Infestation of Malpighia emarginata (Malpighiaceae) by Drosophila suzukii (Diptera: Drosophilidae) in São Paulo State, Brazil

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Infestation of *Malpighia emarginata* (Malpighiaceae) by *Drosophila suzukii* (Diptera: Drosophilidae) in São Paulo State, Brazil

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Drosophila suzukii Matsumura (Diptera: Drosophilidae), also known as the cherry fly or spotted wing drosophila, is possibly native to Asia (Deprá et al. 2014). It is a holometabolous insect that develops its life cycle in 8 to 14 d, depending on the temperature (Cole et al. 2014). Its immature stages develop mainly within fruits. Pupation may occur inside or outside the fruit, but more commonly within the fruit. Adults are winged, measure 2 to 3 mm long, having red eyes, a brown or yellowish-brown thorax and abdomen, and black bands on the abdomen (Walsh et al. 2011). Sexual dimorphism in adults is quite distinct. The females have a sclerotized and serrated ovipositor that distinguishes them from the other drosophilids (Miller et al. 2017) and allows them to infest and physically damage fruits. Males are characterized by a dark spot on the edge of each wing, which is not evident in females (Nikolouli et al. 2018).

Most *Drosophila* species are not considered pests of developing fruit because their immature stages develop in damaged or rotten fruits. However, *D. suzukii* is considered a fly of economic importance, because the damage caused by oviposition and feeding by the larvae lower the quality of fruits, making them non-marketable (Walsh et al. 2011). This results in significant economic losses to fruit crops (Goodhue et al. 2011).

Global fruit production and the invasive characteristic of *D. suzukii* have contributed to make this fly one of the principal insect pests in fruit crops in North America, South America, Asia, and Europe (Asplen et al. 2015). In addition to invasive biology, the spotted wing drosophila is also extremely polyphagous, and attacks a large number of commercial fruit crops (Lee et al. 2015; Kenis et al. 2016; Nikolouli et al. 2018). However, *D. suzukii* prefers to oviposit on red and soft-skinned fruits such as blackberries (*Rubus* spp.; Rosaceae), cherry (*Prunus avium* L.; Rosaceae), raspberry (*Rubus idaeus* L.; Rosaceae), blueberry (*Vaccinium corymbosum* L.; Ericaceae), and strawberry (*Fragaria ananassa* Duchesne ex Rozier; Rosaceae) (Lee et al. 2011, 2015).

The invasive and polyphagous characteristics of *D. suzukii* also have been confirmed in Brazil, where its first occurrence was recorded in 2013 in the states of Santa Catarina and Rio Grande do Sul (Deprá et al. 2014). Since then there have been reports of its occurrence in 5 other Brazilian states in the central-west, southeastern, and southern regions of Brazil (Andreazza et al. 2017; Zanuncio-Junior et al. 2018).

The first report of *D. suzukii* occurring in the state of São Paulo was in 2014 in the city of São Paulo. It was recovered from fruit bought in the market and grown in the southern region of Brazil, where the fruit was probably infested (Vilela & Mori 2014). Another report of the occurrence of *D. suzukii* in the state of São Paulo was in the municipality of Itatiba in 2014, where it was captured in adult traps (banana baits) (Batista et al. 2017).

Early damage by *D. suzukii* in Brazil includes strawberries produced in the state of Rio Grande do Sul (Santos 2014). The damage was characterized as both primary and secondary. The primary damage was related to oviposition and larval feeding (Fig. 1A), whereas secondary damage was due to invasion by microorganisms such as fungi and bacteria (Santos 2014). These 2 types of damage cause fruit quality loss resulting in decline of production and sale of fruits.

Considering the importance of knowledge on the spatial distribution of pest insects, their host utilization, and the damage potential of *D. suzukii* to fruit production in Brazil (Benito et al. 2016), our objectives were to determine the infestation potential of acerola (also known as Barbados cherry), *Malpighia emarginata* Sessé & Moc. ex DC (Malpighiaceae), by *D. suzukii* in the state of São Paulo.

