Zootaxa 4612 (3): 431–439
https://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4612.3.9
http://zoobank.org/urn:lsid:zoobank.org:pub:51F78D2E-E5D9-47B6-B79A-E3624E678D5E

A new flower fly species of *Cepa* Thompson & Vockeroth (Diptera: Syrphidae) from the Valdivian evergreen forest hotspot, Chile

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Abstract

The Neotropical region has a high species richness of flower flies. However, there are many known species awaiting proper description. *Cepa* Thompson & Vockeroth is a Neotropical genus with scattered records and few individuals collected of its three species. In the present study, a female of a new species of *Cepa* is described, *C. simonettii* Barahona-Segovia **sp. nov.**, from the Valdivian evergreen forest representing the first record of this genus in Chile. In addition, an identification key to all known species of *Cepa* is provided. Morphological and biogeographic aspects of this new *Cepa* species are discussed, as well as the potential phylogenetic relationship with other members of Merodontini.

Key words: Merodontini, Neotropical region, *Nothofagus*, temperate forest

Resumen

La región Neotropical tiene una alta riqueza de especies de moscas de las flores. Sin embargo, muchas especies aún esperan ser descritas. *Cepa* Thompson & Vockeroth es un género Neotropical escasamente registrado y con pocos individuos recolectados de sus tres especies. En el presente trabajo, se describe una hembra de una nueva especie de *Cepa*, *C. simonettii* Barahona-Segovia **sp. nov.**, del bosque perennifolio Valdiviano que representa el primer registro de este género en Chile. Además, se proporciona una clave de identificación de todas las especies conocidas de *Cepa*. Discutimos aspectos morfológicos y biogeográficos de la nueva especie de *Cepa*, así como la posible relación filogenética de esta con otras especies de Merodontini.

Palabras claves: Merodontini, región Neotropical, *Nothofagus*, Bosque templado

Introduction

Flower flies (Diptera: Syrphidae) are represented worldwide by more than 5,900 species of 202 genera, in all biogeographic realms except Antarctica (Thompson 1999; Brown 2009; Thompson *et al.* 2010). This family is considered an important group of pollinators of different plants, both in crops and natural areas (Ssymank *et al.* 2008; Lander *et al.* 2009; Canali & Loni 2010; Klecka *et al.* 2018), as well as biological controllers of crop pests (Bugg *et al.* 2008). In addition, they have been used as biological indicators (Sommaggio 1999; Van Steenis & Zuidhoff 2013; Alaniz *et al.* 2018). Syrphidae comprises four subfamilies, Syrphinae, Pipizinae, Microdontinae and Eristalinae (Mengual *et al*. 2015), including saprophagous, predatory and phytophagous larvae (Rotheray & Gilbert 2011; Martínez-Falcón *et al.* 2012; Ricarte *et al.* 2012; Ricarte *et al.* 2017).

Neotropical flower flies were catalogued for the first time by Williston (1886), later revised by Fluke (1956, 1957) and finally by Thompson *et al.* (1976). More recently, Thompson (1999) published an identification key to the genera of Neotropical Syrphidae, with description of new genera and species. In his work, Thompson (1999)

Accepted by A. Ricarte: 29 Apr. 2019; published: 30 May 2019

estimated 1,600 flower fly species belonging to 60 genera to occur in the Neotropics. However, the real number of taxa is higher than currently known as many new species await proper description (Thompson 1999). Chile is one of the Neotropical countries with least number of flower fly species recorded (120 spp.; Montoya *et al.* 2012), but it is possibly the best-known Latin American country in terms of its Syrphidae fauna (Thompson & Thompson 2006). The Chilean flower fly fauna has been entirely revised five times by different authors: Blanchard (1852), Philippi (1865), Shannon (1927), Shannon & Aubertin (1933) and, thirty years later, by Etcheverry (1963). Besides these large studies, descriptions of new species from Chile have been published by Sedman (1965), Etcheverry (1966), Thompson & Marnef (1977), and Thompson & Thompson (2006). Chile has a great variety of ecosystems comprising three biodiversity hotspots (Myers *et al.* 2000). The Valdivian evergreen forest is one of the least explored Chilean hotspots in terms of its flower fly fauna. Therefore, it is very likely that new species of flower flies are found in this ecosystem.

