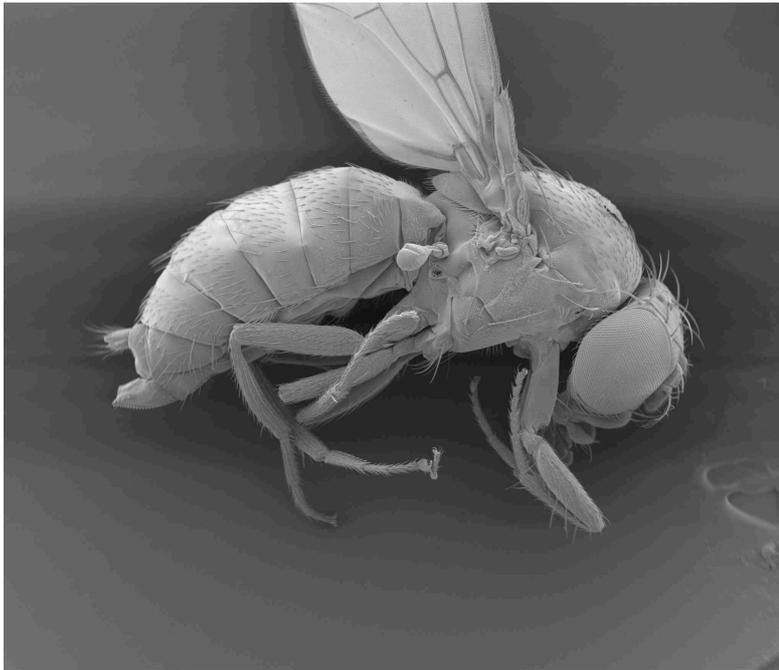


DROSOPHILA SUZUKII: A NEW INVASIVE SPECIES THREATENING EUROPEAN FRUIT PRODUCTION

It lays its eggs and feeds on unwounded ripening fruits of many plant species: Drosophila suzukii is a pest endemic to South East Asia able to threaten the fruit industry worldwide. Here an explanation of its biology and main impacts.



1. A new attack to fruit crops worldwide

The fly *Drosophila suzukii* was described the first time in 1931 by Matsumura. Its taxonomic position is *Diptera Drosophilidae* and it is also known as *Spotted Wing Drosophila* - SWD, in the USA.

This little insect is a pest endemic to South East Asia which recently invaded western countries where it is now threatening both the European and the American fruit industry, due to its egg laying and feeding on unwounded ripening fruits of many plant species.

Since 2009, *D. suzukii* has been reported so far in most of the Mediterranean countries in Europe and is rapidly spreading towards north and east. In most attacked countries *D. suzukii* caused extensive economic damage to small fruits.

Fully grown, *D. suzukii* are drosophilid flies (2-3 mm long) with red eyes, a pale brown or yellowish brown thorax and black stripes on the abdomen.

Key-features



The vinegar fly *Drosophila suzukii*, Spotted Wing Drosophila, is a highly polyphagous invasive pest endemic to South East Asia, which has recently invaded western countries.



Its serrated ovipositor allows this fly to lay eggs on and damage unwounded ripening fruits, thus heavily threatening fruit production.



D. suzukii is spreading rapidly and economic losses are severe, thus it is rapidly becoming a pest of great concern.



A major challenge is the present lack of effective and sustainable control methods, among insecticides, trapping/monitoring, cultural management, alternative controls.



Main host plants are blackberries, blueberries, cherries, peaches, raspberries, strawberries, grapes (wine and table), kiwis, apricots, figs, pears. Several alternative wild hosts

