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PENSOFT

Filling gaps in flower fly distributions: first record of *Aneriophora aureorufa* (Philippi, 1865) (Diptera, Syrphidae) from Argentina

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Abstract
The genus *Aneriophora* Stuardo & Cortés 1952, previously considered endemic to Chile, is recorded for the first time from Argentina. Specimens of *Aneriophora aureorufa* (Philippi, 1865) were collected in Neuquén Province and deposited in the entomological collection of the Instituto Argentino de Zonas Áridas, Mendoza, Argentina. A diagnosis, distribution map, and photographs of *A. aureorufa* are provided.

Key words
Eristalinae, hoverflies, Neotropical Region, new record, Patagonia.

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Introduction

Syrphidae is one of the most diverse and ubiquitous families in Diptera, comprising more than 200 genera and over 6,000 described species worldwide (Brown 2009, Pape and Thompson 2019). Adults of flower fly are key pollinators in crops and natural ecosystem (Ssymank et al. 2008, Lander et al. 2009, Inouye et al. 2015) and their larvae are predators, parasitoids, saprophagous, mycophagous, and phytophagous (Rotheray and MacGowan 2000, Rotheray et al. 2001, Weng and Rotheray 2008, Reemer and Rotheray 2009, Ureña and Hanson 2010, Mengual and Thompson 2011, Rotheray and Gilbert 2011, Zuijen and Nishida 2011, Pérez-Lachaud et al. 2014, Jordaens et al. 2015, Dumbardon-Martial 2016, Fleischmann et al. 2016). Due to their ecological functions, flower fly larvae are used as biological control agents of pests in greenhouses and crops (White et al. 1995, Pineda and Marcos-García 2008, Fidelis et al. 2018) and help as decomposers of organic matter (Lardé 1989, Rotheray et al. 2009, Martínez-Falcón et al. 2012). Furthermore, adults and larvae are good bioindicators of the quality of environments and ecosystems (Sommaggio 1999, Burgio and Sommaggio 2007, Sommaggio and Burgio 2014, Popov et al. 2017).

Despite the high diversity of flower flies in the

Neotropical region, with 60 genera and over 2,000 species (Thompson et al. 2010), studies focused exclusively on flower flies are still few and many flower flies await to be described, as well as their larval morphology and biology (Thompson et al. 1976, Thompson 1999, Amorim 2009). For Argentina, faunistic checklist and new records are sporadic and until now, 170 species belonging to 38 genera have been reported (Thompson et al. 1976, Montoya et al. 2012). The first Diptera inventory for Argentina was done by Lynch-Arribálzaga (1891–1892), followed by a catalogue of Argentine dipterans by Brèthes (1907). Much later, Fluke (1956, 1957) included the Argentine Syrphidae in his Neotropical catalogue. Thereafter, short revisions, taxonomic works, and geographic records of Argentine syrphids have been published (Shannon 1927a, 1927b, Shannon and Aubertin 1933, Blanchard 1938, Lane 1963, Lagrange 1987a, 1987b, Lagrange 1989, Lagrange 1990a, 1990b, Lagrange 1992, Kassebeer 1999, Wakeham-Dawson et al. 2009, Mengual 2011, López-García and Maza 2013, Mengual and López-García 2015, Mengual 2017). In contrast, the flower fly fauna of Chile is the most studied in South America in terms of taxonomic treatment (Blanchard 1852, Philippi 1865, Shannon 1927b, Shannon and Aubertin 1933, Stuardo-Ortiz 1946, Etcheverry 1963). Currently, 123 species and 42 genera are known (Thompson et al. 1976, Montoya et al. 2012, Barahona-Segovia pers. com.). Although they are neighbors, Argentina and Chile have a quite different fauna. Argentina and Chile share around 32.6% of the flower fly species (Thompson 1972, Thompson and Thompson 2006, Montoya et al. 2012). Then endemic genera are present only in Chile, including *Aneriophora* Stuardo & Cortés, 1952 (Thompson 1972, Thompson et al. 1976, Thompson 1999, Polidori et al. 2013, Barahona-Segovia et al. 2016).