The genus *Cepa* Thompson & Vockeroth in Thompson, (2007) (Eristalinae: Merodontini) currently comprises three species: *Cepa alex* (Thompson, 1999) recorded from Brazil and Paraguay; *Cepa margarita* (Thompson, 1999) known from Brazil; and *Cepa apeca* Thompson, 2007 described from Costa Rica. *Cepa* is a new name introduced by Thompson (2007) for *Xela* Thompson & Vockeroth in Thompson (1999), preoccupied by a fossil trilobite. This genus is probably related morphologically and phylogenetically to the genus *Alipumilio* Shannon 1927 (Thompson 1999). *Cepa* is characterized by metallic colorations and punctuated body, conspicuous face morphology with a frontal prominence (produced or not) in the middle of the face, cross vein r-m basal to middle of the cell dm and at the level of the end of the vein SC, cell r_{4+5} blunt apically, short and oval abdomen, and lack of wing shields (Thompson 1999, 2007; Thompson *et al.* 2010). Only females have been recorded of this enigmatic genus inhabiting tropical and subtropical forests (Thompson 1999, 2007; Thompson *et al.* 2010). To date, no information about the biology, ecology and habitats of any *Cepa* species is available.

The aim of this work is to describe a new *Cepa* species from the Valdivian evergreen forest, a biodiversity hotspot of central Chile. This new species represents the first record of this genus in Chile. In addition, an updated identification key to all known species of *Cepa* is provided.

Material and methods

A review of the Chilean flower flies based on material deposited in several public and private entomological collections was carried out and material from the following institutions was studied: 'Museo Nacional de Historia Natural de Santiago, Chile' (MNNC); 'Instituto de Entomología, Universidad Metropolitana de Ciencias de la Educación, Santiago, Chile' (IEUMCE); 'Museo Luis E. Peña, Universidad de Chile, Santiago, Chile' (MEUC); 'Ernesto Krahmer collection, Universidad Austral de Chile, Valdivia, Chile' (UACH); Zoology museum, 'Universidad de Concepción, Concepción, Chile' (MZUC); entomological collection of 'Universidad de la Frontera, Temuco, Chile' (UFRO); 'Universidad de Tarapacá, Arica, Chile' (UTA) and 'Servicio Agrícola y Ganadero, Santiago, Chile' (SAG). From the Ernesto Krahmer's collection in the UACH, a female specimen was assigned to the genus *Cepa* using the identification key of Thompson (1999). To corroborate this identification, Dr. Christian F. Thompson was contacted, and he confirmed the genus identification and suggested that it could be a new species. The morphological description of the specimen follows the terminology proposed by Cumming & Wood (2017).

Measurements were taken with a 1-mm precision ruler in the objective of a Leica S6 D microscope. Total length was measured from the head to the end of the terminal tergite and wing length was measured from the base to the apex. Photographs were made with a Canon 70D camera, equipped with Canon MP-E 65 mm macro lens on a Cognisys StackShot macro rail at the 'Pontificia Universidad Católica' of Chile. Images were made with different focus points and later combined using the software Helicon Focus 6®.

The contents of each label are enclosed within double quotation marks (" ") and individual lines of information are separated by a single slash (/). Square brackets ([ ]) add information on specimen condition and repository collection. Actual specimens of other *Cepa* species could not be accessed for the purpose of the present study. However, published morphological descriptions of other *Cepa* species, as well as Christian F. Thompson's advice corroborate that our individual represents a new species. Original descriptions and images were used to diagnose the new species and to build the identification key. Distribution maps of the *Cepa* species were created with ArcGIS v.10.4.1 (ESRI 2017).

Results

***Cepa simonettii* Barahona-Segovia sp. nov.**
Figs 1–4

Holotype. Female, in excellent condition, found in the Ernesto Krahmer's collection from UACH and finally deposited in the MNHNCL; with the following labels: "Santo Domingo, Valdivia / 22.ix.1987 / Leg. E. Krahmer"; "Holotypus / *Cepa simonettii* / spec. nov. ♀ / det. Barahona-Segovia 2018" [red].

Type locality. Chile: Valdivia Province, Santo Domingo River, -39.903358°S, -73.177680°W, 47 m asl.

Diagnosis. Dark-bluish metallic species. Lunule orange; without frontal protuberance; frons somewhat swollen. Arista and eye bare. Hyaline wing except for the brown-pigmented pterostigma; wing entirely microtrichose. Crossvein r-m located slightly beyond the end of subcostal vein.