In May 2018, a sample of acerola was collected at the Advanced Center for Research in Plant Protection and Animal Health of the Instituto Biológico in Campinas, São Paulo State, Brazil (22.907672°S, 47.016620°W; 699 masl) for recovery of species of Tephritidae. However, 3 specimens of drosophilids with wing spots were recovered. After confirming that these specimens were *D. suzukii*, a new collection was made in Jun 2018 of 41 fruits of acerola. The fruits collected were attached to the plant, had reddish skin color, and were not decaying (as shown in Fig. 1B). Each fruit was measured for length, diam, and weight. They were then individually deposited in 50 mL plastic cups (Copaza, Içara, Santa Catarina, Brazil) containing a thin layer of vermiculite on the bottom. The pots were covered with voile fabric which was fastened with elastic. Each pot was numbered and the information of each fruit was recorded with its respective number. The samples were conditioned at 25 ± 1 °C, 70 ± 10% relative humidity, and a photoperiod of 12:12 h (L:D). After 20 d, the puparia were separated from the vermiculite for sorting and counting. The recovered adults were counted and maintained in Eppendorf tubes containing 70% ethanol for further identification. The identification of adults was based on the observation of morphological characteristics following the keys illustrated by Miller et al. (2017) for *D. suzukii* and Zucchi (2000) for Tephritidae and Braconidae. We consider that the recovery of puparia and adults of *D. suzukii* in fruit samples confirmed acerola as a suitable host of *D. suzukii*. The separation of fruit samples was used to assess if *D. suzukii* was the only insect recovered from each sample of acerola. This also allowed us to precisely quantify infestation rate (puparia per fruit and puparia per g of fruit) (Souza-Filho et al. 2000).

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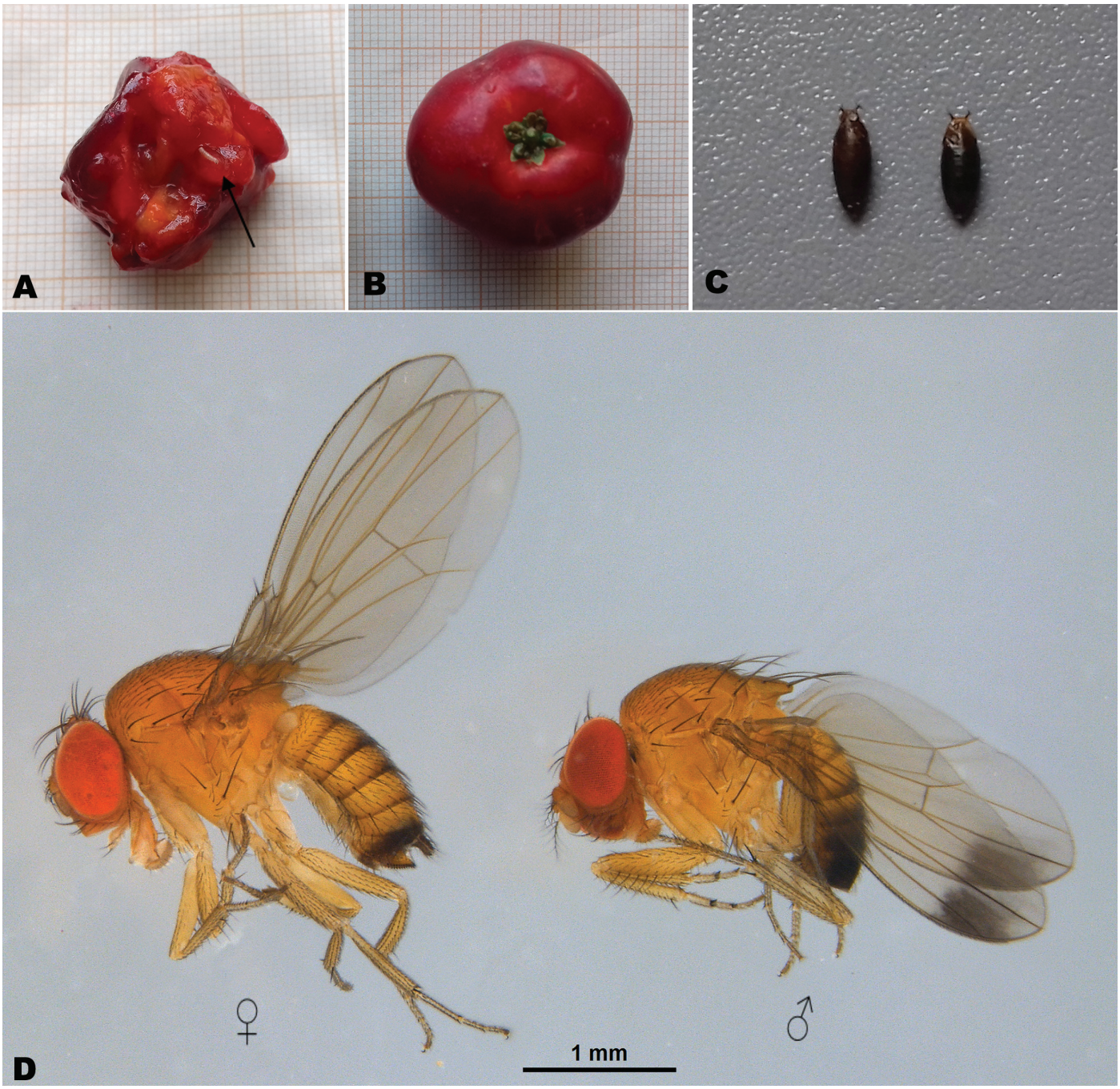

