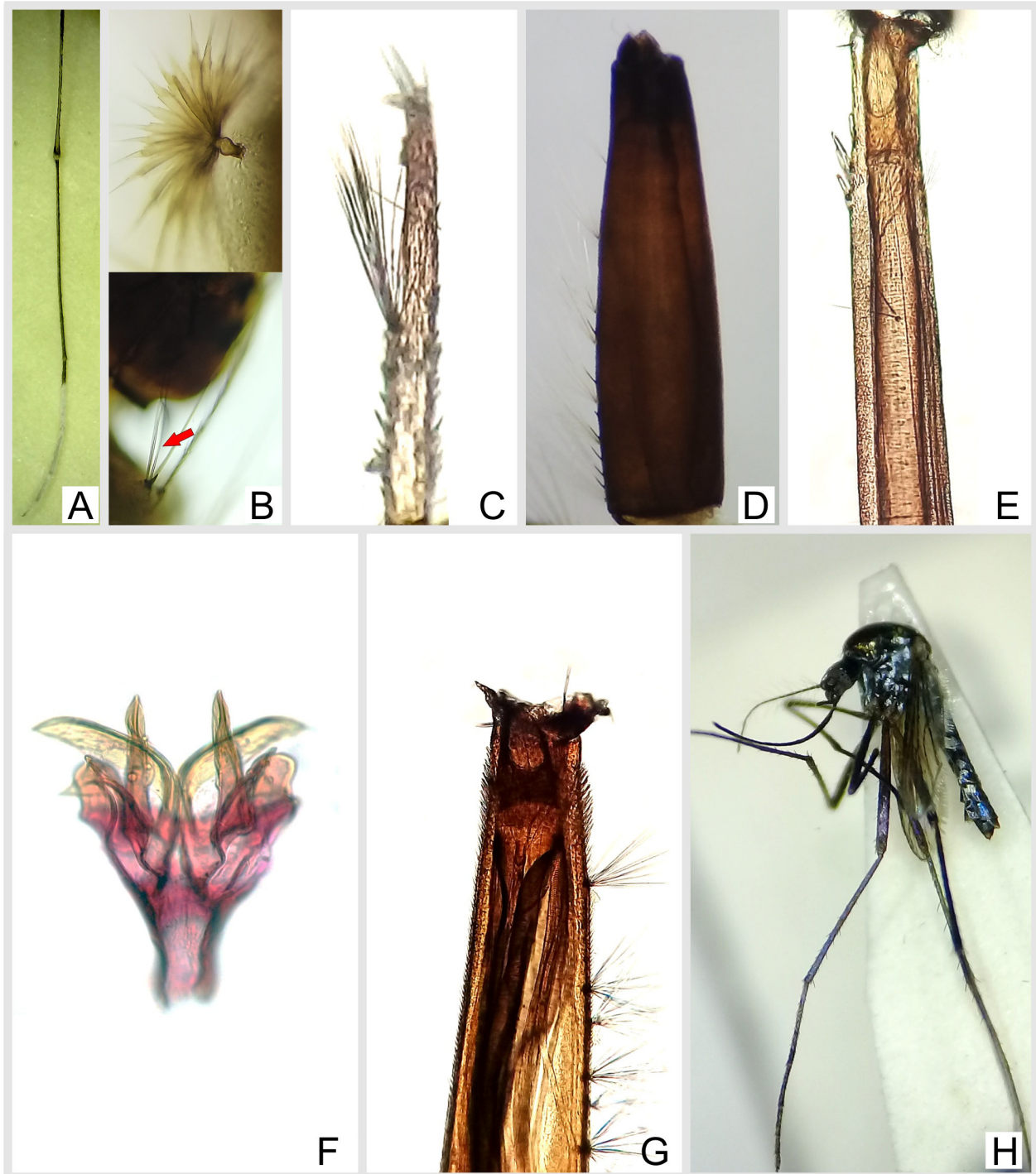
**Identification.** Females of *An. argyritarsis* are characterized by light scales on tarsomeres III–V; no stripes of white scales on sternum I; costa vein of the wing with a light humeral spot longer than the dark prehumeral spot; and white scales on the anterior wing sector.

**Current distribution in Argentina.** Buenos Aires, Catamarca, Chaco, Córdoba, Corrientes, Entre Ríos, Formosa, Jujuy, La Rioja, Misiones, Salta, San Luis, Santa Fe, Santiago del Estero, Tucumán (Rossi 2015) and San Juan (this study).

**Table 1.** Breeding sites where larval instars of mosquitoes were collected in San Juan, Argentina. DE: distribution expanded. NR: New records.