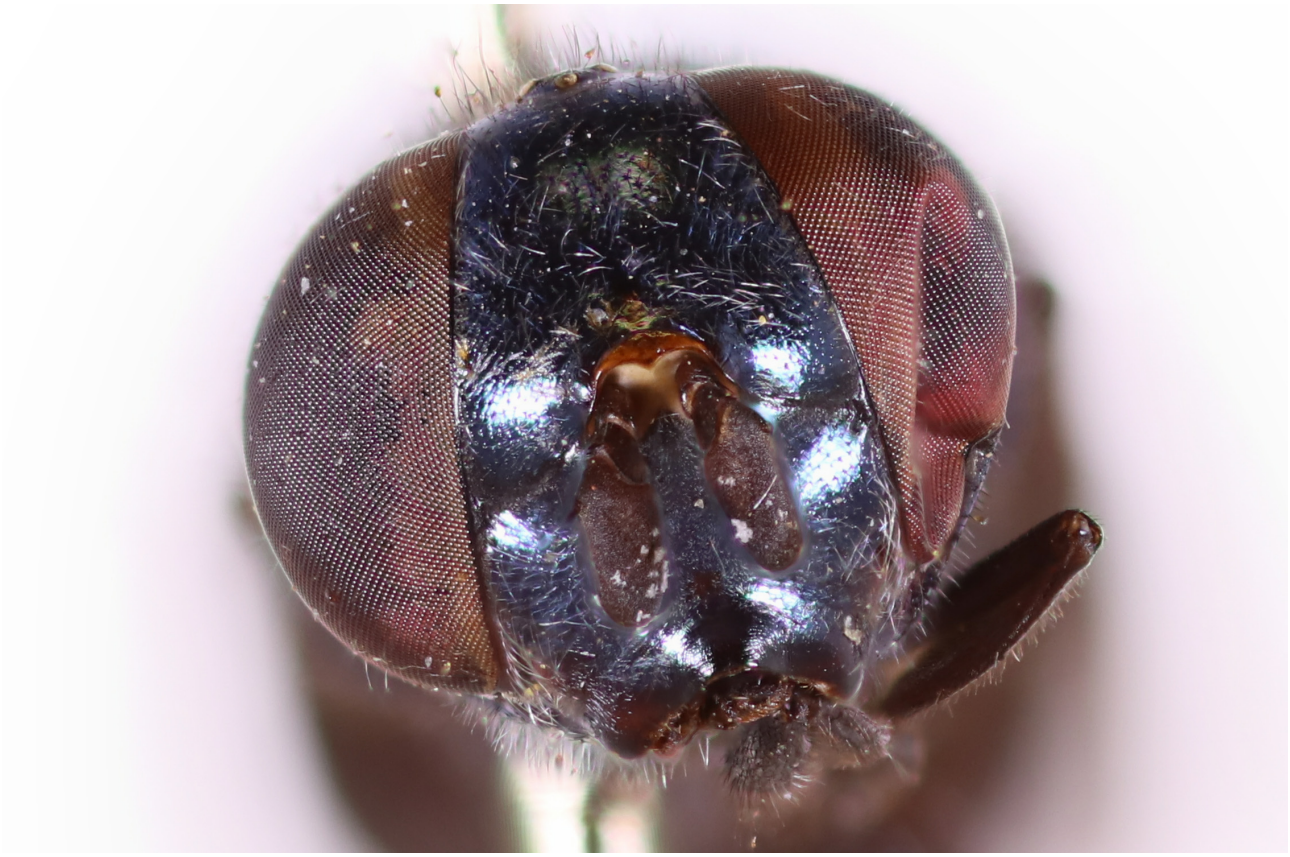

FIGURE 1. *Cepa simonettii* Barahona-Segovia **sp. nov.**, female, head, anterior view.