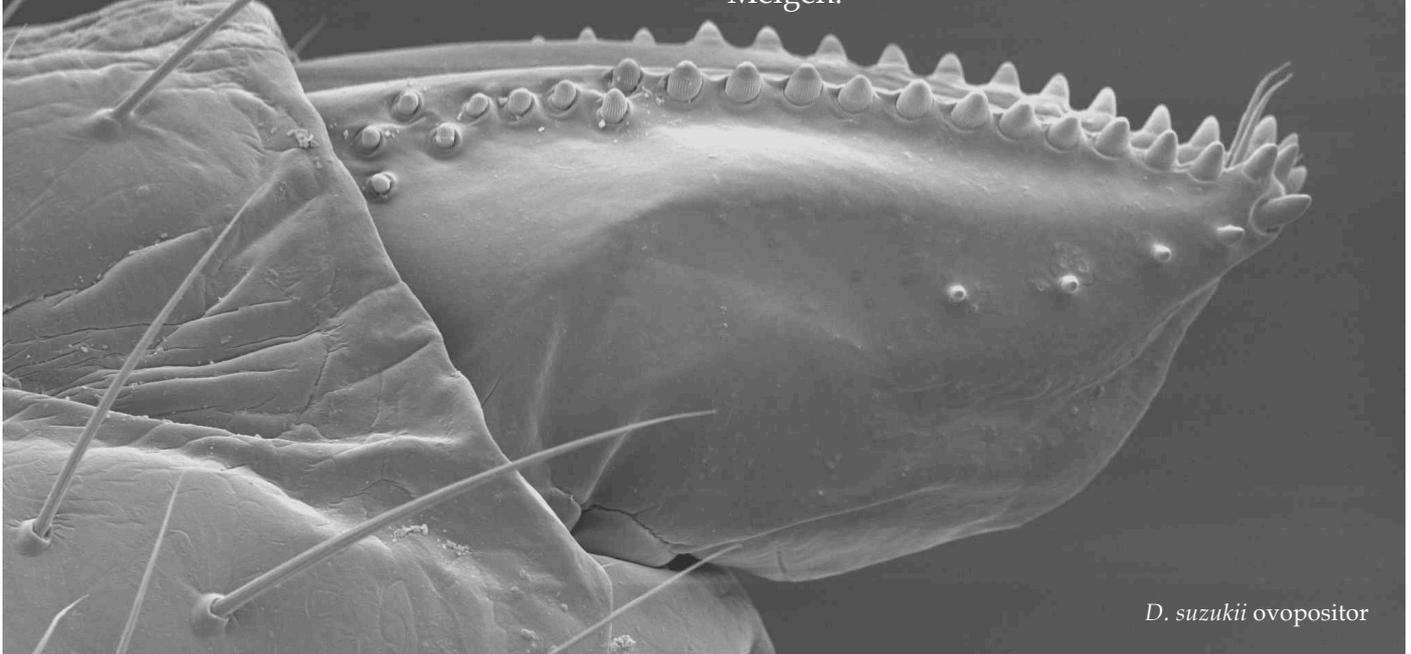


In this essay, authors explore the possible research approaches which may hopefully provide management solutions to the expanding challenge that *D. suzukii* poses to European fruit production.

Sexual dimorphism is evident: males display a dark spot on the leading top edge of each wing and females possess a large serrated ovipositor.

Other characteristics can be identified, such as the sex combs on the foretarsi (*D. suzukii* has one row of combs on the first and one row on the

second tarsal segment). *D. suzukii* belongs to the subgenus *Sophophora*, which is divided into several groups of species. One of them, the *melanogaster* species group, also contains the famous “workhorse” of experimental biology and genetics, *Drosophila melanogaster* Meigen.



D. suzukii ovipositor

The *melanogaster* group is further divided into species subgroups, one of which (the *suzukii* subgroup) composes, together with 6 other subgroups, the “oriental lineage”.

However, relationships between and within these subgroups are still far from being resolved, and the *suzukii* subgroup itself is commonly regarded as polyphyletic.

D. suzukii is currently spreading in many areas, such as the USA (West and East coast), Canada, Mexico and Europe.

In Europe it was first reported in autumn 2008 in Spain (Rasquera Province). In 2009 *D. suzukii* adults were recorded in traps in other regions of Spain (Bellaterra, near Barcelona), France (Montpellier and Maritimes Alpes) and Italy (Trentino). In the same year, in Trentino, the first oviposition on wild hosts (*Vaccinium*, *Fragaria* and *Rubus spp.*) and the first economically relevant damages on several species of cultivated berries were reported.