Species	Coordinates	Update	Species	Coordinates	Update
<i>Aedes aegypti</i>	31°32'53"S, 068°32'30"W	DE	<i>Culex maxi</i>	30°38'26"S, 067°29'56"W	NR
	31°32'38"S, 068°31'46"W	DE	<i>Culex pipiens</i> complex	31°19'57"S, 069°25'14"W	DE
	31°33'22"S, 068°30'23"W	DE		31°31'36"S, 068°32'22"W	DE
	31°41'13"S, 068°35'23"W	DE		31°37'41"S, 068°18'04"W	DE
<i>Aedes albifasciatus</i>	31°34'12"S, 068°23'06"W	DE	31°29'37"S, 068°31'57"W	DE	
	31°56'52"S, 068°27'48"W	DE	31°32'43"S, 068°25' 25"W	DE	
	31°49'18"S, 068°32'99"W	DE	31°39'23"S, 068°34'41"W	DE	
	31°36'12"S, 068°23'22"W	DE	31°31'51"S, 068°30'04"W	DE	
	31°30'12"S, 068°38'26"W	DE	31°32'48"S, 068°43'44"W	DE	
	31°30'38"S, 068°15'40"W	DE	<i>Culex quinquefasciatus</i>	31°33'23"S, 068°30'26"W	NR
	31°34'12"S, 068°26'03"W	DE		<i>Culex saltanensis</i>	31°32'43"S, 068°25'25"W
	30°37'36"S, 067°27'52"W	DE	31°38'43"S, 068°16'55"W		NR
30°37'25"S, 067°28'04"W	DE	31°33'07"S, 068°28'35"W	NR		
<i>Anopheles argyritarsis</i>	30°51'30"S, 067°19'40"W	NR	31°59'05"S, 068°26'07"W	NR	
	30°38'26"S, 067°29'56"W	NR	31°58'47"S, 068°25'48"W	NR	
	30°40'43"S, 067°30'32"W	NR	30°05'52"S, 067°55'12"W	NR	
<i>Anopheles neomaculipalpus</i>	30°51'30"S, 067°19'40"W	NR	30°38'11"S, 067°29'28"W	NR	
<i>Anopheles pseudopunctipennis</i>	30°40'43"S, 067°30'32"W	NR	31°33'57"S, 068°42'39"W	NR	
	31°27'11"S, 068°24'17"W	DE	<i>Culex tramazayguesi</i>	31°32'43"S, 068°25'25"W	DE
	30°38'26"S, 067°29'56"W	DE		31°33'48"S, 068°30'57"W	DE
30°40'43"S, 067°30'32"W	DE	31°58'45"S, 068°25'34"W		DE	
<i>Culex acharistus</i>	31°27'13"S, 068°24'16"W	NR	31°58'47"S, 068°25'47"W	DE	
	31°33'38"S, 068°27'41"W	NR	31°35'21"S, 068°44'01"W	DE	
	30°09'05"S, 068°34'39"W	NR	<i>Haemagogus spegazzinii</i>	30°51'51"S, 067°20'07"W	NR
	31°58'46"S, 068°25'53"W	NR		30°51'49"S, 067°19'18"W	NR
<i>Culex apicinus</i>	31°30'13"S, 068°38'27"W	NR	<i>Psorophora cyanescens</i>	31°37'41"S, 068°17'12"W	DE
	31°33'58"S, 068°42'39"W	NR		31°56'52"S, 068°27'48"W	DE
	30°09'05"S, 068°34'39"W	NR		31°56'52"S, 068°27'48"W	DE
	30°05'41"S, 067°55'01"W	NR		32°07'55"S, 068°27'33"W	DE
	30°37'13"S, 067°28'57"W	NR			
	30° 37'33"S, 067°28'34"W	NR			





**Figure 2.** Morphological details of some specimens. **A.** *Anopheles argyritarsis*, leg III. **B.** *Anopheles neomaculipalpus*: above, leaflets with serrate margins; down, red arrow indicates the single seta 9-P. **C.** *Culex acharistus* antenna, seta 1A is observed in the middle. **D.** *Culex apicinus* siphon. **E.** *Culex maxi* siphon, dorsal subapical spines are observed. **F.** *Culex quinquefasciatus*, male genitalia. **G.** *Culex saltanensis*, siphon with spicules covering it. **H.** *Haemagogus spegazzinii*, side view.

**Bionomic data.** Immature stages are mainly developed in puddles and occasionally in artificial breeding sites (Linthicum 1988; Rossi and Almirón 2004). Other authors reported captures on pools of water around rocks in streambeds, and on phytotelmata of *Aechmea distichantha* Lemaire, 1853 and *Vriesea friburgensis* var. *tucumanaensis* (Mez) L.B.Sm. 1952 (Veggiani and Rossi 2017). This paper reports larvae collection in natural breeding sites such as pools of water formed by overflowing rivers, and artificial ones such as disused swimming pools,

where they coexist with specimens of *Anopheles neomaculipalpus* Curry, 1931, *An. pseudopunctipennis*, and *Culex maxi* Dyar, 1928.

#### *Anopheles neomaculipalpus* Curry, 1931

Figure 2B

**New records.** ARGENTINA • 6 L; San Juan province, Las Tumanas; 30°51'30"S, 067°19'40"W; 750 m a.s.l.; 18 Dec. 2016; F. Cano leg.; CuUNSJ005. • 3 L; San Juan province, Valle Fértil; 30°40'43"S, 067°30'32"W; 691 m

a.s.l.; 08 Mar. 2018; L.M. Díaz Nieto, F. Cano; M. Miranda leg.; CuUNSJ006.

**Identification.** *Anopheles neomaculipalpus* larvae are characterized by setae I-III-V palmate, and leaflets with serrate margins, having seta 2-C thicker than seta 3-C, seta 9-P without branches, and usually simple setae 6-IV and V.

