

Spotted-Wing *Drosophila* *Drosophila suzukii* (Matsumura) (Insecta: Diptera: Drosophilidae) ¹

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Introduction

Drosophila or pomace flies are small insects commonly found in association with over-ripened or rotten fruits and vegetables. There are approximately 1,500 known species in the genus *Drosophila* (Markow and O'Grady 2006). *Drosophila* flies are sometimes called small fruit flies. However, true fruit flies belong to the family Tephritidae. Not only are they larger, but they are common and often important agricultural pests (Green 2002). The vast majority of *Drosophila* flies are associated with rotten or over-ripened fruits and are nuisance pests. However, a few species such as the spotted-wing drosophila, *Drosophila suzukii* (Matsumura), can infest un-ripened fruits and are of economic significance. First detected within the continental United States in August 2008, *Drosophila suzukii* has become a serious threat to fruit crops.

Distribution

Drosophila suzukii is native to southeast Asia and is widely distributed in China, India, Korea, Myanmar, Russia, and Thailand (Toda 1987, Oku 2003, Hauser et al. 2009). Within Europe, this species is also widely distributed in France, Italy and Spain (European and Mediterranean Plant Protection Organization 2010). Within the United States, it has been established in Hawaii since 1980 (Kaneshiro 1983). In the continental US, it was first detected in Santa Cruz County, California, on caneberry and strawberry

plants (Bolda et al. 2010). Since then, it has rapidly spread to new areas including Florida, Louisiana, Michigan, North Carolina, Oregon, South Carolina, Utah, Washington, and Wisconsin in the US, and British Columbia in Canada (Walsh et al. 2011).

Description

Adults

Florida is home to at least 27 additional *Drosophila* spp. including *Drosophila melanogaster*. Some of these could easily be confused with *Drosophila suzukii* due to their spotted-wings. Therefore, expert examination by a specialist is needed for positive identification and confirmation (Steck et al. 2009).

Drosophila suzukii adults are small (3–4 mm) yellowish-brown flies with red eyes. The adults have a pale brown or yellowish-brown thorax with black bands on the abdomen. The antennae are short and stubby with branched arista. Males have a distinguishing dark spot along the front edge of each wing. Spotless males are also possible, but are rarely observed in the field and should be verified by a taxonomist for positive identification. In addition, males have two rows of combs on each fore tarsus which are absent in females.

The females have a serrated ovipositor with which they penetrate the fruit skin. The serrations are much darker

1. This document is EENY492, one of a series of the Department of Entomology and Nematology, UF/IFAS Extension. Original publication date May 2011. Reviewed February 2017. Visit the EDIS website at <https://edis.ifas.ufl.edu>. This document is also available on the Featured Creatures website at <https://entnemdept.ufl.edu/creatures/>.

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than the rest of ovipositor (Kanzawa 1939; Walsh et al. 2011).



Figure 1. Adult male spotted-wing drosophila, *Drosophila sukuii* (Matsumura).

Credits: Martin Hauser, California Department of Food and Agriculture



Figure 2. Adult female spotted-wing drosophila, *Drosophila sukuii* (Matsumura).

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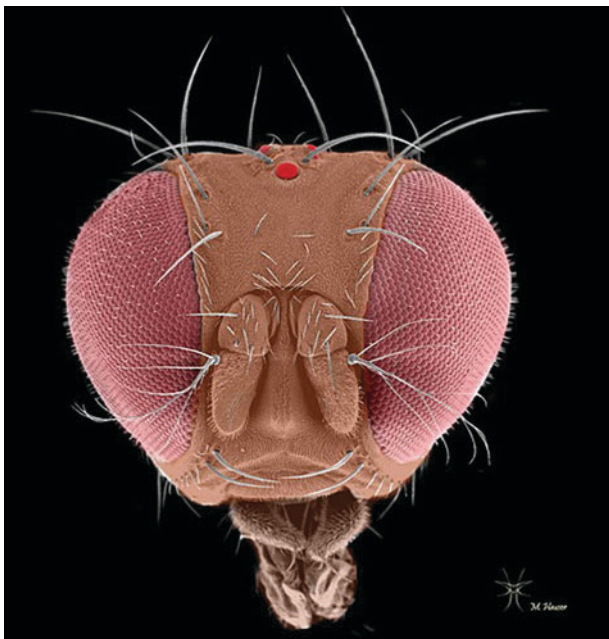


Figure 3. Head of an adult spotted-wing drosophila, *Drosophila sukuii* (Matsumura), frontal view.