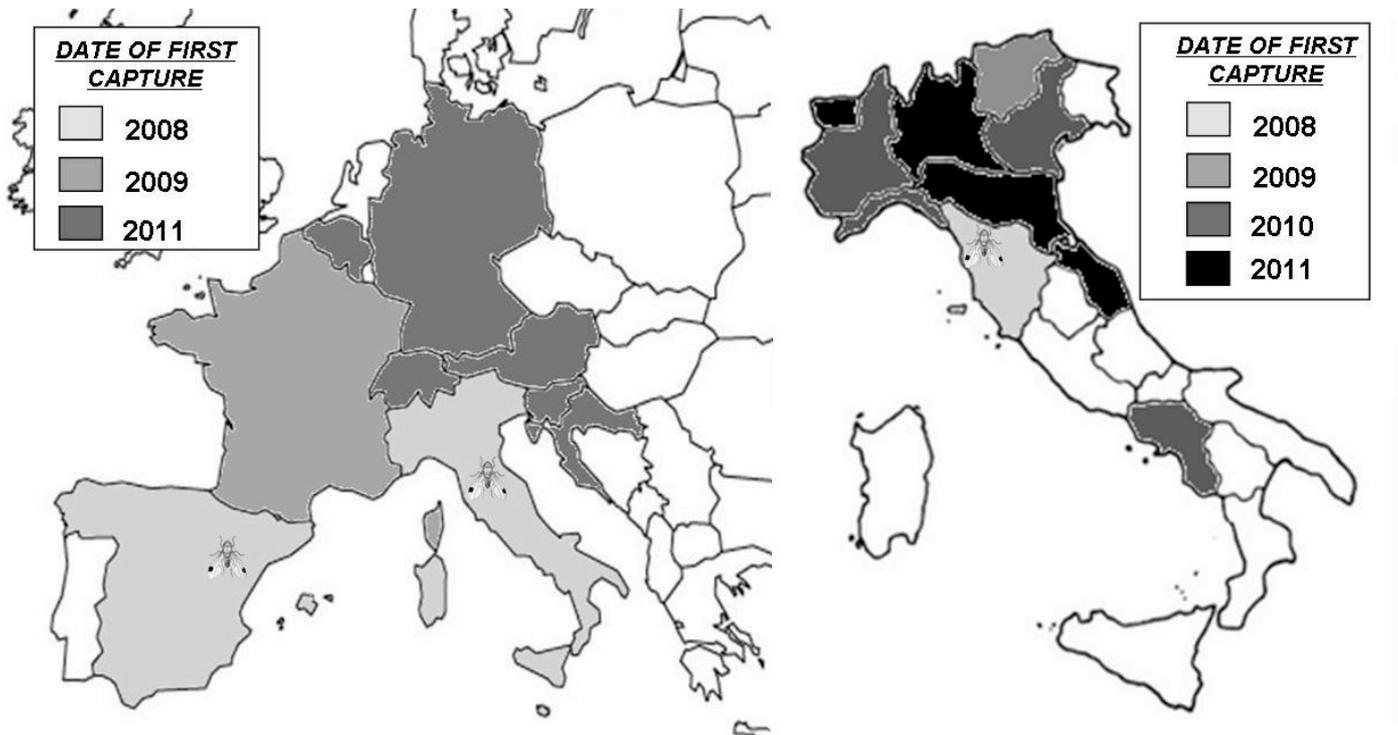
Polyphyletic

When in a group the last common ancestor is not a current member, that group is called “polyphyletic.”

A most evident example is that of the warm-blooded animals: both mammals and birds are part of the group, but the most recent common ancestor was cold-blooded.



Mass trapping is a possible non-chemical control method: in this experiment, traps are located along the orchard 2 mt from each other. This trap-bottle contains 150 ml of apple cider vinegar and 50 ml of red wine.



By 2010-2012, the range of *D. suzukii* was further enlarged. In Italy it was reported in several other regions: Piemonte, Lombardia, Veneto, Emilia Romagna, Liguria, Marche, Calabria, Campania and Sicilia and in France it was found from Corsica up to Ile de France. Then, many other European countries made their first record: Switzerland, Slovenia, Croazia, Austria, Germany and Belgium. It appears to be spreading rapidly and all of continental Europe is at risk for invasion. Considering the recent reports together with the outputs of the available degree-day phenological models and analysis of *D. suzukii* host plants distribution, it is very likely that *D. suzukii* will spread all over Europe. Indeed, ecological simulations indicate the northern humid areas as more suitable ecosystems compared to the Mediterranean drier environments, especially because desiccation seems to be a limiting factor for drosophilids.

If the current climate changes are taken into account, even Scandinavian countries can not be considered exempt from these risks of invasion. On a wider geographic perspective, according to *D. suzukii* biology, the global

expansion in regions with climatic conditions spanning from subtropical to continental is highly likely to happen.

Unlike most other Drosophilidae, possibly exempting *D. subpulchrella*, *D. suzukii* is able to oviposit in healthy, unwounded fruit thanks to the serrated female ovipositor and not only on damaged or overripe fruits. Hence, ripening fruits are preferred over overripe ones.