Fig. 1. Fruit damaged by prominent drosophilid larvae (A), fruit of acerola (B), drosphilid puparia (C), and adults of *Drosophila suzukii* (Diptera: Drosophilidae) (D).

Sixty-four puparia were recovered, of which 47 were of *D. suzukii* (Fig. 1C) and 17 were Tephritidae. Thirty-three adults of *D. suzukii* (22 females and 11 males) (Fig. 1D), 5 tephritids, and 11 braconids emerged. Of the 41 fruits collected, we recovered adults of *D. suzukii* in 17, and in 12 fruits, it was the only insect to emerge (Table 1). Infestation rate for *D. suzukii* varied from 1 to 5 puparia per fruit and 0.19 to 1.58 puparia per g of fruit.

In this study, we confirmed the first recorded the infestation of acerola fruits by *D. suzukii*, and determined that acerola frequently serves as host for spotted wing drosophila. Confirmation of acerola as a suitable host of *D. suzukii* was made by the recovery of both puparia and adults. Thus, it appears that this fly can complete its life cycle using fruits of acerola as the host. The observation that *D. suzukii* was, in many cases, the only insect recovered from individual fruit samples (Table 1) suggests that it may be a primary invader. Further work is needed to ascertain that it can oviposit successfully without the presence of pre-existing wounds or other damage to the fruit.

Considering the importance of acerola production for the state of São Paulo, which was as high as 3,927 metric tons and 524 ha in 2017 (IBGE 2017), *D. suzukii* has the potential to be a serious insect pest of this crop. Thus, studies on the distribution of *D. susukii* and its host utilization are important to understand the role of this insect as a fruit pest in Brazil. *Drosophila suzukii* already has been shown to be an insect with dispersal potential (Andreazza et al. 2017) and impact on cultivated fruits in Brazil (Andreazza et al. 2016; Benito et al. 2016). In addition, it can occur in production areas (Santos 2014) and forests.

Table 1. Length, diameter, weight, rate of infestation and species recovered from individualized acerola samples collected in Campinas, São Paulo, Brazil.