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Figure 4. Wing of an adult male spotted-wing drosophila, *Drosophila sukuii* (Matsumura). Spotless males are also possible, but are rarely observed in the field.

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Figure 5. Ovipositor of an adult female spotted-wing drosophila, *Drosophila sukuii* (Matsumura), lateral view.

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Figure 6. SEM of an ovipositor of an adult female spotted-wing drosophila, *Drosophila sukuii* (Matsumura), lateral view.

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Eggs

The eggs are translucent, milky-white, and glossy. The eggs develop and hatch within the fruit in which they are laid (Walsh et al. 2011).

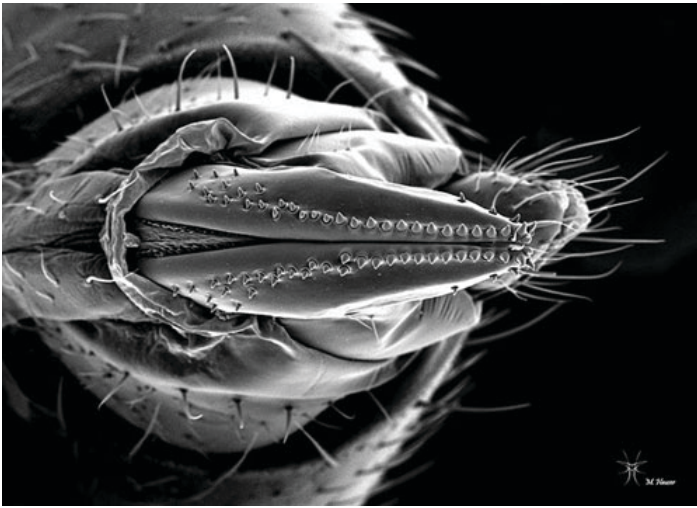


Figure 7. SEM of an ovipositor of an adult female spotted-wing drosophila, *Drosophila suzukii* (Matsumura), posterior view.
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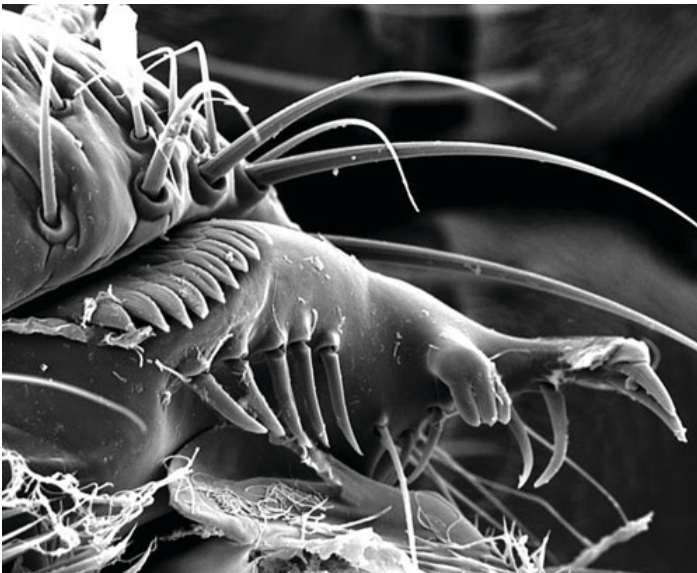


Figure 8. SEM of genitalia of an adult male spotted-wing drosophila, *Drosophila suzukii* (Matsumura).
Credits: Martin Hauser, California Department of Food and Agriculture

Larvae

The larvae are milky-white and cylindrical with black mouthparts. The body is tapered anteriorly with elevated posterior spiracles. First instar larvae are approximately 0.07 mm in length. Internal organs of larvae are visible after it has consumed some fruit. Larval development occurs inside the fruit and develops through three instars before pupation. Mature larvae may grow up to 6 mm in length (Kanzawa 1939; Walsh et al. 2011).