Most damage caused by *D. suzukii* is due to larvae feeding on fruit flesh, however the insertion of the prominent ovipositor into the skin of the fruit can cause physical damage to the fruit, as it provides access to secondary infections of pathogens - such as filamentous fungi, yeasts and bacteria - that may cause faster deterioration and further losses. Additional costs are related to increased production costs related to pest control (monitoring and chemical input costs, increased labour and fruit selection, reduction of the fruit shelf life, storage costs) and to the decrease of foreign market appeal for production from contaminated areas.

Adults of *D. suzukii* reach maturity one or two days after emergence (during the warm season). Mating occurs from the first days of life and females start to oviposit already from the second day from emergence. Females typically lay 1-3 eggs per fruit in up to 7-16 fruits per day; since they are able to oviposit for 10-59 days, they can lay up to a total of 600 eggs during their lifetime (around 400 eggs on average). Eggs hatch within 2 to 72 hours after being laid inside fruits, and larvae mature (inside the fruit) in

3 to 13 days. Pupae reside inside or, less frequently, outside the fruit, for 3 to 15 days. Depending on the temperature, a minimum of 8 days is required from oviposition to adult emergence. This very short generation time implies that *D. suzukii* can complete several generations in a single cropping cycle and up to 7 to 15 generations in a year, according to the specific climatic conditions, thus allowing an explosive population growth.



A female specimen of *D. suzukii*

The ability to survive and reproduce in a wide range of climatic conditions is obviously a relevant factor for insects. Limiting temperatures for *D. suzukii* reproduction are between 10 °C and 32 °C for oviposition and up to 30 °C for male fertility. and Alpine areas). The peak of activity and development is

around 20 to 25°C. *D. suzukii* can thus be considered a species with high thermal tolerance, being both heat tolerant (viable *D. suzukii* populations resist to the hot summers in Spain) and cold tolerant (*D. suzukii* is present in cold areas, such as mountain regions in Japan and Alpine areas).

Adults are particularly tolerant to cold compared to other drosophilids and mated females in reproductive diapause are considered to be the overwintering stage of *D. suzukii*. Whether this tolerance is physiological or mediated by behavioural adaptation is still unclear and several authors suggest that *D. suzukii* survival under harsh conditions might be increased by altitudinal migration, acclimatization and/or overwintering in man-made habitats or other sheltered sites.

D. suzukii is able to develop on a very wide range of both cultivated and wild soft-skinned fruits with many host plants in the native and in the invaded areas, with berries being the preferred hosts. The wide host range represents a pest management constraint not only because *D. suzukii* can cause damage to many species, but also because populations can survive almost everywhere, alternating hosts with different ripening times through the year, both cultivated and wild. Indeed, crop plants, usually cultivated in high density monoculture, allow rapid and impressive population growth, while wild hosts and ornamental plants may serve as refuges from management treatments, and provide later re-infestation sources and overwintering habitats.

D. suzukii has a high dispersal potential, which would seem to be confirmed by its rapid spread in



A male *D. suzukii* on a strawberry

in invaded countries and its presence on several continents, as well as remote islands. Passive diffusion due to global trade is likely the main cause of the spread of *D. suzukii*, as for many other invasive species. The apparently intact and healthy

status (before larval activity) of the fruits infested with *D. suzukii* is likely to compound the problem, as it increases the risk that infestation will remain undetected and thus the risk of passive dissemination of *D. suzukii*.

The complexity of the environment, of the agroecosystems, and the high concentration of soft fruits as intensive crops in a small territory represent an important force for D. suzukii in Trentino. More research and a multiple control are needed to limit the damage in a sustainable way.



