Study visit to the Italian research institute Edmund Mach Foundation to investigate on the subject of parasitoids of *Drosophila suzukii*.

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- In Europe several *Hymenoptera* parasitoid species parasitize *D. suzukii* and these could offer growers a potential avenue for biocontrol of this pest.
- The pupal parasitoid *Trichopria drosophilae* is, at the time of writing, the best parasitoid candidate in Europe to control *D. suzukii*.
- Reducing *D. suzukii* populations through parasitism would help to improve the outcome of other control strategies within an IPM context.

Background:

This study visit took place at the Italian research institute Edmund Mach Foundation at the agricultural entomology and zoology department. The Edmund Mach Foundation is currently working and extremely active on several projects based on antagonists for biological control with particular attention to the invasive alien species (i.e. *D. suzukii*). Over the last four years their research programmes have focused on finding and testing the efficacy of different parasitoids species for the control of *D. suzukii*, particularly, during my visit, the pupal parasitoid *T. drosophilae* was being tested in a field trial.

The activities were coordinated by Professor Gianfranco Anfora and Simone Puppato who kindly instructed me on the latest findings and on the use of this parasitoid. During these two days I visited the laboratories, research sites (cherry orchards) and talked to scientists to become familiar with the techniques used to carry out this experiment about the dispersal ability of the parasitoid *T. drosophilae*.

Travel Findings:

Damage can be caused to soft and stone fruits by *D. suzukii* (spotted wing drosophila, SWD), reducing fruit quality and making the fruit unmarketable. This is an increasing problem for fruit producers across the UK. At the time of writing, biological control against this pest remains pretty much unutilized due to the lack of natural enemies or parasitoids in the newly invaded regions such as Europe and America. Indeed invasive species, often, do not arrive with their specific diseases or parasitoids, or the latter fail to establish in the new environment.

Many studies have shown how several pupal and larval parasitoid species can successfully attack *D. suzukii* under laboratory conditions; however these are not likely to provide adequate control of *D. suzukii* in field conditions (Chabert et al. 2012; Rossi Stacconi et al. 2015; Miller et al. 2015). Some pupal parasitoids (i.e.

Pachycrepoideus vindemmiae and *Spalangia erythromera*) are extremely generalist and would not effectively contribute to reduce the pest population below the economic threshold levels and potentially affect non-target species (Girod et al., 2018; Wang and Messing, 2004). Indigenous larval parasitoids (i.e. *Asobara tabida* and *Leptopilina heterotoma*) very often fail to parasitize *D. suzukii* due to a very strong immune response of *D. suzukii* larvae resulting in a very low parasitizing rate (Poyet et al, 2013).

Unlike the parasitoids mentioned above, the experiment carried out at the Edmund Mach Foundation showed how *T. drosophilae* can be considered a potential candidate offering a sustainable solution to the soft fruit growers for the management of *D.* suzukii.

T. drosophilae is a cosmopolitan pupal parasitoid that attacks many species of Drosophilidae, including the invasive *D. suzukii* (Daane et al., 2016; Wang et al., 2016c) (Figure 1). This species has been reported to attack and develop from *D. suzukii* in its newly invaded regions such as Europe. Moreover this parasitoid did not show preference between *D. suzukii* and other native Drosophila species and has a limited host range, different to *P. vindemmiae* which is known to parasitize over 60 fly species (Mazzetto et al, 2016; Wang et al, 2016; Zhao et al, 2013).

Figure 1. Left: *T. drosophilae* female, right: *T. drosophilae* laying an egg in a *D. suzukii* pupa (Figure from Edmund Mach Foundation*).*

These characteristics together with the feasibility of *T. drosophilae* mass rearing, suggest the possibility for a field trial where the researchers at the Edmund Mach Foundation either tested the dispersal ability of the parasitoid or the effect of the augmentorium technique for enhancing the parasitoid's action (Mazzetto et al, 2016). The impact of this parasitoid on adult *D. suzukii* emergence was tested in different locations in Italy in infested crops cherry, strawberry, raspberry and blueberry. Pupae and larvae baited sentinel traps were used to assess the presence of *T. drosophilae* from its release point to the crop (Figure 2).

Under field conditions parasitoids were found in sentinel traps ≤ 40 metres from the release point, but the emergence of *D. suzukii* adults was significantly reduced only in traps 10 metres, from the *T. drosophilae* release point (Rossi Stacconi et al., 2018). However, the distribution and impact will have been influenced by the low numbers of parasitoids that were released (500 males and 500 females parasitoids each week over a 5-week period) during the trial (Rossi Stacconi et al., 2018).

Figure 2. Left: sentinel trap containing bait, right: bait infested with *D. suzukii* pupae and larvae (Figure from Edmund Mach Foundation).

In combination with *T. drosophilae* releases, the augmentorium technique was tested. The augmentorium consists of containers where infested fruit is regularly deposited. This construction is isolated from the external environment by a fine mesh net such that emerging pests remain confined inside the container, but parasitoids can move freely in and out. This technique reduces pest pressure on the crop and simultaneously increases the number of natural enemies (Klungness et al., 2005).

In this experiment two cubic augmentoria (30 cm side; 0.027m^3 each) were used within the crop during the entire harvesting period, fruit dropped on the ground was weekly collected in the augmentoria.

D. suzukii infestation was evaluated by sampling fruit, both from the plant, and the ground. The augmentorium treatment significantly increased *T. drosophilae* emergence and decreased *D. suzukii* emergence from fruit. The presence of an augmentoria enhances the parasitoid activity, highlighting the potential for the exploitation of *T. drosophilae* in biocontrol programs for *D. suzukii*.

Evidently, as a pupal parasitoid, *T. drosophilae* exercises its control activity only once the damage has already occurred. Therefore its use should be employed constantly with periodic releases over a wide area in order to allow the establishment

of a stable population of *T. drosophilae* over the wild areas surrounding the crops, tackling the first *D. suzukii* generations before the ripening of the host fruit (e.g. cherries).

These findings on the dispersal and augmenting of *T. drosophilae* provide valuable information which could contribute towards the development of a successful biological parasitism method to be incorporated in a complete IPM control strategy.

Personal Statement:

Currently, I am leading a Worshipful Company of Fruiterers (WCoF) project on UK native *D. suzukii* parasitoids. In particular we are looking for the parasitoid *T. drosophilae* which has not been formally identified in the UK yet. This study visit provided me with a unique opportunity to strengthen my knowledge on the biological control of *D. suzukii* helping me with the WCoF project. I learned the most recent techniques on how to use *T. drosophilae* in a research trial and I was able to discuss with many scientists ideas on how to improve pest control measures by using *D. suzukii* parasitoids. I have developed connections with other researchers and established new links for potential future cooperation into new areas of research. This study tour will benefit the UK industry by providing a means for communicating information and details of research in Italy on the biocontrol of this highly invasive pest to UK growers.

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