Description. Length: 6.8 mm; Wing: 6.6 mm. **FEMALE**. ***Head***: dark-blue, shiny, with fine punctuation and black pilosity; face concave, without frontal protuberance. Gena black with short and scarce white pilosity; lunule dark orange and bare (Fig. 1). The space between the eyes (i.e. frons width) is as long as the antenna length. Ocellar triangle in the vertex with pale orange ocelli, occupying approximately the medial 1/3 of vertex and scarcely protuberant (Fig. 2); occiput reduced laterally with short and black pile. Bare reddish eye. Scape, pedicel and basoflagellomere black. Scape and pedicel in a 1:1 ratio. Basoflagellomere five times longer than the scape and pedicel together. Arista black and bare. ***Thorax***: Mesonotum dark-blue, shiny with short black pilosity (Figs. 2, 3). Postpronotum with sparse pilosity. Anterior spiracle with white pilosity. Anterior anepisternum flattened; posterior anepisternum convex with large and dark pilosity dorsally (Fig. 3). Anepimeron with sparse and continuous pilosity. Katepisternum with short and black pilosity (Fig. 3). Metasternum with long pilosity. Scutellum with apical marginal sulcus and black erected pilosity (Fig. 3). ***Legs***: Coxae, trochanters, and femora dark blue to brown; tibiae, tarsi and claws dark brown. The anterior femora with short black pile; middle and posterior femora with black pile longer than those on the anterior femora. ***Wing*** (Fig. 4): entirely microtrichose, hyaline, except pterostigma brown pigmented in color. Cell r_{4+5} blunt apically. Crossvein r-m placed in the basal third of cell dm, slightly beyond (more apical) the end of the vein sc. Dorsal and ventral calypters pale; margin with large pale pilosity. Halter entirely black.

Abdomen: blackish brown, stocky, strongly curved ventrally at 3rd segment; with fine black pilosity on both tergites and sternites. Fine punctuation in all abdominal tergites; 5th tergite light brown and with fine and dense punctuation.

FIGURE 2. *Cepa simonettii* Barahona-Segovia **sp. nov.**, female, dorsal view.

FIGURE 3. *Cepa simonettii* Barahona-Segovia **sp. nov.**, female, lateral view.

MALE. Unknown.

Etymology. The specific epithet '*simonettii*' refers to Javier A. Simonetti (1955–present), an internationally acknowledged conservation biologist, member of the Chilean Academy of Sciences and full professor at the University of Chile. Javier Simonetti has dedicated his professional life to understand both the biodiversity of Chile and its conservation. Therefore, to recognize his contribution to conservation biology of the Chilean flora and fauna, this new species is named after him. Specific epithet to be treated as a noun in the genitive case.

Distribution. Only known from the lowland Valdivian evergreen forest of Chile, Los Ríos region (Fig. 5).

Remarks: This new species represents the first record of the genus *Cepa* from Chile. Only of the female holotype of *Cepa simonetii* **sp. nov.** was collected in this Valdivian evergreen forest, an ecosystem with *Nothofagus* trees and hygrophilous vegetation (Cecilia Ruíz pers. com.).

FIGURE 4. *Cepa simonettii* Barahona-Segovia **sp. nov.**, female, left wing.

Identification key to all known species of *Cepa*

The following key is adapted from Thompson (2007).

1. Antennae blackish; frontal prominence greatly pronounced (Fig. 1; Thompson, 2007: figure 1) crossvein r-m placed slightly beyond the end of subcostal cell. 2
- Antennae entirely or partially orange; frontal prominence not greatly pronounced (Thompson, 2007: figure 2); crossvein r-m at the end level of subcostal cell. 3
2. Lunule shiny blue; wing extensive bare basomedially; wings bicolored: dark brown basally, light brown apically (Thompson, 2007: figure 1) (Brazil, Paraguay; Fig. 5) . . . . . *C. alex* (Thompson)
- Lunule orange (Fig. 1); wing entirely microtrichose; wings not bicolored (Fig. 4) (Chile; Fig. 5). . . . . *C. simonettii* Barahona-Segovia **sp. nov.**
3. Antennae entirely orange; wings hyaline and almost entirely microtrichose; 3rd costal section shorter than 4th (Brazil; Fig. 5) . . . . . *C. margarita* (Thompson)
- Antennae dark brown, partly orange ventrally; wing hyaline except for the brownish antero-apical 1/4; wing cells c, r and bm without microtrichia; 3rd and 4th costal sections equal in length (Thompson, 2007: figure 2) (Costa Rica; Fig. 5). . . . . *C. apeca* Thompson