The monotypic genus *Aneriophora* (Syrphidae, Eristalinae, Milesiini), with the species *Aneriophora aureorufa* (Philippi, 1865), is distributed between the regions of Maule and Aysén in Chile (Thompson et al. 1976, Barahona-Segovia et al. 2016, Alaniz et al. 2018). These regions represent 5 different geographical areas where *A. aureorufa* occurs: Nahuelbuta, Araucanía foothills, Valdivian coast, Los Lagos Andean foothills, and Chiloé (Barahona-Segovia et al. 2016, Alaniz et al. 2018). Adults of *A. aureorufa* are mostly found on "ulmo" *Eucryphia cordifolia* Cavanilles and "peta" *Myrceugenia planipes* (Hooker and Arnott), during the flowering season (Polidori et al. 2013, Smith-Ramírez et al. 2016). Natural distribution range for both tree species is located along the Andes Mountain Range between 45° and 37° S, at elevations up to 700 m in Chile and Argentina in the so-called Valdivian Forest and Andean Patagonian Forest (Kausel 1966, Landrum 1988, Zuloaga et al. 2008). *Aneriophora aureorufa* is associated through Batesian mimicry with the bumblebee *Bombus dahlbomii* Guérin-Méneville, 1835 (Hymenoptera, Apidae), which is endemic to Chile and Argentina and ranges from central Chile to the southern areas of these countries (Abrahamovich et al. 2004, Polidori et al. 2013). Both species are pollinators, although *A. aureorufa* is considered a specialist because it has only been found on "ulmo" and "peta" (Polidori et al. 2013, Smith-Ramírez et al. 2014, 2016, Barahona-Segovia et al. 2016). This specialization has led some authors to suggest that *A. aureorufa* can be a good bioindicator of the quality of some ecosystems where these two plant species occur (Alaniz et al. 2018). In this sense, it is important to highlight that floral resources for *A. aureorufa* have declined and will continue to decline at a rate of 1–4.5% per year in Chile, primarily due to deforestation and livestock activity (Ramos-Jiliberto et al. 2009, Barahona-Segovia et al. 2016, Alaniz et al. 2018). Consequently, *E. cordifolia* was classified as Near Threatened in Argentina in the IUCN Red List (IUCN 2019).

Here, we provide the first record of *A. aureorufa* from Argentina, together with a distribution map, photographs, and diagnosis of this species.

Methods

The examined material is deposited at the Entomological Collection of the "Instituto Argentino de Zonas Áridas" (CEI), Mendoza, Argentina. A total of 6 specimens from Argentina were studied and identified using the original description (Philippi 1865) and the publications of Thompson (1972, 1999). The morphological terminology used in diagnosis follows Thompson (1999). Argentine specimens were morphologically compared with others from Chile deposited in different institutions: Museo Nacional de Historia Natural, Santiago de Chile, Chile (MNHNCL); Museo Entomológico Luis E. Peña, Universidad de Chile, Santiago de Chile, Chile (MEUC); Museo de Zoología, Universidad de Concepción, Concepción, Chile (MZUC) and Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany.

The distribution map (Fig. 1) was created with ArcGis v. 10.6.1 for records from Chile and Argentina using data from the literature, citizen science program records (CSP), specimen labels from MNHN, MEUC, MZUC, Universidad Austral de Chile, Valdivia, Chile (UACH), Instituto de Entomología de la Universidad Metropolitana de Ciencias de la Educación, Santiago de Chile, Chile (IEUMCE), Canadian National Collection of Insects, Ottawa, Canada (CNC), ZFMK, and CEI (Appendix, Table A1). The aim of the distribution map was to calculate relative distances from all points known from Chile with the new record in Argentina.

Adult photos of *A. aureorufa* were taken with a stereomicroscope Leica S6D equipped with a Leica ES3 camera. Then, digital photographs were combined using the image-stacking freeware Combine ZP v. 1.0 (Hadley 2012).