Pupae

The pupae are cylindrical, reddish brown with two small projections at the end. They are approximately 2–3 mm

long. Pupation can occur either inside or on the exterior of fruit.



Figure 9. Larvae of *Drosophila* spp. on overripe banana.
Credits: Whitney Cranshaw, Colorado State University, Bugwood.org



Figure 10. Pupae of *Drosophila* spp. on overripe banana.
Credits: Whitney Cranshaw, Colorado State University, Bugwood.org

Life Cycle

Drosophila suzukii prefers a moderate climate but can also survive in cold conditions (Kanzawa 1939). The flies are most active at 20°C (68°F). Activity becomes reduced at temperatures above 30°C (86°F) or below freezing. However, *Drosophila suzukii* is firmly established on the island of Hokkaido in Japan where winters average -4 to -12°C (Kimura 2004), suggesting the possibility of its establishment in cooler climates. Preliminary research from Oregon suggests that *Drosophila suzukii* larvae, pupae, and adults have the potential to survive fluctuating overwintering conditions for periods up to 60 days. Adults are able to withstand longer periods of cold conditions than larvae or pupae (Walsh et al. 2011). In general, *Drosophila* spp. are very sensitive to desiccation. However, sensitivity to desiccation depends upon climatic conditions and flies

could develop desiccation resistance over time (Davidson 1990; Bradley et al. 1999).

Like most *Drosophila* spp., reproduction in *Drosophila suzukii* is rapid. The total life cycle may be completed within one to two weeks depending upon the climatic conditions (Kanzawa 1939). Adult life span is about three to nine weeks. However, flies emerging late in the season overwinter and may live longer. In Japan, the fly produces 10 to 13 generations (Kanzawa 1939). Flies could survive up to 10 generations per year under California climate conditions (Walsh et al. 2011). The egg, larval and pupal stages last from 1–3, 3–13, and 4–5 days, respectively (Kanzawa 1939). Degree-day models on *Drosophila suzukii* suggest that the entire life cycle (egg to egg laying female) can be completed within 12 to 15 days at 18.3°C (65°F) or a little more than a week at 21.1°C (70°F) (Walsh et al. 2011).

A single female can lay one to 60 eggs per day and 200–600 eggs in her lifetime. A female lays approximately one to three eggs per oviposition site. The eggs are laid singly and are randomly distributed on fruits. Multiple clutches of larvae may be present on the same fruit because females may oviposit on the same fruit (Kanzawa 1939; Mitsui et al. 2006; Walsh et al. 2011).

Hosts

Drosophila suzukii has a wide host range, including:

- *Cornus kousa*, dogwood
- *Eugenia uniflora*, Surinam cherry
- *Fragaria ananassa*, strawberries
- *Morus* spp., mulberry
- *Murraya paniculata*, orange jasmine
- *Myrica rubra*, Chinese bayberry
- *Prunus* spp.—*P. avium*, sweet cherries; *P. domestica*, plums; *P. persica*, peaches
- *Pyrus pyrifolia*, Asian pears
- *Ribes* spp., currants
- *Rubus* spp.—*R. armeniacus*, Himalayan blackberries; *R. loganobaccus*, loganberries; *R. idaeus*, raspberries; *R. laciniatus*, evergreen blackberries; *R. ursinus*, marionberries
- *Vaccinium* spp., blueberry, cranberry
- *Vitis vinifera*, wine grape

The following hard fruits may be attacked if the skin is already broken:

- *Actinidia* spp., kiwi
- *Diospyros kaki*, persimmons
- *Eriobotrya japonica*, loquat
- *Ficus carica*, fig
- *Lycopersicon* spp., tomato
- *Malus domestica*, apple
- *Pyrus* spp., pear

Damage

Fruit infestation is initially manifested by scars on the fruit surface left by ovipositing females (stinging). The initial oviposition site becomes sunken. Damage is caused primarily by larvae feeding on fruit pulp turning the fruit flesh brown and soft. The larger larvae cut breathing holes in fruit. Infested fruit collapse around the feeding site very rapidly and rot due to mold or secondary infections (Beers et al. 2010).