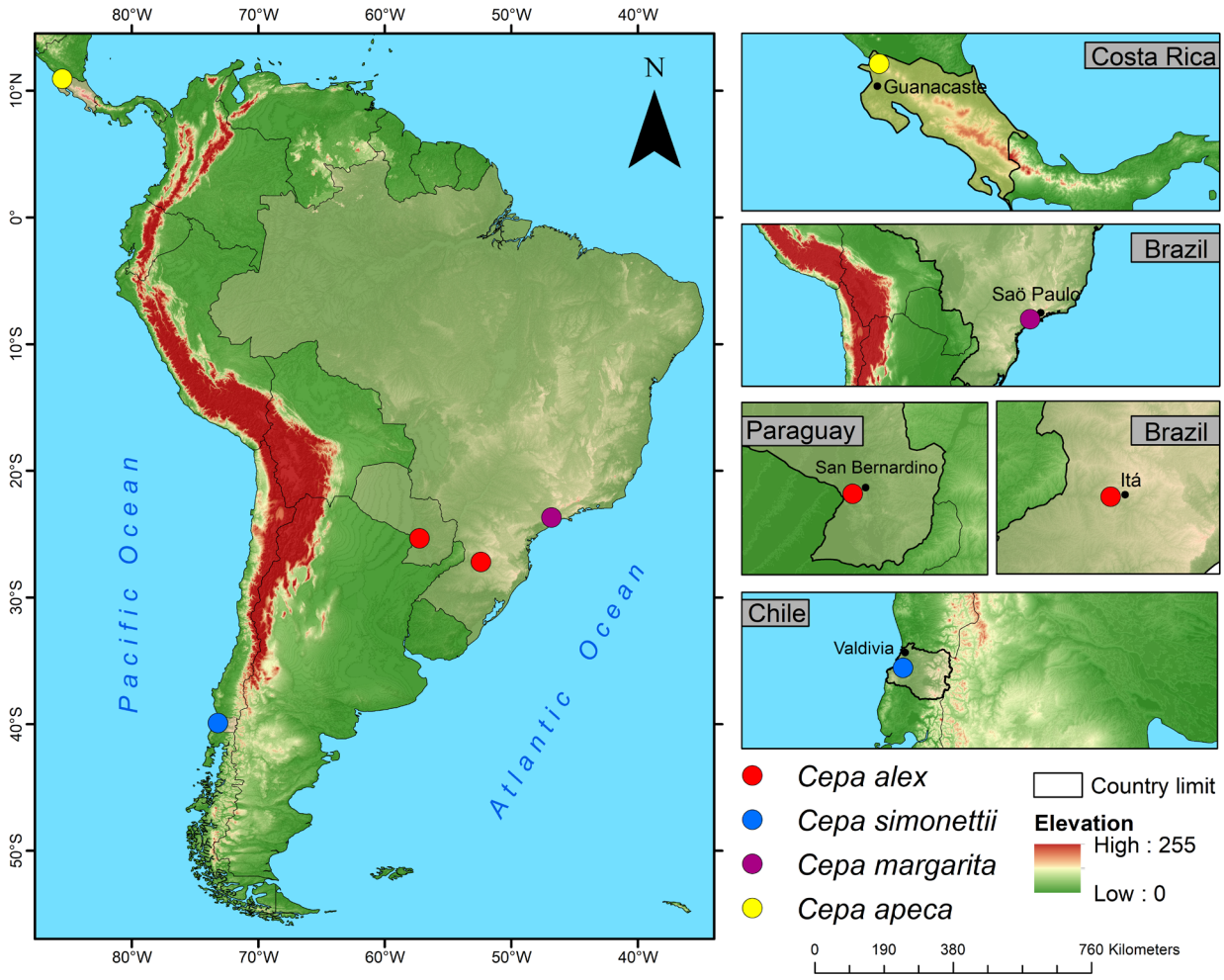

FIGURE 5. Distribution of the four known *Cepa* species.

Discussion

Cepa is a Neotropical genus rarely collected. So far, only nine *Cepa* specimens have been published, all of them females: six individuals of *C. alex*, and the holotypes of *C. margarita*, *C. apeca* and *C. simonettii* **sp. nov.** Prior to the finding of *C. simonettii* **sp. nov**., all other *Cepa* species have been scarcely recorded from different tropical or subtropical forests, always in lowlands (see Fig. 5), from countries such as Costa Rica, Brazil and Paraguay, but not from temperate forests. The Valdivian evergreen forest is part of the hotspot of central Chile and extends for 250 km from the Toltén River (40º50' S) to south of the Llico River (41º30' S; Smith-Ramírez 2004). It consists of several native and endemic plants (Villagrán & Hinojosa 1997; Rodríguez *et al.* 2018) and it is characterized by intense rain along the whole year (around 4,000-5,000 mm), with a mean temperature of 17.4 ºC (Smith-Ramírez 2004). The genus *Cepa* represents a large gap in distribution and knowledge for Neotropical flower flies (Thompson 1999, 2007). This might be due to insufficient sampling effort by the entomologists or to the specific biology of its immature stages. The most southern record known is near Itá in Brazil (see Fig. 5) and in our study, the current distribution of the genus *Cepa* is expanded in more than 2,100 km southwest, becoming the southernmost record of the genus. *Cepa simonettii* **sp. nov.** is the second species of the tribe Merodontini recorded from Chile, together with *Eumerus strigatus* (Fallén), an introduced flower fly species detected infesting onion and garlic crops in the Metropolitan region (Gerding *et al.* 1999).