Results

New records (n = 1 female, 5 males). Argentina, Neuquén province, near Lácar Lake, Pucará, 40.1635° S,

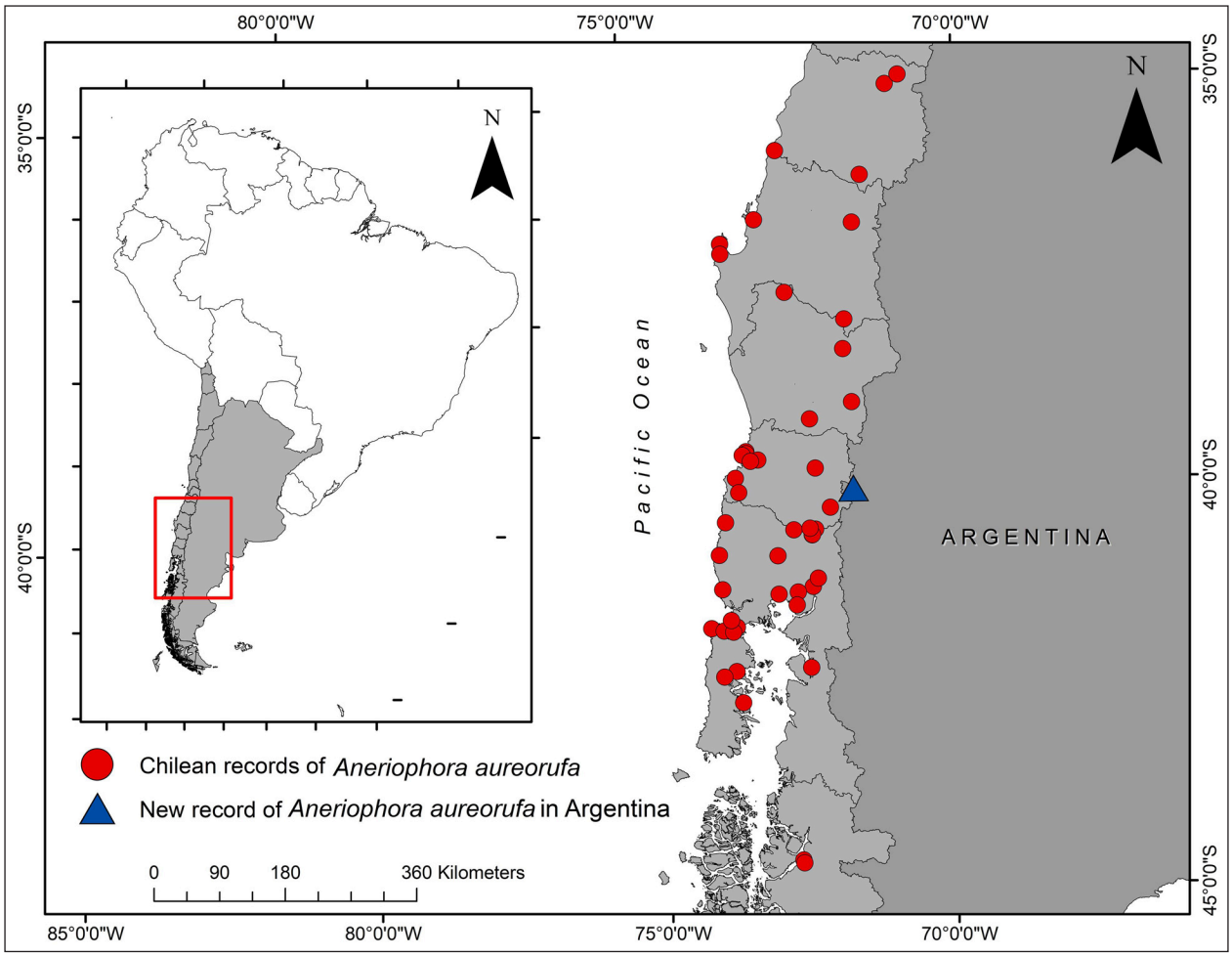


Figure 1. Distribution map of *Aneriophora aureorufa* (Philippi, 1865) in Chile and Argentina based on literature records and studied specimens.