**Current distribution in Argentina.** Chaco, Corrientes, Formosa, Misiones, Salta, Santa Fe (Rossi 2015) and San Juan (this study).

**Bionomic data.** Stein et al. (2011) reported the presence of larvae in temporary pools. Dantur Juri et al. (2011) found this species in the edges of woods that had marshy areas, typical of cattle pasture. In this work, *An. neomaculipalpus* larvae were collected together with *An. argyritarsis*, *An. pseudopunctipennis* and *Culex maxi* larvae from natural and artificial breeding sites such as side-pools of rivers and disused swimming pools.

### *Culex acharistus* Root, 1927

Figure 2C

**New records.** ARGENTINA • 7 L; San Juan province, Santa Lucía; 31°33'38"S, 068°27'41"W; 588 m a.s.l.; 04 Oct. 2004; A. Molina leg.; CuUNSJ007. • 3 ♀; San Juan province, San Martín; 31°27'13"S, 068°24'16"W; 613 m a.s.l.; 28 Apr. 2009; F. Cano leg.; CuUNSJ008. • 14 ♀, 2 L; San Juan province, Jáchal; 30°09'05"S, 068°34'39"W; 1103 m a.s.l.; 10 Apr. 2016; A.F. Murúa leg.; CuUNSJ009, CuUNSJ010. • 12 ♀; San Juan province, Sarmiento; 31°58'46"S, 068°25'53"W; 574 m a.s.l.; 22 Feb. 2019; L.M. Díaz Nieto, F. Cano, A.F. Murúa leg.; CuUNSJ011.

**Identification.** *Culex acharistus* larvae differ from other *Culex* species in the insertion of seta 1-A near the middle of the antenna and the shape of the teeth of the mentum.

**Current distribution in Argentina.** Buenos Aires, Catamarca, Chubut, Córdoba, Corrientes, Jujuy, Misiones, Neuquén, Río Negro, Tucumán (Rossi 2015) and San Juan (this study).

**Bionomic data.** Linares et al. (2016) collected larvae from temporary rock pools free of vegetation and in the shade. Rossi and Almirón (2004) reported this species in artificial breeding sites such as disused tires, swimming pools and plastic and metal containers. In this work, larvae were collected together with *Cx. apicinus* specimens in natural, permanent, and semipermanent bodies of water including ditches and pools created by overflowing rivers and the rising water table.

### *Culex apicinus* Philippi, 1965

Figure 2D

**New records.** ARGENTINA • 3 L; San Juan province, Santa Lucía; 31°30'13"S, 068°38'27"W; 610 m a.s.l.; 27 Sep. 2004; A.F. Murúa, A. Molina, S. Díaz leg.; CuUNSJ012. • 20 L; San Juan province, Zonda; 31°33'58"S, 068°42'39"W; 772 m a.s.l.; 10 Nov. 2005; F. Cano leg.; CuUNSJ013. • 44 L; San Juan province, Jáchal;

30°09'05"S, 068°34'39"W; 1103 m a.s.l.; 10 Apr. 2016; A.F. Murúa leg.; CuUNSJ014. • 22 L; San Juan province, Valle Fértil, Ischigualasto; 30°05'41"S, 067°55'01"W; 1249 m a.s.l.; 22 Sep. 2002; F. Cano leg.; CuUNSJ015. • 66 L; San Juan province, Valle Fértil; 30°37'13"S, 067°28'57"W; 891 m a.s.l.; 10 Feb. 2014; G. Blanco leg.; CuUNSJ016. • 1 L, San Juan province, Valle Fértil; 30°37'33"S, 067°28'34"W; 866 m a.s.l.; 20 Jan. 2004; F. Cano leg.; CuUNSJ017.

**Identification.** *Culex apicinus* larvae present seta 1-S in five or more pairs, seta 1a-S inserted between the pecten teeth, the siphon index lower than four, and highly sclerotized head, siphon and saddle.

**Current distribution in Argentina.** Buenos Aires, Catamarca, Chubut, Córdoba, Corrientes, Jujuy, La Pampa, La Rioja, Mendoza, Misiones, Neuquén, Río Negro, Salta, San Luis, Santa Cruz, Santa Fe, Tucumán (Rossi 2015) and San Juan (this study).

**Bionomic data.** The immature stages of this species are frequently found in artificial breeding sites and, to a lesser extent, in natural ones (Almirón and Brewer 1996). In this work, specimens were collected from artificial water sources such as flowing artesian wells, adding a new breeding site to those already described by other authors who mentioned swimming pools, cemetery vases and tires, and different types of outdoor containers with rainwater (Díaz-Nieto et al. 2013; Rossi and Almirón 2004). Coinciding with Veggiani and Rossi (2017), *Cx. apicinus* larvae were also collected together with *Cx. acharistus* larvae from natural bodies of water such as side-pools of rivers.

### *Culex maxi* Dyar, 1928

Figure 2E

**New records.** ARGENTINA • 5 L; San Juan province, Valle Fértil; 30°38'26"S, 067°29'56"W; 925 m a.s.l.; 13 Dec. 2017; F. Cano leg.; CuUNSJ018.

**Identification.** *Culex maxi* larvae are characterized by a siphon with 2–4 small subapical spines on the dorsal side.

