

First record of the invasive vinegar fly *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae) from eastern Turkey

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Received: 19.12.2014 • Accepted/Published Online: 05.09.2015 • Final Version: 05.02.2016

Abstract: *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae) is native to East Asia and invasive on the European and American continents. The first records in both Europe and the United States were in 2008. Since that year, it has widely moved across these continents. As *D. suzukii* females lay eggs in healthy ripening fruits of several species, particularly in small soft fruits and berries, the species causes agricultural damage. The soft thin-skinned fruit pest, identified as *D. suzukii*, has been found in Erzurum, Turkey, where damaged strawberry crops were observed and cultured in the middle of August and September 2014. Initially, 2 adults, 3 pupae, and several larvae were observed. Emergence of male and female adults continued for 10 more days. Here we report the first finding of *D. suzukii* in Turkey.

Key words: Spotted-wing drosophila, Anatolia, invasive species, small-fruit crop pest

Invasive vinegar fly *Drosophila suzukii*, commonly known as spotted-wing drosophila (SWD), is a fruit crop pest endemic to Southeast Asia (Walsh et al., 2011) and was first reported outside of this region in Hawaii in the 1980s (Hauser, 2011). The first records from the North American mainland were made in 2008 from central California, USA (Hauser et al., 2009), and it is now widespread throughout the central and southern states, causing agricultural damage to summer fruits such as cherries, strawberries, and peaches (Hauser, 2011). The first records in Europe of *D. suzukii* were in Spain and Italy in 2008, simultaneously (Raspi et al., 2011; Calabria et al., 2012; Cini et al., 2012). However, spatial analysis of its distribution across Europe suggested the south of France as the most likely spreading center (Cini et al., 2014). Considering the close proximity of these first records to ports, it is likely that the first individuals may have arrived as eggs or larvae in fruits that had been sea-traded from Asia (Rota-Stabelli et al., 2013). The first report of crop damage in Europe was in northern Italy (Grassi et al., 2009; Calabria et al., 2012). It has also been detected in various localities across Europe (as shown in Figure 1), expanding across an altitudinal range from 27 to 1550 m above sea level; SWD has spread approximately 1400 km through infested fruits (Hauser, 2011; Calabria et al., 2012; Kiss et al., 2013).

D. suzukii is taxonomically classified under genus *Drosophila* and subgenus *Sophophora* as a member of the *melanogaster* species group and within the *suzukii* species subgroup (Yang et al., 2004; Ashburner et al., 2005). In contrast to common drosophilids, which oviposit on damaged or rotting fruits, females of *D. suzukii* lay eggs under the soft skin of healthy, ripening fruits by using their sharp and serrated ovipositor, which wounds the host physically and leaves it vulnerable to secondary contagion by pathogens (Sasaki and Sato, 1995; Cini et al., 2012). Developing larvae, hatched from eggs, cause the fruit to become soft and rotten, which leads to substantial crop deterioration, thus making *D. suzukii* an economically damaging pest (Goodhue et al., 2011). Although it is difficult to estimate financial damage caused by a scientifically unknown pest such as *D. suzukii*, yield losses of 20% and 80% were reported in the United States in 2008 and 2009, respectively (Bolda et al., 2010; Walsh et al., 2011). In Europe, losses of up to 80% occurred in the strawberry crops of southern France in 2010 (Lee et al., 2011). Originally described in insect illustrations from Japan, *D. suzukii* is a red-eyed drosophilid with a yellowish brown thorax and pale brown abdomen with black transverse stripes. Males are easily recognized by having a distinct apical wing spot and 2 sets of short sex

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Figure 1. Distribution map of *D. suzukii* in Europe based on published records. Data from Baroffio and Fisher (2011), Lethmayer (2011), Milek et al. (2011), Raspi et al. (2011), Seljak (2011), Calabria et al. (2012), EPPO (2012), Mortelmans et al. (2012), Vogt et al. (2012), Kiss et al. (2013), Marongiu et al. (2013), Rota-Stabelli et al. (2013), Cini et al. (2014), EPPO (2014 a, b), Toševski et al. (2014), Zovko (2014), and EPPO (2015a, 2015b, 2015c) (● = previous records with fewer than 10 localities; ■ = previous records with more than 10 localities; ★ = new record).

combs on the first and second tarsal segments of the fore leg (Figures 2a and 2b). Wing spots allow *D. suzukii* males to be distinguished from other species in the polyphyletic *suzukii* subgroup, which includes mainly Oriental species; however, 2 exceptions to this are *D. biarmipes* (EPPO, 2013) and *D. subpulchrella* (Takamori et al., 2006; EPPO, 2013). Despite the similar spotting of the wings, these 2 closely related species can be differentiated from *D. suzukii* by their sex combs, as *D. biarmipes* has 2 combs on the first segment of the fore tarsi instead of 1, and *D. subpulchrella* shows 2 sets of combs in each segment, but facing different directions, not in a single row as seen in *D. suzukii* (Hauser, 2011). Male genitalia are also characteristic and an indicator for species identification (Takamori et al., 2006; Walsh et al., 2011).