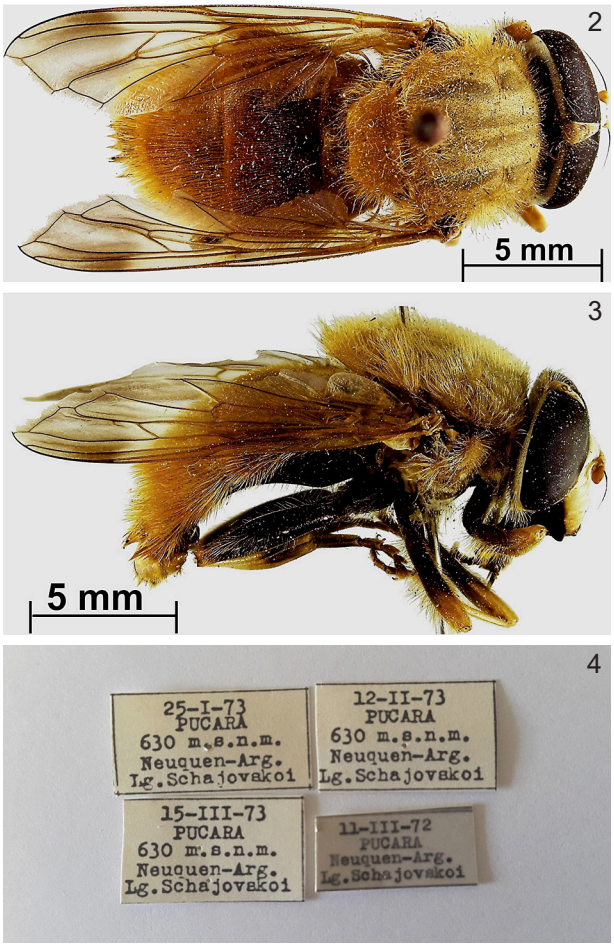
071.6326° W, altitude 630 m a.s.l., 11-III-1972, leg. Schajovskoi, 1 ♂ (CEI195312); same data, 25-I-1973, leg. Schajovskoi, 1 ♀ (CEI19509); same data, 12-II-1973, leg. Schajovskoi, 3 ♂ (CEI19508, CEI19510, CEI19512); same data, 15-III-1973, leg. Schajovskoi, 1 ♂ (CEI19513) (Fig. 1).

Diagnosis (adapted from Thompson 1972, 1999). *Aneriophora aureorufa* is characterized as a large fly (length 20 mm or more). Head: twice as high as long, face bare, lightly orange pilose and produced downwards. One-half of face below of bottom of eyes, slightly concave under antennae, with traces of small medial tubercle and genae shiny. Facial grooves short, extending along basal one-third of eyes and facial stripes indistinct. Frontal prominence low, on dorsal third of head. Front of male very short, as long as eye contiguity and only one-half as long as vertical triangle. Vertical triangle long, more than twice as long as broad at occiput. Front of female broad, ocellar tringle always distinctly before posterior margin of eyes. Eyes bare, holoptic in male. Antennae very short with basoflagellomere almost quadrate, arista long. Thorax: as long as broad, mostly orange pilose, with long mesonotal pile. Katepisternum with broadly separated dorsal and ventral pile patches. Anepimeron with posterior portion bare; katepimeron, meron and katatergum bare. Metasternum pilose, postmetacoxal bridge incomplete and scutellum with ventral pile fringe and apical emarginated rim. Legs: simple, except for metafemora very slightly swollen before apex in males and with only few ventral spines, metatibiae with a short, broad, rounded projection at apex. Wings: Vein M_1 and cross-vein dm-cu disjunctive, not continuous; M_2 present; cell cup with a long petiole, with petiole much longer than petiole of cell r_{4+5}. Abdomen oval, tergites orange with long orange pile and sternites shiny black with black pile (Figs 2–4).

Discussion

The present study documents the first record of *A. aureorufa* from Argentina, which has been previously considered endemic to Chile (Thompson 1972, Thompson et al. 1976, Polidori et al. 2013, Barahona-Segovia et al. 2016). This expands the geographical range of this species to the East, to the Argentine Patagonia. The locality of the new record is 145 km from the nearest Chilean southern point and 141.59 km from the nearest northern point (Fig. 1).