**Current distribution in Argentina.** Buenos Aires, Catamarca, Chaco, Córdoba, Corrientes, Entre Ríos, Formosa, Jujuy, La Pampa, La Rioja, Misiones, Salta, Santa Fe, Santiago del Estero, Tucumán (Rossi 2015) and San Juan (this study).

**Bionomic data.** They develop in a great variety of water bodies that include temporary and permanent, natural and artificial pools (Almirón and Harbach 1996). Stein et al. (2011) collected larvae in natural breeding sites in the presence or absence of grasses. Other authors collected immature stages from disused tires, swimming pools, and metal and concrete containers (Campos et al. 1993; Almirón and Brewer 1996). Coinciding with these authors, larvae were collected from a disused swimming pool coexisting with *Anopheles argyritarsis*, *An. neomaculipalpus* and *An. pseudopunctipennis* larvae.

***Culex quinquefasciatus* Say, 1823**

Figure 2F

**New records.** ARGENTINA • 10 MG; San Juan province, Rawson; 31°33'23"S, 068°30'26"W; 617 m a.s.l.; 17 Mar. 2018; L.M. Díaz Nieto leg.; CuUNSJ019.

**Identification.** *Culex quinquefasciatus* can be distinguished from the other species of the Pipiens complex by the male genitalia with a minimum DV/V ratio of 0.4, and parallel and tapered dorsal arms.

**Current distribution in Argentina.** Buenos Aires, Catamarca, Chaco, Córdoba, Corrientes, Entre Ríos, Formosa, Jujuy, La Pampa, La Rioja, Mendoza, Misiones, Salta, San Luis, Santa Fe, Santiago del Estero, Tucumán (Rossi 2015) and San Juan (this study).

**Bionomic data.** This species develops mainly in artificial breeding sites, such as ditches, sewers and pools with superficial water (Stein et al. 2011, 2016b; Grech et al. 2013). Nevertheless, Almirón and Brewer (1996) reported collections in natural habitats with aquatic vegetation. In this work, larvae were collected from artificial ditches with permanent water of the urban irrigation system, a new type of breeding site.

***Culex saltanensis* Dyar, 1928**

Figure 2G

**New records.** ARGENTINA • 13 L; San Juan province, 9 de Julio; 31°32'43"S, 068°25'25"W, 610 m a.s.l.; 8 May. 2002; A.F. Murúa, M. Bilbao, O. Mañá leg.; CuUNSJ020. • 2 L; San Juan province, Caucete; 31°38'43"S, 068°16'55"W; 580 m a.s.l.; 4 Mar. 2005; A.F. Murúa, M. Bilbao, O. Mañá leg.; CuUNSJ021. • 2 L; San Juan province, Santa Lucia; 31°33'07"S, 068°28'35"W; 620 m a.s.l.; 11 Mar. 2005; A.F. Murúa, M. Bilbao, O. Mañá leg.; CuUNSJ022. • 4 L; San Juan province, Zonda; 31°33'57"S, 068°42'39"W; 770 m a.s.l.; 24 Nov. 2005; F. Cano leg.; CuUNSJ023 • 10 L; San Juan province, Sarmiento; 31°59'05"S, 068°26'07"W; 552 m a.s.l.; 22 Feb. 2019; A.F. Murúa, F. Cano, L.M. Díaz Nieto leg.; CuUNSJ024 • 2 L; San Juan province, Sarmiento; 31°58'47"S, 068°25'48"W; 552 m a.s.l.; 22 Feb. 2019; A.F. Murúa, F. Cano, L.M. Díaz Nieto leg.; CuUNSJ025. • 2 L; San Juan province, Valle Fértil, Ischigualasto; 30°05'52"S, 067°55'12"W; 1275 m a.s.l.; 11 Oct. 2005; F. Cano leg.; CuUNSJ026. • 5 ♂, San Juan province, Valle Fértil; 30°38'11"S, 067°29'28"W; 975 m a.s.l.; 30 Mar. 2018; F. Cano leg.; CuUNSJ027.

**Identification.** *Culex saltanensis* larvae are recognized by the presence of spicules in the apical third of the siphon.

**Current distribution in Argentina.** Catamarca, Chaco, Córdoba, Corrientes, Formosa, La Pampa, La Rioja, Misiones, Salta, Santa Fe, Santiago del Estero, Tucumán (Rossi 2015) and San Juan (this study).

**Bionomic data.** Almirón and Brewer (1996) found larvae in different natural environments. Linares et al. (2016) reported collections in concrete ponds with high sun exposure and green water due to the presence of algae and organic matter in suspension. In this work,

larvae were collected from natural and artificial breeding sites coexisting with *Aedes albifasciatus* larvae. We report two new breeding sites: disused tires and pools of water created by excessive urban irrigation.

***Haemagogus spegazzinii* Brethes, 1912**

Figure 2H

**New records.** ARGENTINA • 1 ♀; San Juan province, Las Tumanas; 30°51'51"S, 067°20'07"W; 791 m a.s.l.; 15 Jan 2005; F. Cano leg.; CuUNSJ028. • 2 ♀; San Juan province, Las Tumanas; 30°51'49"S, 067°19'18"W; 732 m a.s.l.; 11 Jan. 2016; A.F. Murúa leg.; CuUNSJ029.