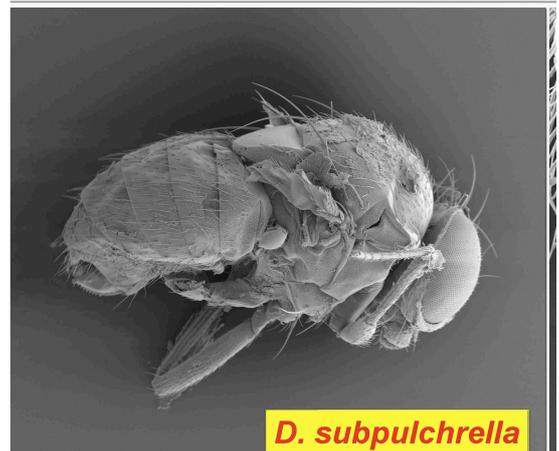
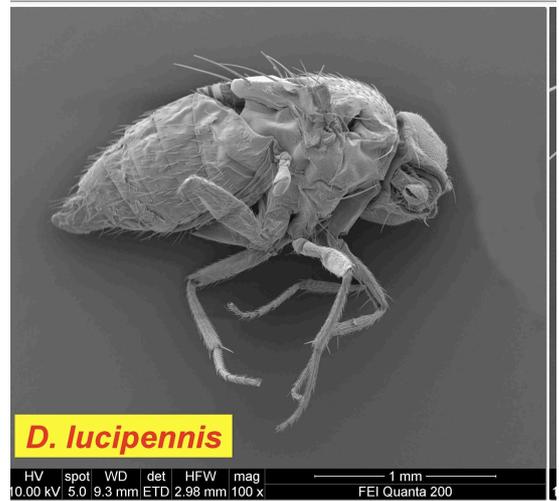
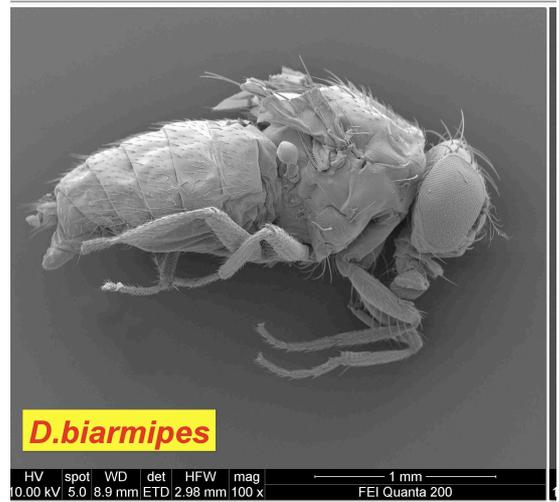
Damages caused by *D. suzukii* on main host plants

Estimating the costs associated with *D. suzukii* impact is a complex task, with several factors (direct and indirect costs) that must be taken into account, their interdependency and the dynamic nature of the system. Preliminary studies in the USA indicate an annual loss of more than 500 million dollars in five affected crops (strawberries, blueberries, raspberries, blackberries and cherries) in three states (California, Oregon and Washington). Because of regional monoculture, economical losses might be even larger in proportion at a local scale. A preliminary study estimated that Trento province (Northern Italy), the area devoted to small fruit cultivation (about 400 hectares) faced a loss around 500,000€ in 2010 and 3 million€ in 2011.

In conclusion, the rapid spread of the invasive fruit pest *D. suzukii* poses a challenge to fruit production in Western countries. The biology of *D. suzukii* suggests that an effective control effort requires an area wide IPM program. In order to accomplish this, research needs to address *D. suzukii* basic biology, the development of management tools, the transfer of knowledge and technology to users and, finally, the implementation of the IPM program also at a cultural and societal level. While short term solutions to limit the current dramatic damage are strongly needed, only long-term and environmentally friendly management approaches will allow a sustainable control of this pest. To this aim, research is being carried out to shed light on many knowledge gaps that are still present. Still much has to be done: the future of research will surely see a great increase in the knowledge of *D. suzukii* biology, impact and management.

This text comes partly from a literature review and partly from the experiments carried out at Fondazione Edmund Mach. An in-depth report has been recently published on behalf of the ENVIROCHANGE project:

Cini A., Ioriatti C., Anfora G., 2012. A review of the invasion of *Drosophila suzukii* in Europe and a draft research agenda for Integrated Pest Management. Bulletin of Insectology, 65 (1): 149-160.



THE ENVIROCHANGE PROJECT

The EnviroChange project focuses on global change and sustainable management of agriculture in highly developed mountain environment.

It aims at assessing the short-term biological, environmental and economic impact of climatic change on agriculture at the level of the Trentino region particularly on quality

and pest management that are more likely to be influenced by climate change in the short term. The final aim is to preserve and improve the quality of life of habitants, protecting environment and biodiversity for the future generations, as well as to represent a model for sustainable development of mountain areas.

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Fondazione E. Mach

Published by Fondazione Edmund Mach

September 2012

EnviroChange is coordinated by:

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The project is funded by Provincia Autonoma di Trento, Italy



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