Based on the previous records and known biology of the species, *A. aureorufa* can be considered as native to



Figures 2–4. Specimen of *Aneriophora aureorufa* (Philippi 1865) from Argentina deposited at Entomological Collection of the Instituto Argentino de Zonas Áridas. **2.** Habitus, dorsal view. **3.** Lateral view. **4.** Specimen labels.

the Andean Patagonian and Valdivian Forests of Argentina and Chile. The geographic distribution range of *A. aureorufa* in Argentina coincides with part of geographic distribution range of *B. dahlbomii*, a bumblebee endemic to Chile and Argentina that is considered its mimetic model (Abrahamovich et al. 2004, Polidori et al. 2013). The new locality in Argentina for *A. aureorufa* is part of the so-called Valdivian Forest, where the tree species *E. cordifolia* and *M. planipes* frequently visited by this flower fly are present (Kausel 1966, Landrum 1988, Zuloaga et al. 2008, Morrone 2014). Based on the geographic distribution of *B. dahlbomii* and the tree species mentioned above, *A. aureorufa* might be present in the Argentine provinces of Neuquén, Rio Negro, Chubut, and Santa Cruz, where the distribution of "ulmo" and "peta" overlap with that of the bumblebee (Abrahamovich et al. 2004, Zuloaga et al. 2008).

Very little is known about the biology of *A. aureorufa*, its role as pollinator, or the potential impact of anthropogenic activities on this flower fly (Polidori et al. 2013, Smith-Ramirez et al. 2014, Barahona-Segovia et al. 2016). The immature stages of this flower fly species are still unknown, and we can only guess that they could play an important role in forest ecosystems as recyclers of organic matter, sharing the saprophagous habits of most of the members of the tribe Milesiini (Thompson and Rotheray 1998, Rotheray and McGowan 2000, Rotheray and Gilbert 2011, Barahona-Segovia et al. 2016).

The new finding highlights the need of further studies involving *Aneriophora* in order to better understand its role in pollination and decomposition processes in the Valdivian and Andean Patagonian forests of Argentina, as well as other ecosystem services (Rotheray and McGowan 2000, Burgio and Sommaggio 2007, Morrone 2014, Alaniz et al. 2018). Equally important is to study the activity of. *A. aureorufa* as floral visitor of *E. cordifolia*, a tree species nearly threatened in Argentina (IUCN 2019) and its potential as an environmental quality bioindicator (Sommaggio 1999, Burgio and Sommaggio 2007, Alaniz et al. 2018). Thus, studying the interactions and possible threats for *A. aureorufa* in Argentine Patagonia will give us a better knowledge on this species and habitat dynamics. Barahona-Segovia et al. (2016) calculated an historical habitat loss of 68% for this syrphid species in Chile due to agriculture, change of land use, and reforestation with exotic plants. Thus, we strongly believe that the survey of this syrphid species will help to evaluate the effects of habitat loss and fragmentation in the Argentine Patagonia, and that these new records may open new avenues for research on plant-animal interactions.

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Authors' Contributions

GPLG, RMBS, CMD, NM, and XM prepared the manuscript. The distribution map was created by RMBS. Flower fly specimens were identified by GPLG, NM, XM, and RMBS.

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Appendix

Table A1. Records of *Aneriophora aureorufa* (Philippi, 1865) used in Figure 1.

#	Localities	Country	Coordinates	Date, leg., specimen data	Source/reference
1	Valdivia	Chile	39.8139°S, 073.2458°W	1865. R.A. Philippi, holotype, 1♀, 1♂	Philippi 1865
2	Chile	Chile	35.6751°S, 071.5430°W	1926. R. Shannon, 1♀.	Shannon 1926
3	Chile	Chile	35.6751°S, 071.5430°W	1933. R. Shannon & D. Aubertin, 3♀, 4♂	Shannon & Aubertin 1933
4	Chile	Chile	35.6751°S, 071.5430°W	1949. F.M. Hull, record only	Hull 1949
5	Curacutín	Chile	38.4333°S, 071.8833°W	1963. M. Etcheverry, record only	Etcheverry 1963
6	Bío Bío	Chile	36.7728°S, 073.0630°W	1963. M. Etcheverry, record only	Etcheverry 1963
7	Llanquihue	Chile	41.2606°S, 073.0065°W	1963. M. Etcheverry, record only	Etcheverry 1963
8	Maullín	Chile	41.6167°S, 073.6000°W	1963. M. Etcheverry, record only	Etcheverry 1963
9	Chiloé	Chile	42.6767°S, 073.9934°W	1963. M. Etcheverry, record only	Etcheverry 1963
10	Aulén	Chile	41.8769°S, 072.8200°W	1963. M. Etcheverry, record only	Etcheverry 1963
11	Malleco	Chile	38.2500°S, 072.2500°W	1976. Thompson et al. 1♀, 1♂	Thompson 1976
12	Aysén	Chile	44.9166°S, 073.5833°W	1976. Thompson et al. 1♀, 1♂	Thompson 1976
13	Guabún, Lacucycuy Peninsula	Chile	41.6333°S, 074.0166°W	II.2007. obs. Smith-Ramírez et al., 8 adults	Smith-Ramirez et al. 2016

Table A1. *Continued*.