**Identification.** Females are characterized by a scutum with metallic green, blue, coppery or bronze scales, and by the absence or weak development of the lower meso-katepisternal setae.

**Current distribution in Argentina.** Catamarca, Chaco, Córdoba, Corrientes, Formosa, Jujuy, Mendoza, Misiones, Salta, San Luis, Santa Fe, Santiago del Estero, Tucumán (Rossi 2015) and San Juan (this study).

**Bionomic data.** These larvae develop in water bodies of natural environments such as holes in trees and rocks (Lane 1953b). Campos and Gleiser (2016) affirmed that adults do not have anthropophilic behavior and are captured during daylight hours. In this work, adult specimens were only captured in the afternoon, corroborating their statement.

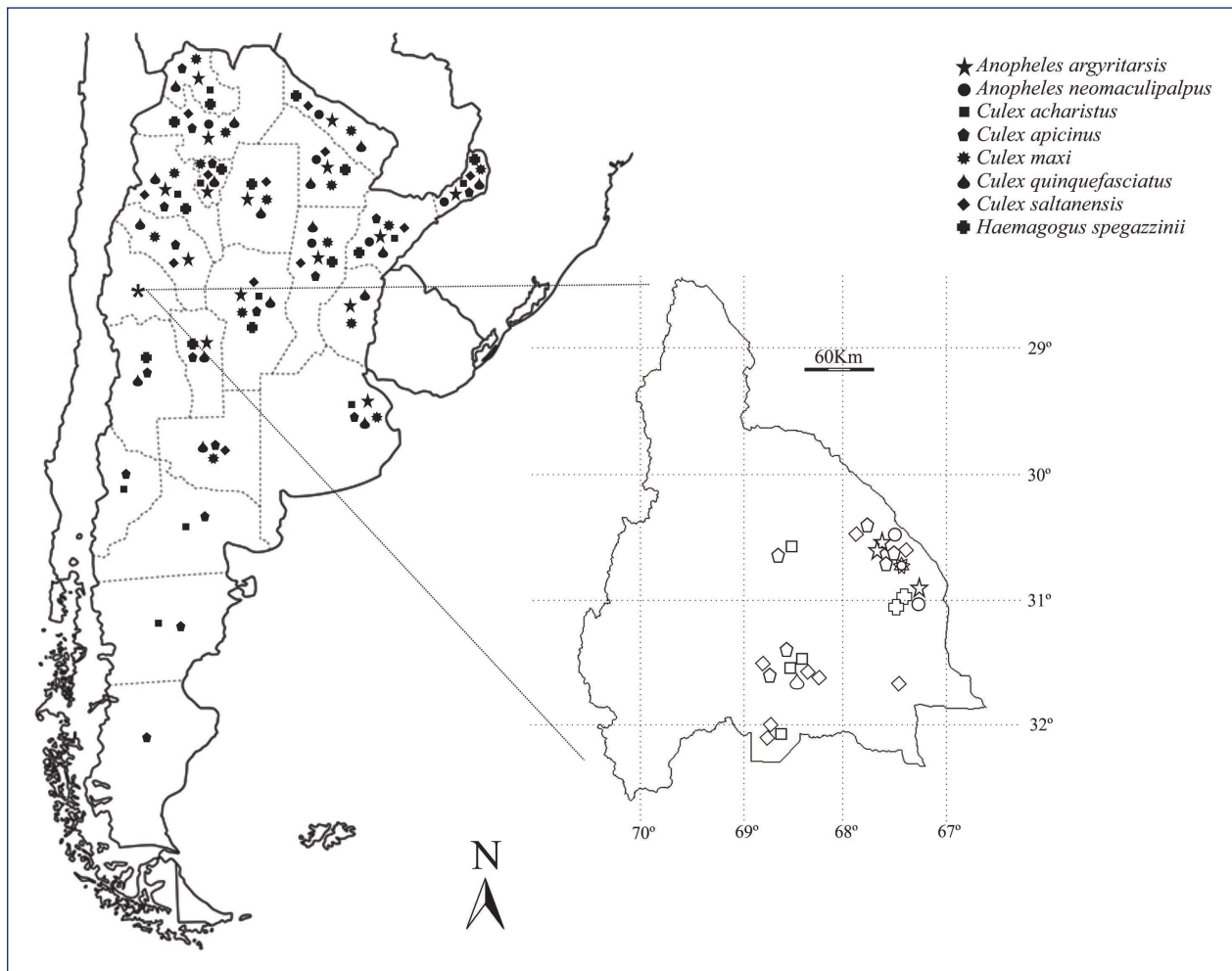
**Discussion**

Knowledge of diversity and distribution of mosquitoes is necessary to understand the dynamic of the transmission of vector-borne pathogens, which in turn contributes to the implementation of appropriate population management programs. From a total of 246 species of Culicidae recorded from Argentina (Stein et al. 2018), the Cuyo region is represented by approximately 12% (Stein et al. 2016a) and San Juan by approximately 3%. This, coupled with the fact that some records from San Juan go back over six decades with species that have only had one record to date, results in the need to fill the gap about distribution of Culicidae in this region. This paper updates the knowledge of the Culicidae distribution in Argentina, adding new records of eight species from San Juan (Fig. 3), expanding the distribution of six previously recorded species, and including additional information about the collection locality for all collected species.