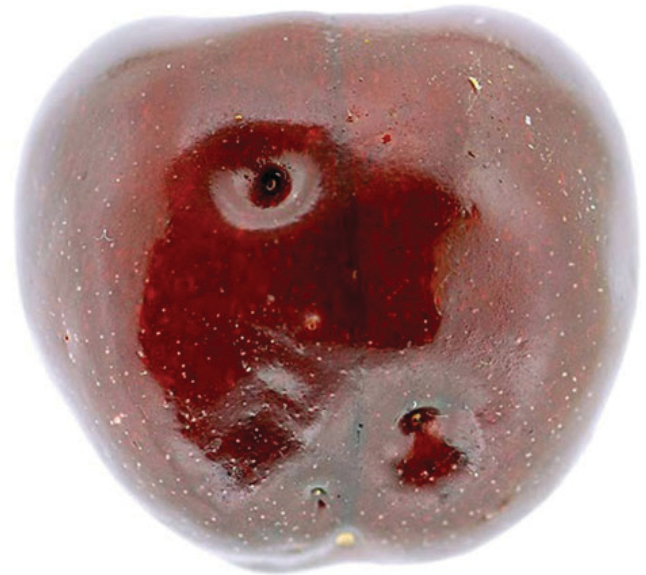


Figure 11. Oviposition scars from a female spotted-wing drosophila, *Drosophila suzukii* (Matsumura), on a cherry fruit.

Credits: Martin Hauser, California Department of Food and Agriculture

Management

Monitoring and Trapping

Management practices for spotted-wing drosophila are similar to those used to manage common *Drosophila* flies. Monitor adult fly populations before fruit begin ripening and before flies begin laying eggs. Bucket-style traps or quart containers used for monitoring other *Drosophila* flies can be effectively used for monitoring *Drosophila suzukii*. Mixtures of yeast, sugar, and water; fruit purees, distillates from apple cider vinegar or wine; ethanol, acetic acid, and phenylethanol in 1:22:5 ratios are potent baits

for monitoring *Drosophila suzukii* populations. However, traps baited with yeast-sugar-water mixtures facilitate easy identification of flies because of the clear color of the bait material. Addition of a small drop of dish soap as a surfactant or placement of a sticky card within the traps improves trap efficiency by retaining the flies which have already entered the traps. The traps perform best when deployed under cool and shady areas in the field (Walsh et al. 2011).



Figure 12. Simple funnel trap baited with vinegar to trap adult *Drosophila*.

Credits: Whitney Cranshaw, Colorado State University, Bugwood.org

Cultural Control

Good field sanitation is critical to prevent further spread of flies. Ripe fruit should be picked frequently to minimize population buildup. All damaged fruit should be removed from the field and destroyed, either by burial or disposal in closed containers. *Drosophila* flies are weak fliers but spread easily through infested fruits or by wind. Therefore, all nearby sources of fruit should be managed to eliminate flies (Ministry of Agriculture and Lands, British Columbia 2009).

Biological Control

Parasitoids from the families Braconidae and Cynipidae are potential biocontrol agents of *Drosophila suzukii*. *Orius insidiosus* has been reported to feed exclusively on *Drosophila suzukii*. (Kanzawa 1939; Dubuffett et al. 2009; and Walsh et al. 2011). However, the role of beneficial organisms in management of *Drosophila suzukii* has not been fully ascertained (Walsh et al. 2011).

Chemical Control

Insecticide sprays effective against other *Drosophila* flies are also effective against *Drosophila suzukii* adults. However, *Drosophila suzukii*'s preference for ripening fruit necessitates use of chemicals with shorter pre-harvest intervals (Walsh et al. 2011).

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