#	Localities	Country	Coordinates	Date, leg., specimen data	Source/reference
14	Estación Científica Huinay, Hornopirén	Chile	42.3666°S, 072.4094°W	20.I–24.I.2012. obs. Polidori et al., 12♀	Polidori et al. 2013
15	Polincay	Chile	41.4471°S, 072.8978°W	02.II.2016. Leg. Marcelo Maturana, 1♀	CSP
16	Estación Biológica Senda Darwin, km14	Chile	41.8865°S, 073.6731°W	17.II.2016. Leg. Barahona-Segovia, 1 adult	CSP
17	Caulin, Chacao, Chiloé	Chile	41.8279°S, 073.6086°W	17.II.2016. Leg. Barahona-Segovia, 1♀	CSP
18	Putrihuen, Castro	Chile	42.4337°S, 073.8631°W	26.II.2016. Leg. Barahona-Segovia, 1♂	CSP
19	Lago Lleu lleu, Bío bio, Arauco	Chile	38.1500°S, 073.3333°W	10. IX.2017. Leg. Sanhueza, 1 adult	CSP
20	Caulin, Chacao, Chiloé	Chile	41.8279°S, 073.6086°W	17.II.2016. Leg. Barahona-Segovia, 1♀	PCBS
21	Parque Nacional Alerce Andino	Chile	41.5905°S, 072.6062°W	13.II.2016. Leg. Barahona-Segovia, 3♂	PCBS
22	Lago Chapo	Chile	41.4308°S, 072.5808°W	18.II.2017. Leg. Barahona-Segovia, 1♂	PCBS
23	Cerros Bahía San Pedro	Chile	40.9338°S, 073.8382°W	03.II.2016. Obs. Barahona-Segovia, 1 adult	Pers. obs.
24	Rio Chaiuhín	Chile	39.9986°S, 073.5155°W	13.II.2016. Obs. Barahona-Segovia, 1 adult	Pers. obs.
25	Km 8 to Parque Oncol, Valdivia	Chile	39.6759°S, 073.3256°W	14.II.2016. Obs. Barahona-Segovia, 1 adult	Pers. obs.
26	Lago Riñihue	Chile	39.9118°S, 072.2304°W	13.II.2017. Obs. Barahona-Segovia, 1♀	Pers. obs.
27	Lago Huishe	Chile	40.4012°S, 072.0070°W	15.II.2017. Obs. Barahona-Segovia, 1 adult	Pers. obs.
28	Rio Pescado	Chile	41.3582°S, 073.8142°W	22.II.2017. Obs. Barahona-Segovia, 1♂	Pers. obs.
29	Rio Cisnes	Chile	44.7676°S, 072.6688°W	01.III.2017. Obs. Barahona-Segovia, 1 adult	Pers. obs.
30	Punta Lavapie	Chile	37.2320°S, 073.5835°W	II.1964, 1♀	UACH
31	Puerto Octay	Chile	40.9756°S, 072.8872°W	II.1968, 1♀	MZUC
32	Concepción	Chile	36.8259°S, 073.0424°W	II.1962, 1♂	MEUC
33	Fundo Los Coigües	Chile	39.3056°S, 072.2917°W	31.II.1964, 1♂	MEUC
34	Pucatrihue	Chile	40.5374°S, 073.7107°W	21.II.1967, 1♂	MEUC
35	Dalcahue, Chiloé	Chile	42.3730°S, 073.6523°W	II.1980. Leg. R. Sierpe, 1♀	MEUC
36	Parque Nacional Alerce Costero	Chile	40.1750°S, 073.4735°W	01.II.1993. Leg. Curkovic, 1♀	MEUC
37	Las Tablas, Curicó	Chile	35.1960°S, 070.9947°W	I.1993. Leg. L.E. Peña, A. Ugarte, 1♀	MEUC
38	Puerto Cisnes	Chile	44.7296°S, 072.6812°W	7.I.1967. Leg. Zapata, 1♀	IEUMCE
39	Guabun, Ancud	Chile	41.8279°S, 074.0313°W	II.1967. Leg. José Herrera, 1♀	IEUMCE