Thompson (1999) stated that *Cepa* (as *Xela*) belongs to the tribe Merodontini. As defined by Thompson (1972), there is no doubt that *Cepa* keys out to the tribe Merodontini (as Eumerini in Thompson 1972) based on the morphological characters used in his identification key to the Eristalinae tribes. This idea is mentioned again by Thompson (2007). Little reasoned information is given in the literature about the phylogenetic relationships of *Cepa*, which

is phenotypically similar to *Alipumilio* (Thompson 1999). Male genitalia characters are usually used to assess the tribal membership (Thompson 1999), but only *Cepa* females are known so far. Doczkal & Pape (2009) did not include neither *Cepa* or *Alipumilio* in their morphological analysis of Merodontini, as neither did any previous phylogenetic study (Hippa & Ståhls 2005; Mengual *et al.* 2015; Young *et al*. 2016). Ståhls *et al*. (2003) included *Alipumilio* in their molecular analysis and resolved it as close to *Eumerus* and *Merodon* Meigen, as sister group of *Graptomyza* Wiedemann, but without strong support. New fresh material and male specimens are needed to infer the phylogenetic relationships of this small genus. Several reasons may explain the current scarcity of *Cepa* records in phylogenetic and other studies: small body size or small geographical species range and their unknown biology as mentioned above (Scheffers *et al.* 2012).

This new *Cepa* species is morphologically similar to *C. alex*, except for the fact that *C. simonettii* **sp. nov.** presents hyaline wings with brown pigmented pterostigma and orange lunule. This morphological resemblance could suggest that in the past, *C. alex* and *C. simonettii* **sp. nov**. had a common ancestor and after the geo-climatic changes in the Mesozoic, both species diverged in the current taxa. Some authors (Landrum 1981; Villagrán & Hinojosa 1997; Gillung & de Carvalho 2009; Tumini *et al.* 2018) suggest that several taxa had a continuous distribution in the past, before the aridification conditions and geo-climatic events in the Mesozoic era. For example, spider flies of the genus *Lasia* (Diptera: Acroceridae) or river crabs of the genus *Aegla* (Decapoda: Aeglidae) are distributed both in Brazil and in Chile (Gillung & de Carvalho 2009; Tumini *et al.* 2018). A paleo-palynology analysis of Chilean temperate flora has shown similarities with the current forests of the Planalto in southern Brazil and NW of Argentina (see Landrum 1981; Villagrán & Hinojosa 1997). This suggests that until the Miocene, this forest type was continuous across the subtropics of South America under mesic climate conditions and without marked seasonality (Villagrán & Hinojosa 1997). We suggest that the genus *Cepa* has a distribution similar to that of *Lasia* and *Aegla* in the past, before the subtropical forests were fragmented by the aridification and/or rising of the Andes in the Pliocene.

In conclusion, the presence of *C. simonettii* **sp. nov.** in Valdivian evergreen forests of Southern South America fills in part of the distribution gaps in the knowledge of the Chilean Syrphidae, where few new species has been described for the last 13 years. The record of this genus in Chile opens new questions about its biology, ecology or biogeography. Therefore, new surveys are needed to find more specimens of *Cepa* flower flies in the Valdivian evergreen forest, especially males. This could help to solve phylogenetic questions between *Cepa* and the other Merodontini flower flies.

Acknowledgments

We thank Dolly Lanfranco and Cecilia Ruiz (UACH) for allowing us to work with the valuable collection of Ernesto Krahmer; Cecilia Smith for all the logistic support; Enrico Rezende for providing the camera system; F. C. Thompson for confirming the presence of the genus in Chile and flowing comments; Ximo Mengual and Peter D. Lewis for valuable comments and contribution in the English review of our manuscript; to Antonio Ricarte and anonymous reviewers for their time dedicated to our work. R.M.B.-S. thanks the doctoral grant CONICYT 21160404.

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