*Anopheles neomaculipalpus* is associated with humid environments in the Northeast and, more restricted way, in the Center and Northwest of Argentina. This study moves the boundary of the known geographic area to a new region, Cuyo, which is more arid than its original location. In relation to *An. argyritarsis*, this study provides a locality at the southern limit of its wide distribution in the north and center of the country (Stein et al. 2016a).

The recorded species of *Culex* generally follow to the known geographical distribution for the genus (Stein





**Figure 3.** New records of the mosquito species from San Juan (white symbols), and their previous occurrences (black symbols) in Argentina.

et al. 2016a). The new record of *Cx. quinquefasciatus*, identified through observations of male genitalia, was already expected due to the previously known distribution of this species in Argentina and its relation with *Cx. pipiens* (Almirón et al. 1995; Diez et al. 2012; Cardo et al. 2016). In relation to *Culex apicinus* Philippi, 1965 and *Cx. saltanensis* Dyar, 1928, their previous records from San Juan are not considered valid due to the lack of specific information of their collection localities by Murúa et al. (2005) and Rossi (2015). In this work, *Cx. apicinus* presents close records in neighboring provinces, while *Cx. saltanensis* is the first record in the region (Stein et al. 2016a).

*Haemagogus spegazzinii*, which breeds exclusively in fitotelmata, is the southernmost species of the genus; with its finding in San Juan, this study extends its occurrence to the entire region of Cuyo (Campos and Gleiser 2016).

Regarding the species with expanded distribution in the province, some are important for public health since they are vectors of pathogens that cause diseases in animals and humans, such as: *Aedes aegypti*, well-known vector of Dengue, Zika and Chikungunya viruses and yellow fever; *Ae. albifasciatus*, vector of the Western equine encephalitis virus; *Cx. quinquefasciatus*, vector of the Saint Louis encephalitis virus (Contigiani et al. 2016);

and *Anopheles pseudopunctipennis*, vector of the parasite that causes malaria (Dantur Juri and Zaidenberg 2016).

From our findings and previous citations, the culicid fauna of San Juan Province consists of 16 species: *Aedes aegypti*, *Ae. albifasciatus*, *Anopheles argyritarsis*, *An. neomaculipalpus*, *An. pseudopunctipennis*, *Culex acharistus*, *Cx. apicinus*, *Cx. cuyanus*, *Cx. maxi*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. saltanensis*, *Cx. tramazayguesi*, *Haemagogus spegazzinii*, *Psorophora cyanescens*, and *Ps. discruciens*.

It is important to highlight that environmental changes, resulting from anthropic intervention, favor the establishment and distribution of Culicidae. In this sense, this paper shows that 62% of the breeding sites identified (32 of 52) were of anthropic origin, and 94% of the collected species (13 of 14) were found in breeding sites created due to poor water management. This information will be useful to provincial and national agencies in charge of vector control. Upcoming studies will surely enlarge this list of species and their breeding sites.

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## Authors' Contributions

AFM developed the research project that resulted in the article. LMDN, ML and WRA identified the specimens. AFM, LMDN, FAC, and LS participated in the collection of specimens. LMDN photographed and edited the images. AFM and LMDN wrote the text and AFM, LMDN, FAC, ML, WRA and LS read, made suggestions and accepted the last version of the manuscript.

