

## New records of the invasive pest *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae) in the South American continent

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### Nuevos registros de la especie plaga invasora *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae) en el continente Sudamericano

**RESUMEN.** El presente estudio presenta cuatro nuevos registros de *Drosophila suzukii* Matsumura, 1931 (Diptera: Drosophilidae) en Argentina, extendiendo el área de su distribución geográfica en América del Sur. Un primer registro se localiza al este, en la mesopotamia Argentina, aquí las moscas fueron capturadas en plantaciones de moras y naranjas. Otro registro se localiza en Ticucho, Provincia de Tucumán, al noroeste del registro previo y en huésped desconocido, posiblemente cactus *Opuntia*. Finalmente, los otros dos registros fueron realizados en plantaciones de frambuesas en localidades de la región Patagónica, siendo los registros más australes de esta especie en el continente. A modo de revisión de la invasión de esta especie plaga en el continente, se recopilan todos los registros de *D. suzukii* en América del Sur publicados hasta la fecha. Los datos apoyan el escenario de una invasión incipiente de *D. suzukii* en áreas localizadas en latitudes meridionales de América del Sur. El establecimiento de *D. suzukii* en estas nuevas áreas puede implicar daños y pérdidas económicas para las economías regionales.

**PALABRAS CLAVE.** América del Sur. *Drosophila* de alas manchadas. Invasión biológica. Plaga invasora potencial.

**ABSTRACT.** The present study reports new presences of *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae) in four localities in Argentina, extending its geographical range in South America. Among the new records, one is located in Mesopotamia region in eastern Argentina, where flies were captured around orange and mulberry orchards. The other record is located at Ticucho, Province of Tucumán, northwest from the previous record, where flies were collected from an unknown host, possibly *Opuntia* cactus. The other two captures of *D. suzukii* were performed in raspberries plantations located at the Patagonia region, and represent the southernmost record of this species in South America. All previous reports of *D. suzukii* in South America are also presented, as a review of the invasion of this pest species to the continent. The data support the scenario of an incipient invasion of *D. suzukii* in southern latitudes of South America. The geographical distribution of *D. suzukii* to new areas could imply damages and economic losses for regional economies.

**KEYWORDS.** Biological invasion. Potential invasive pest. South America. Spotted wing *Drosophila*.

*Drosophila suzukii* Matsumura, 1931 (Diptera: Drosophilidae), also known as “spotted wing *Drosophila*”, is a native species from the south-eastern Palaearctic region that has recently expanded its range to wider areas of the world. It has been found in Europe and North America (Walsh et al., 2011; Cini et al., 2012, 2014; Asplen et al., 2015); and recently, it has also been found in South America expanding its distribution in this continent (Bitner-Mathé et al., 2014; Deprá et al., 2014; dos Santos, 2014; Paula et al., 2014; Vilela & Mori, 2014; González et al., 2015; Santadino et al., 2015; Santos Geisler et al., 2015; Andreatza et al., 2016; Wollmann et al., 2016; Lue et al., 2017). Out of the approximately 1200 species that belong to the genus *Drosophila*, only three species, *D. suzukii*, *D. pulchrella* Tan, Hsu & Sheng, 1949, and *D. subpulchrella* Takamori & Watabe in Takamori, Watabe, Fuyama, Zhang & Aotsuka, 2006, bear ovipositors with enlarged, modified bristles. A comparative study of fruit susceptibility among *D. suzukii* and three of its closest relatives revealed that only *D. suzukii* and *D. subpulchrella* are able to puncture the intact skin of raspberries and cherries and lay eggs (Atallah et al., 2014). Then, these eggs develop into larvae that feed on the fruit pulp damaging them by means of fruit tissue collapse facilitating infection by secondary pathogens like bacteria and yeasts, and also other drosophilid species. *Drosophila suzukii* uses as breeding sites mainly commercial soft-skinned fruits such as blueberries, blackberries, raspberries, cherries, strawberries, among others (reviewed in Poyet et al., 2015). This species has also been found to breed in other non-soft skinned fruits like apples, loquats, persimmons, tomatoes, bananas, figs and kiwis; but in these cases when fruits are previously damaged or overripe (reviewed in Vilela & Mori, 2014). There are reports from several parts of the world that *D. suzukii* can cause substantial damage to commercial plantations generating economic losses to fruit producers (reviewed in Asplen et al., 2015). In the present study we document the presence of *D. suzukii* in four new localities in southern latitudes of South America. One located in east Argentina at the Mesopotamia region, a second one located at a western location to the previously mentioned point, and two other locations in the Patagonia region. We also present a review of previously reported records of *D. suzukii* in South America in order to establish an up-to-date distribution of this species in the continent.