40	Termas de Rio Blanco	Chile	39.1083°S, 071.6165°W	19.II.1973. Leg. José Herrera, 8♀, 2♂	IEUMCE
41	Ralún, Llanquihue	Chile	41.3697°S, 072.3317°W	10.II.1986. Leg. Jaime Solervicens, 1♀	IEUMCE
42	Las Trancas, Chillán	Chile	36.8956°S, 071.5413°W	II.1964. Leg. Etcheverry, 2♂,1♀	MNHN
43	Parque Nacional Nahuelbuta	Chile	37.1100°S, 073.5800°W	II.1981. Leg. M. Cerda, 1♂	MNHN
44	Valdivia	Chile	39.8000°S, 073.2400°W	26.XII.1987. Leg. E. Krahmer, 2♂	MNHN
45	Osorno, Anticura	Chile	40.6500°S, 0 72.1667°W	5. III.1978. Leg. W. Mathis, 1♂	ZFMK
46	Osorno, Anticura	Chile	40.6500°S, 072.1667°W	11–12.III. 1978. Leg. W. Mathis, 1♀	ZFMK
47	Llanquihue, Cayutué	Chile	41.2333°S, 072.2666°W	13.II.1998. Leg. N.E. Woodley, 1♂	ZFMK
48	Chile	Chile	35.6751°S, 071.54296°W	13.II.1894. Leg. Bigot, 1♀	CNC
49	Osorno, Río Gol Gol	Chile	40.6500°S, 072.3500°W	10.II.1957. Leg. L. Pena, 1♀	CNC
50	Puerto Cisnes, Aysen	Chile	44.7500°S, 072.6666°W	1–15.II. 1961. Leg. L. Pena, 5♀	CNC
51	Dalcahue, Isla Chiloe	Chile	42.3776°S, 073.6518°W	1–8. II. 1962. Leg. L. Pena, 1♀	CNC
52	Curicó, Estero la Jaula	Chile	35.0830°S, 070.8000°W	I.1964. Leg. L. Pena, 1♂	CNC
53	Los Lagos, Llanquihue, Carelmapu	Chile	41.7416°S, 073.6985°W	I.1964. Leg. L. Pena, 1♀	CNC
54	Rio Blanco, Malleco	Chile	38.4333°S, 071.8833°W	II.1964. Leg. L. Pena, 1♀	CNC
55	Chiloé, Ahoni, 40 km Southeast of Castro	Chile	42.7616°S, 073.571°W	24.XII.1993. Leg. G. & M. Wood, 1 adult	CNC
56	Linares Amb. Bullileo 50 km E Parral	Chile	36.3167°S, 071.4167°W	12.I,1994. G. & M. Wood, 1♀	CNC
57	Osorno, Puyehue National Park	Chile	40.7333°S, 072.3166°W	14.I–3.II. 2017. Leg. V.C. Silva, D.S. Amorim, 1 adult	CNC
58	Los Lagos, Puyehue National Park	Chile	40.7321°S, 072.3133°W	7.II.2018. Leg. J.H., A.W., A.M. Skevington, 13 adult	CNC
59	Los Lagos, Puyehue National Park	Chile	40.7321°S, 072.3133°W	7.II.2018. Leg. J.H., A.W., A.M. Skevington, 2♀, 6 adult	CNC
60	Los Lagos, Puyehue National Park	Chile	40.7355°S, 072.3081°W	7.II.2018. Leg. J.H., A.W., A.M. Skevington, 1♀	CNC
61	Neuquén, Pucará, near Lácar Lake (new record)	Argentina	40.1635°S, 071.6326°W	11.III.1972, 25.I–12.II–15.III.1973. Leg. Schachovskoj, 1♂, 4♂, 1♀	CEI

Adult = unsexed specimen; ♀, ♂ = sexed specimen; obs = observation; pers. obs. = personal observation; record only = mention of the country only (without sex and number of specimen); CSP = citizen science program.