## References

- Almirón WR, Brewer ME (1996) Classification of immature stage habitats of Culicidae (Diptera) collected in Córdoba, Argentina. *Memórias do Instituto Oswaldo Cruz* 91 (1): 1–9. <https://doi.org/10.1590/S0074-02761996000100001>
- Almirón WR, Harbach RE (1996) Taxonomy and biology of *Culex (Culex) maxi* Dyar (Diptera: Culicidae) in South America. *Memórias do Instituto Oswaldo Cruz* 91 (5): 579–588. <https://doi.org/10.1590/S0074-02761996000500008>
- Almirón WR, Humeres SG, Gardenal CN (1995) Distribution and hybridization between *Culex pipiens* and *Culex quinquefasciatus* (Diptera: Culicidae) in Argentina. *Memórias do Instituto Oswaldo Cruz* 90: 469–473. <https://doi.org/10.1590/S0074-02761995000400007>
- Bachmann AO, Casal OH (1962) Mosquitos argentinos que crían en aguas salobres y saladas. *Revista de la Sociedad Entomológica Argentina* 25 (1–4): 21–27.
- Campos RE, Gleiser RM (2016) Mosquitos que crían en microambientes acuáticos naturales. In: Berón CM, Campos RE, Gleiser RM, Díaz Nieto LM, Salomón OD, Schweigmann N (Eds) Investigaciones sobre mosquitos de Argentina. Universidad Nacional de Mar del Plata, Mar del Plata, 119–141.
- Campos RE, Maciá A, García JJ (1993) Fluctuaciones estacionales de culicidos (Diptera) y sus enemigos naturales en zonas urbanas de los alrededores de La Plata, provincia de Buenos Aires. *Neotropica* 39 (101–102): 55–66.
- Cardo MV, Rubio A, Junges M, Vezzani D, Carbajo AE (2016) Distribution of the members of the Papiens Assemblage in the sympatric area from Argentina: which is where and when? *Memórias do Instituto Oswaldo Cruz* 111 (11): 676–685. <https://doi.org/10.1590/0074-02760160148>
- Carrizo Páez RE, Carrizo Páez MA, Murúa AF (2016) Primer registro de *Aedes aegypti* (Diptera: Culicidae) en San Juan, Argentina. *Revista de la Sociedad Entomológica Argentina* 75 (1–2): 93–95.
- Contigiani MS, Diaz LA, Spinsanti LI, Tauro LB (2016) Arbovirus. In: Berón CM, Campos RE, Gleiser RM, Díaz Nieto LM, Salomón OD, Schweigmann N (Eds) Investigaciones sobre mosquitos de Argentina. Universidad Nacional de Mar del Plata, Mar del Plata, 157–178.
- DAEUA, Departamento de Agricultura de los Estados Unidos de America (1970) Control de Mosquito en Granjas de Riego. *Manual de Agricultura* N° 319. Organización Mundial de la Salud, Whashington, 34 pp.
- Dantur Juri MJ, Stein M, Mureb Sallum MA (2011) Occurrence of *Anopheles (Anopheles) neomaculipalpus* Curry innorth-western Argentina. *Journal of Vector Borne Diseases* 48: 64–66.
- Dantur Juri MJ, Zaidenberg M (2016) Malaria en Argentina. In: Berón CM, Campos RE, Gleiser RM, Díaz Nieto LM, Salomón OD, Schweigmann N (Eds) Investigaciones sobre mosquitos de Argentina. Universidad Nacional de Mar del Plata, Mar del Plata, 179–191.
- Darsie RF Jr (1985) Mosquitoes of Argentina. Part I. Keys for identification of adult females and fourth stage larvae in english and spanish (Diptera, Culicidae). *Mosquito Systematics* 17 (3): 153–362.
- Diez F, Bresler JV, Quirán EM, Rossi GC (2012) Hybrid forms of the *Culex pipiens* complex (Diptera: Culicidae): new records in La Pampa Province, Argentina. *Check List* 8 (2): 251–253. <https://doi.org/10.15560/8.2.251>
- Díaz-Nieto LM, Maciá A, Parisi G, Farina JL, Vidal-Domínguez ME, Perotti MA, Berón CM (2013) Distribution of mosquitoes in the South East of Argentina and first report on the analysis based on 18S rDNA and COI sequences. *PloS ONE* 8 (9): e75516. <https://doi.org/10.1371/journal.pone.0075516>
- Duret JP (1954a) Nuevo mosquito argentino. *Neotropica* 1 (2): 23–26.
- Duret JP (1954b) Datos sobre culicidos de la región cuyana (Diptera: Culicidae). *Revista de Sanidad Militar Argentina* 53 (2): 12–13.
- Duret JP (1968) Dos especies nuevas de *Culex (Culex)* de la Argentina (Diptera, Culicidae). *Physis* 27 (75): 323–328.
- Fabbri CM, Morales MA, Luppo VC, Cappato Berger F, Balanitra B, Manrique M, Fierro F, Goenaga S, Enria DA, Levis SC (2011) Brote de encefalitis de San Luis en la Provincia de San Juan, Argentina. *Revista Argentina de Microbiología* 1: 89.
- Forattini OP (1965) *Entomología Médica*. 2° Volume. Culicini: *Culex, Aedes e Psorophora*. Universidade de São Paulo, São Paulo, 506 pp.
- Grech M, Sartor P, Estallo E, Ludueña-Almeida F, Almirón W (2013) Characterisation of *Culex quinquefasciatus* (Diptera: Culicidae) larval habitats at ground level and temporal fluctuations of larval abundance in Córdoba, Argentina. *Memórias do Instituto Oswaldo Cruz* 108 (6): 772–777. <https://doi.org/10.1590/0074-0276108062013014>
- Harbach RE (2012) *Culex pipiens*: species versus species complex—taxonomic history and perspective. *Journal of the American Mosquito Control Association* 28 (4 suppl): 10–24. <https://doi.org/10.2987/8756-971X-28.4.10>
- Lane J (1953a) Neotropical Culicidae: Dixinae, Chaoborinae and Culicinae; Tribes Anophelini, Toxorhynchitini and Culicini (genus *Culex* only). Vol. 1. Universidade de São Paulo, São Paulo, 548 pp.
- Lane J (1953b) Neotropical Culicidae, Vol. 2. Tribe Culicini, *Deinocerites, Uranotaenia, Mansonia, Orthopodomyia, Aedeomyia, Aedes, Psorophora, Haemagogus*, tribe Sabethini, *Trichoprosopon, Wyeomyia, Phoniomyia, Limatus* and *Sabethes*. Universidade de São Paulo, São Paulo, 1112 pp.
- Laurito M, Visintin AM, Almirón WR (2008) *Culex saltanensis* morphological redescription of the immature and adult stages. *Journal of the American Mosquito Control Association* 24 (2): 203–211. <https://doi.org/10.2987/5641.1>
- Linares MA, Laurito M, Visintin AM, Rossi GC, Stein M, Almirón WR (2016) New mosquito records (Diptera: Culicidae) from northwestern Argentina. *Check List* 12 (4): 1–8. <https://doi.org/10.15560/12.4.1944>
- Linthicum KJ (1988) A revision of the Argyritarsis section of the subgenus *Nyssorhynchus* of *Anopheles* (Diptera: Culicidae). *Mosquito Systematics* 20 (2): 98–271.