				Infestation rate		
Fruit	Length (cm)	Diam (cm)	Weight (g)	Puparia per fruit	Puparia per g	Species (quantity)
1	1.7	2.1	4.3	3	0.69	*Drosophila suzukii* (1), *Doryctobracon areolatus* (1)
2	1.9	2.5	6.9	6	0.86	*D. suzukii* (3), *D. areolatus* (1)
3	2.0	2.3	6.4	3	0.46	*D. areolatus* (1)
4	1.9	2.6	6.5	0	0.00	—
5	1.8	2.2	5.3	5	0.94	*D. suzukii* (3), *D. areolatus* (1), *Anastrepha* sp. (1)
6	2.0	2.1	4.1	1	0.24	*D. areolatus* (1)
7	1.8	2.3	5.4	1	0.18	—
8	1.7	2.1	4.1	1	0.24	*D. suzukii* (1)
9	1.6	2.0	3.8	4	1.05	*D. suzukii* (3)
10	1.6	2.1	4.2	3	0.71	*D. suzukii* (2), *Utetes anastrephae* (1)
11	1.6	1.9	3.7	1	0.27	*Anastrepha* sp. (1)
12	1.7	2.2	4.5	2	0.44	*D. areolatus* (2)
13	1.5	1.9	3.2	1	0.31	*D. suzukii* (1)
14	1.6	1.9	3.2	0	0.00	—
15	1.8	2.2	4.8	0	0.00	—
16	1.7	2.3	5.5	0	0.00	—
17	1.6	2.1	4.1	3	0.73	*D. suzukii* (1)
18	1.6	2.2	4.5	2	0.44	*D. areolatus* (1), *A. fraterculus* (1)
19	1.5	2.0	3.7	0	0.00	—
20	1.7	2.2	4.7	3	0.63	*D. suzukii* (1)
21	1.7	2.0	3.9	0	0.00	—
22	1.7	2.1	4.1	2	0.48	*D. areolatus* (2)
23	1.6	1.9	3.2	3	0.93	*D. suzukii* (3)
24	1.4	1.8	2.8	1	0.35	*D. suzukii* (1)
25	1.6	1.8	3.2	5	1.56	*D. suzukii* (4)
26	1.6	2.0	3.5	0	0.00	—
27	1.4	1.6	2.3	0	0.00	—
28	1.4	1.7	2.4	3	1.25	*D. suzukii* (2), *A. fraterculus* (1)
29	1.4	1.7	2.4	0	0.00	—
30	1.7	2.0	3.8	0	0.00	—
31	1.4	1.7	2.4	1	0.41	*A. fraterculus* (1)
32	1.5	1.8	2.7	0	0.00	—
33	1.4	1.6	2.1	1	0.47	—
34	1.5	1.8	2.9	2	0.68	*D. suzukii* (2)
35	1.6	2.0	3.4	2	0.58	*D. suzukii* (1)
36	1.3	1.5	1.9	3	1.57	*D. suzukii* (3)
37	1.4	1.6	2.0	2	1.00	*D. suzukii* (1)
38	1.3	1.8	2.1	0	0.00	—
39	1.3	1.6	1.4	0	0.00	—
40	1.1	1.4	1.0	0	0.00	—
41	2.0	2.1	3.5	0	0.00	—

It is likely that *D. suzukii* is causing damage already to fruit in Brazil. However, due to the confusion between females of *D. suzukii* and other non-pest drosophilids (Santos 2014), the small size of *D. suzukii*, and the lack of knowledge by the Brazilian producers about this insect, the occurrence of *D. suzukii* and its damage in commercial fruit crops in Brazil is not fully appreciated.

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Summary

After the first record of *Drosophila suzukii* Matsumura (Diptera: Drosophilidae) in Brazil in 2013, this insect pest was able to spread through several Brazilian regions. This power of dissemination is probably linked to the invasive biology and polyphagous habit that *D. suzukii* has shown in several countries, including Brazil. In this study, we recorded the infestation of acerola fruits (*Malpighia emarginata* Sessé & Moc. Ex. DC) (Malpighiaceae) by *D. suzukii* and discuss its status as a potential pest of this fruit.

Key Words: first record; spotted wing drosophila; acerola; red fruit; primary invader

Sumário

Após o primeiro registro de *Drosophila suzukii* Matsumura (Diptera: Drosophilidae) no Brasil em 2013, esse inseto praga conseguiu se disseminar por várias regiões brasileiras. Esse poder de disseminação provavelmente está ligado a biologia invasora e polifagia que *D. suzukii*

tem mostrado em vários países, inclusive no Brasil. Neste estudo, nós registramos a infestação de *D. suzukii* em frutas de acerola (*Malpighia emarginata* Sessé & Moc. ex DC.) (Malpighiaceae) e discutimos seu status potencial de praga para essa frutífera.

Palavras Chave: primeiro registro; spotted wing drosophila; acerola; fruta vermelha; invasor primário

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