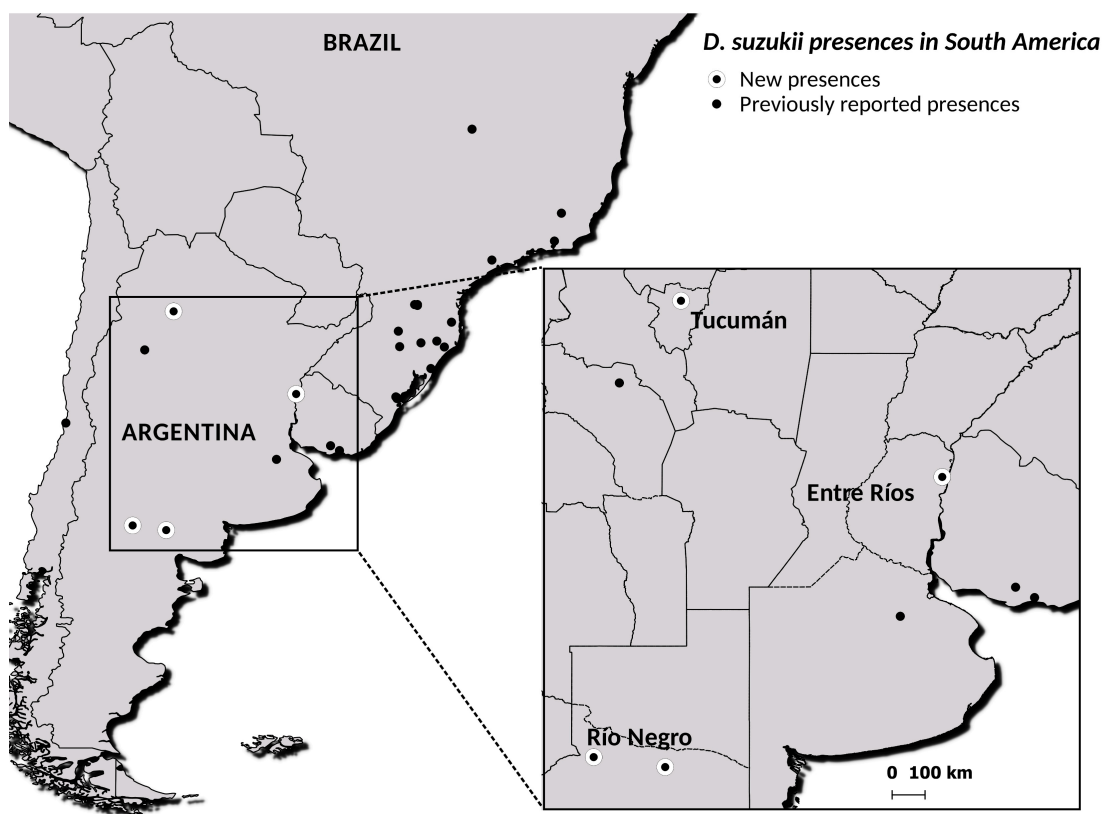
Table I summarizes the information on the collection sites of *D. suzukii* and other drosophilids presented in this study. Adult flies of *D. suzukii* were captured near the locality of Ticucho, Province of Tucumán, northwestern Argentina. At this site, flies were collected

from an unknown host, possibly *Opuntia ficus-indica* (L) Miller (cacti) by Prof. Esteban Hasson from IEGEBA (CONICET) / EGE (UBA) who handed the specimens to us. The capture was performed using plastic traps with banana and yeast placed for 3 - 4 days. At the province of Entre Ríos, *D. suzukii* flies were collected using banana baited traps with live yeast in ripe *Citrus sinensis* (L) Osbeck (oranges) of the variety Valencia and *Morus* sp. L (mulberries) at the Experimental Agricultural Station “Estación Yuqueri” of the Instituto Nacional de Tecnología Agropecuaria (INTA) near Concordia city. Plastic traps with banana and yeast were placed for 3 - 4 hours at ground level between mid-afternoon and sunset. Finally, *D. suzukii* flies emerged from *Rubus idaeus* L (raspberries) collected in commercial plantations at two localities in the Province of Río Negro: Choele Choele and General Roca. Fruits picked at the field were taken to the lab, placed in Petri dishes with filter paper discs on the base and stoked in breeding chambers at  $20 \pm 1$  °C and a 16-h light: 8-h dark cycle. Pupae were observed at 6 to 7 days from arrival and adults emerged at days 7 to 10. Collection sites are shown in Figure 1 (white points, see enlarged box) together with those sites where *D. suzukii* presence has been previously reported in the South American continent. The identification of *D. suzukii* adults was based on external sexual dimorphic characteristics: males by the dark spot on the distal part of wings and by the two rows of sex combs on the foretarsi, and females by the distinctive large serrated oviscapt in their terminalia observed in a stereo microscope. Adult females and male specimens, and also eggs and pupae samples from the different collection sites are shown in Figure 2.