- Márquez J, Ripoll Y, Dalmazzo A, Arizza M, Jordán M (2014) Árboles nativos de la Provincia de San Juan. Universidad Nacional de San Juan, San Juan, 78 pp.
- Mazza S, Basualdo C (1938) Caso autóctono de paludismo comprobado en el Dept. Albardón, Prov. San Juan. Presencia de *Anopheles pseudopunctipennis* en la región. Misión de Estudios de Patología Regional Argentina 35: 17–20.
- Mitchell CJ, Darsie RF, Monath MD (1984) Occurrence of autogenous *Culex pipiens* Linnaeus, 1758 (Diptera: Culicidae) in Argentina and notes on distribution of the complex. Mosquito Systematics 16 (4): 308–316.
- Morello J (1958) La Provincia Fitogeográfica del Monte. Opera Lilloana 2: 1–155.
- MSN, Ministerio de Salud Pública de La Nación (2011) Probable Brote de Encefalitis por flavivirus, en la provincia de San Juan. <https://www.sadi.org.ar/publicaciones/item/71-alerta-casos-de-encefalitis-por-flavivirus>. Accessed on: 2011-3-28.
- Murúa F, Almirón W, Bilbao ML, Mañá MO, Díaz S, Molina A, Cano F (2005) Inventario de mosquitos (Diptera: Culicidae) de la ciudad de San Juan (Argentina). Revista Sociedad Entomológica Argentina 64 (4): 566–567.
- Murúa F, Díaz Nieto LM, Cano F (2018) Arañas, Alacranes y Mosquitos de Importancia Sanitaria en San Juan. Explorando caminos de encuentro con la naturaleza. Universidad Nacional de San Juan, San Juan, 114 pp.
- Neiman GS, Quaranta GJ (2013) Eventualidad y movilización de la mano de obra en el contexto de la restructuración de la agricultura de la provincia de San Juan. Población & Sociedad 20 (1): 77–98.
- Poblete AG, Minetti JL (1999) Configuración espacial del clima de San Juan. In: Universidad Nacional de San Juan (Eds) Síntesis del Cuaternario de la Provincia de San Juan. XI Reunión de campo del CADINQUA. Universidad Nacional de San Juan, San Juan, 1–14.
- Reinert JF (2009) List of abbreviations for currently valid generic-level taxa in family Culicidae (Diptera). European Mosquito Bulletin 27: 68–76.
- Rossi GC (2015) Annotated checklist, distribution, and taxonomic bibliography of the mosquitoes (Insecta: Diptera: Culicidae) of Argentina. Check List 11 (4): 1–15. <https://doi.org/10.15560/11.4.1712>
- Rossi GC, Almirón WR (2004) Clave ilustrada para la identificación de larvas de mosquitos de interés sanitario encontradas en criaderos artificiales en la Argentina. Série Enfermedades Transmisibles, Publicación Monográfica 5. Fundación Mundo Sano, Buenos Aires, 53 pp.
- Rossi GC, Mariluis JC, Schnack JA, Spinelli GR (2002) Dípteros vectores (Culicidae y Calliphoridae) de la provincia de Buenos Aires. CoBioBo 4, Probiota 3: 1–45.
- Rossi GC, Laurito M, Almirón WR (2008) Morphological description of the pupa and redescription of the adults and larva of *Culex (Culex) apicinus* Philippi (Diptera: Culicidae). Zootaxa 1941 (1): 31–42. <https://doi.org/10.11646/zootaxa.1941.1.3>
- Stein M, Ludueña-Almeida F, Willener JA, Almirón WR (2011) Classification of immature mosquito species according to characteristics of the larval habitat in the subtropical province of Chaco, Argentina. Memórias do Instituto Oswaldo Cruz 106 (4): 400–407. <https://doi.org/10.1590/S0074-02762011000400004>
- Stein M, Rossi GC, Almirón WR (2016a) Distribución geográfica de Culicidae de Argentina. In: Berón CM, Campos RE, Gleiser RM, Díaz Nieto LM, Salomón OD, Schweigmann N (Eds) Investigaciones sobre mosquitos de Argentina. Universidad Nacional de Mar del Plata, Mar del Plata, 47–56.
- Stein M, Santana M, Galindo LM, Etchepare E, Willener JA, Almirón WR (2016b) Culicidae (Diptera) community structure, spatial and temporal distribution in three environments of the province of Chaco, Argentina. Acta Tropica 156: 57–67. <https://doi.org/10.1016/j.actatropica.2015.12.002>
- Stein M, Alvarez CN, Alonso AC, Bangher DN, Willener JA, Campos RE (2018) New records of mosquitoes (Diptera: Culicidae) found in phytotelmata in northern Argentina. Zootaxa 4399 (1): 87–100. <https://doi.org/10.11646/zootaxa.4399.1.5>
- Veggiani CA, Rossi GC (2017) Mosquitoes (Diptera: Culicidae) of the meridian zone of the subtropical mountainous rainforest of Argentina: update on the fauna and geographical distribution. Check List 13 (2): 1–13. <https://doi.org/10.15560/13.2.2102>