On the other hand, females are characterized by a large, sharp, serrated ovipositor with dark teeth, which allows them to lay eggs on healthy, ripening fruits by breaking the fruit's soft skin (Calabria et al., 2012) (Figure 3). This distinct combination of serrated ovipositor in females and wing spots and sex combs in males is characteristic in *D. suzukii* and is not found in any other species of Nearctic or Palearctic origin (Calabria et al., 2012).

In this paper, we report the first record of *D. suzukii* from the province of Erzurum, located in the Eastern Anatolian Region of Turkey.

On 24 September 2014, ripening strawberry crops potentially infested by a drosophilid were observed in Erzurum (39°54'27.2"N, 41°16'18.3"E; Figure 1) and collected for further analysis. Damaged crops (Figure 4)

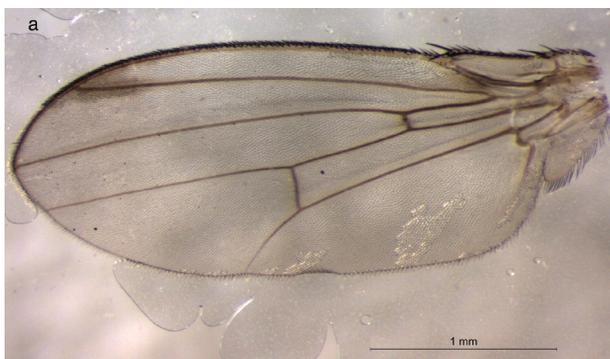


Figure 2. Photograph of male *D. suzukii*. (a) Wing with single dark spot near wing tip (scale bar: 1 mm); (b) front feet with 2 sex combs (scale bar: 0.2 mm).



Figure 3. Photograph of *D. suzukii* female's serrated ovipositor with dark teeth.

were collected from the garden of the Department of Horticulture at Atatürk University's Faculty of Agriculture, then placed into plastic tubs and cultured in standard laboratory conditions (25 ± 2 °C and $50 \pm 5\%$ humidity). Two adults, 3 pupae, and several larvae were observed the following day. Emergence of adults continued for 10 more days. Adults were collected from tubs and transported in ethanol to the Genetics Laboratory at Hacettepe University's Department of Biology for advanced morphological identification. Identification was carried out using a Leica EZ4 stereomicroscope. Six females and 2 males were observed. All observations were photographed. A distinct apical wing spot was observed in all male flies (Figure 2a), and the characteristic 2 sets of sex combs were also present in all males (Figure 2b). In addition, 2 female adults had serrated ovipositors with dark teeth (Figure 3). Thus, all laboratory identification showed that the collected drosophilids were indeed *D. suzukii* adults. Specimens were deposited in the collection of the Entomology Museum, Erzurum, Turkey (EMET).

Identification of drosophilid species is often difficult, because of the fact that there are few available sources that include all known species, especially those of less-studied pests. Morphological characters are effective enough for adult flies for a species-level identification, but immature stages can only be identified by using molecular techniques (Hauser, 2011). We identified adult flies through their



Figure 4. General view of strawberry found in Department of Horticulture at Atatürk University's Faculty of Agriculture, Erzurum, damaged due to *D. suzukii* larvae feeding. (photo by Göksel Tozlu).

morphological characters. Consequently, *D. suzukii* is a new record for the Turkish *Drosophila* fauna.

The damage caused by *D. suzukii* larvae feeding on fresh fruits, especially cherries and berries, makes the fruit useless for the market (Rota-Stabelli et al., 2013). Thanks to its high ecological adaptability and compliance with different growing techniques, strawberry (*Fragaria × ananassa* Duch.) is one of the most cultivated and commercially valued fruits in the world. Anatolia has considerable advantages in terms of strawberry cultivation, and perennial production is likely with respect to its high ecological diversity. Since the beginning of cultivation in Turkey, more than 50 short-day and day-neutral varieties were tested for growing in the Mediterranean Region in particular, as well as in the Marmara and Aegean Regions, and in parts of the Black Sea and Eastern Anatolia Regions. Adaptation experiments showed some region-variety correlation, as day-neutral varieties, which have growing potential in both summer and fall seasons, are predominantly cultivated in Erzurum (Ağaoğlu, 1986). Based on observations conducted in the aforementioned garden, and due to the estimated damage on strawberry production being as high as 80% for this season, it is supposed that *D. suzukii* could be a potential agricultural pest for strawberries and other summer fruits cultivated in the area, and pest management studies should be considered hereafter.

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