*Drosophila suzukii* represents 21% of the total sample of drosophilid flies in the sample from Ticucho locality (Fig. 1; Table I). Interestingly, the collection at this site was performed in an area where wild native cacti of the genus *Opuntia* are the main host available. As reported elsewhere (González et al., 2015; Wang et al., 2016), *Opuntia* can be an alternative non-crop host for *D. suzukii* in suitable habitats. In Concordia area, our findings indicate that *D. suzukii* represents 6.8% of the total drosophilids collected in traps at the mulberry plantation, and 1.7% at Valencia orange plantation (Fig. 1; Table I). Although mulberries are considered one of the preferred fruit hosts of *D. suzukii* (Lee et al., 2015), our collecting data reveals a low relative abundance of this species in relation to other drosophilids. This could be the result of an inefficient trapping methodology and/or a consequence of low population size for *D. suzukii* given the recent colonization of this area. On the other hand, fly samples collected at the orange plantation in

Locality (Province)	Geographic coordinates	Host	Date of collection	<i>Drosophila suzukii</i>		Other Drosophilidae <sup>1</sup>	Relative abundance of <i>D. suzukii</i> (%) <sup>2</sup>
				Females	Males		
Ticucho (Tucumán)	26°33'39.9"S, 65°15'27.47"W	Unknown Host (possibly <i>Opuntia</i> cacti)	February, 2015	6	2	31	21.00
Concordia (Entre Ríos)	31°22'38.2"S, 58°07'07.1"W	Orange	December, 2014	-	4	237	1.70
	31°22'30.9"S, 58°07'16.9"W	Mulberry	December, 2014	5	9	191	6.80
Choele Choel (Río Negro)	39°18'12.42"S, 65°41'21.03"W	Raspberries	March, 2014	12	5	8	68.00
General Roca (Río Negro)	39°01'54.23"S, 67°38'33.78"W	Raspberries	March, 2014	22	3	5	83.00

**Table I Collection sites, geographic coordinates, hosts, dates of collection, total number of *Drosophila suzukii* and its relative abundance in the present study.** <sup>1</sup> All Drosophilidae were identified using the key reported by McAlpine (1981), *D. suzukii* flies were identified by the peculiar external sexual morphological characteristics of this species. <sup>2</sup> Calculated as the percentage of *D. suzukii* over the total of drosophilids sampled.

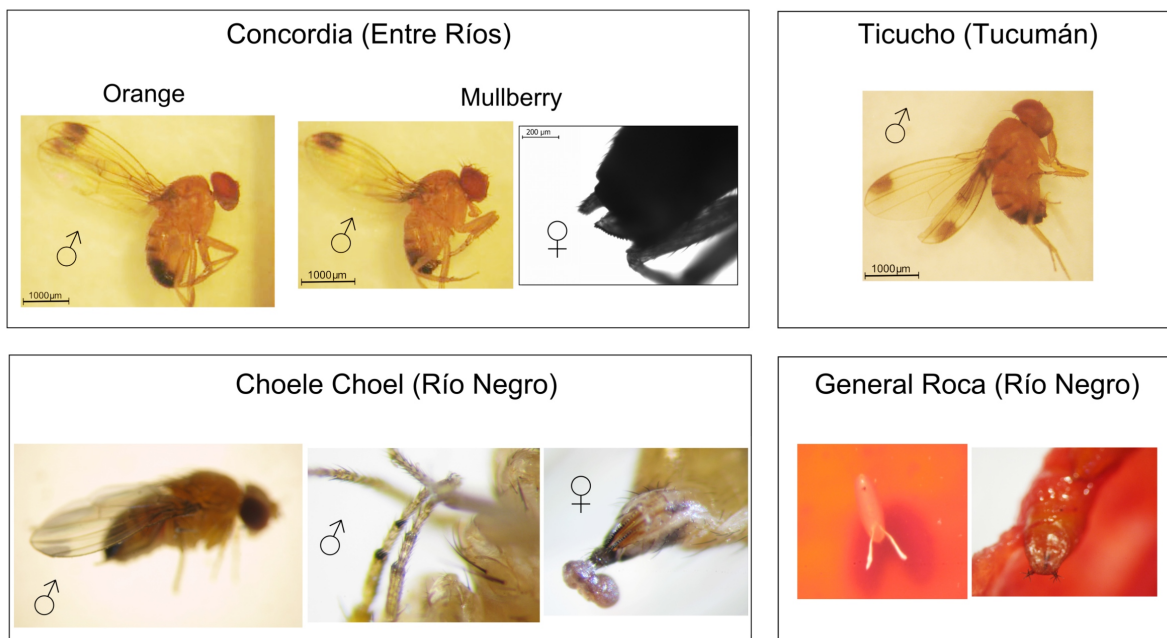


**Fig. 1. Map showing the location sites where *D. suzukii* was found in South America: new data (white dots) and previous reports (black dots). Zoom-in shows the new records in a map with political borders of the Argentinean provinces.** Geographic sites of previously reported presences of *D. suzukii* in South America where obtained from Bitner-Mathé et al. (2014), Deprá et al. (2014), dos Santos (2014), Paula et al. (2014), Vilela & Mori (2014), González et al. (2015), Santadino et al. (2015), Santos Geisler et al. (2015), Andreatza et al. (2016), Wollmann et al. (2016), and Lue et al. (2017).

Concordia agree with the reports showing that *D. suzukii* can use hard skinned fruits as hosts, such as oranges, as long as they are overmature, decaying or previously damaged (see Vilela & Mori, 2014; Asplen et al., 2015; Andreatza et al., 2017 for reviews). The relative high abundance of *D. suzukii* that emerged from raspberries in Choele Choel and General Roca localities, 68% and 83% respectively (Fig. 1; Table I), evidence the known preference of this species for this cultivated exotic host (Abraham et al., 2015; Poyet et al., 2015). This record represents the presence of *D. suzukii* at southernmost latitude in South America, as shown in Figure 1.

All in all, here we present new data on the recent invasion and on the geographic distribution of *D. suzukii* in South America. Our data show the spatial expansion of *D. suzukii* niche in the southern areas of the American continent. *Drosophila suzukii* was detected in areas near the Atlantic coast in subtropical Atlantic rainforest in southeast Brazil (Bitner-Mathé et al., 2014; Deprá et al., 2014; dos Santos, 2014; Paula et al., 2014; Vilela & Mori, 2014; Santos Geisler et al., 2015; Andreatza et al., 2016; Wollmann et al., 2016), in the southern coast of Uruguay (González et al., 2015) and in the pampean phytogeographical region in the province of Buenos Aires, Argentina (Santadino et al., 2015). We report a new record of *D. suzukii* in the locality of Concordia. Same as previous reports in a locality of the province of Buenos Aires, this location presents a Cfa climate

(according to Koppen-Geiger classification) with subtropical and temperate climate with rainy weather, well-defined seasons with negative temperatures in winter and warm summers. The novel report of *D. suzukii* in Ticucho is located in an area with a Cwa climate, with a desert warm-temperate climate and a hot summer. Meanwhile, *D. suzukii* was previously reported in the locality of Anillaco, Province of La Rioja (Lue et al., 2017), which presents, like Ticucho, a Bwk climate but is located south and closer to the Andes mountains than Ticucho. These reports, together with the novel finding of *D. suzukii* in the Argentinean Patagonia with a cold and arid Bsk climate, evidence a geographic extension of *D. suzukii* in South America to areas with different climates and away from the Atlantic coast region, one of the proposed starting points of invasion. In this scenario the invasion follows an east to west route. As an alternative, the invasion could have gone from a west to east route, from the pacific through the Andes mountains to nearby localities in the Patagonia and west Argentina regions. Future surveys that include, for example phylogeographic approaches, would have to resolve this issue. Finally, there is evidence to consider the status of *D. suzukii* from an “unconfirmed or expected presence” proposed by Asplen et al. (2015) to an incipient confirmed presence in southern areas of South America. Further studies are needed to understand the dynamics of this pest in different ecosystems, especially



**Fig. 2. Images of different stages of the life cycle of *Drosophila suzukii* from samples collected at new localities reported in the present study** Females were photographed using a camera mounted on a Leica DMLB stereo microscope using Leica Application Suite 4.0 software. Males were photographed using a camera mounted on a Leica MZ6 stereo microscope. Embryo and pupa from General Roca were photographed using a digital camera Canon PowerShot G9 mounted with Soligor Adaptor Tube G7 on a Zeiss Stemi DV4 Stereo Microscope.



in agroecosystems to mitigate a potential negative impact on the regional economies in South America.

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