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Prospects for biocontrol of *Drosophila suzukii* by invertebrates in Germany

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Ongoing research aims to identify native parasitoids of Drosophilidae in Germany and tries to assess their ability for natural control as well as their suitability for being used as biological control agents in pest management of *Drosophila suzukii*. Due to the lack of adapted and specific native antagonists of *D. suzukii*, collection of parasitoids attacking native *Drosophila* species took place in different regions in Germany during 2015 and 2016. Over several months naturally infested fruit were collected from plants and soil. We captured seven different *Drosophila* parasitoid species. First experiments illustrated that the pupal parasitoids *Trichopria drosophilae*, *Spalangia erythromera* and *Pachycrepoideus vindemmiae* successfully parasitize *D. suzukii*. The two larval parasitoids *Leptopilina heterotoma* and *Asobara rufescens* were not successful in parasitizing the new host species. Lifetime fecundity, progeny production and sex ratio of the progeny during the life period of female parasitoids were investigated in two German populations of *T. drosophilae*. Females and males of both strains lived on average more than 30 days. The number of eggs produced over the whole lifespan was higher in the Central German population (85.5 ± 2.7 eggs/female) than in the South German population (80.7 ± 3.4 eggs/female). Compared to this the female offspring was slightly superior in South German population (61%) than in Central German population (46%). Progeny development usually lasted about three weeks in both strains.

Evaluation of the potential biological control of *Drosophila suzukii* with Asian parasitoids

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Native to Asia, the Spotted Wing Drosophila, *Drosophila suzukii* (Diptera: Drosophilidae) has successfully invaded the Americas and Europe since the late 2000s, followed by rapid range expansion and increased damage records within these continents. Despite a few indigenous larval and pupal parasitoids being recorded and attacking *D. suzukii* in Europe, the control effects of these European parasitoids are rather limited due to lower parasitism rates and/or impossible to complete development within the host body of *D. suzukii*. Classical biological control is strongly considered as a sustainable approach to control *D. suzukii* in invaded regions by introducing natural enemies from its native region. In the the framework of the EU-funded project DROPSA, we conducted extensive surveys in varied habitats, locations and time of the season in 2015 and 2016 in China and Japan, where *D. suzukii* causes little damage and very little is known on its natural enemy complex. Three Asian larval parasitoids were recovered from field surveys, e.g. *Leptopilina japonica*, *Ganaspis brasiliensis* and *Asobara japonica*. Efficiency of Asian larval parasitoids was studied in the quarantine laboratory to understand whether the parastioids are able to forage and parasitize *D. suzukii* reared with artificial diet or fresh blueberry. Single mated female parasitoid was used and allowed to forage for 48 h with 10–30 24 h old fly larvae in a tube. Then the number of emerging flies and parasitoids were counted and the dead host larvae were dissected to record encapsulation events. Three Asian parasitoids can attack and successfully develop in *D. suzukii* larvae in both rearing substrates, while as a control the European *Leptopilina heterotoma* eggs were all encapsulated by *D. suzukii*. Moreover, *G. brasiliensis* strains showed a strong preference for the host larvae in blueberries in comparison with the diet, indicating a high degree of behaviour response of the parasitoid to fruit cues. No-choice host specific tests of three Asian parastioids were also conducted with *D. suzukii* and another four non-target *Drosophila* species in Europe. Our preliminary results showed that *G. brasiliensis* Japan strain was more host specific than other two Asian parasitoids. Further research is still required to fully understand the efficiency and host specificity of the selected Asian larval parasitoid.

Pathogens to control *Drosophila suzukii*

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Drosophila suzukii MATSUMURA (Spotted Wing Drosophila, SWD) is an invasive pest that causes enormous damage to soft ripening fruits. It appeared first in Germany in 2011. During the last years, investigations on potential natural enemies and microbial antagonists have been intensified. The widely used biocontrol agent *Bacillus thuringiensis israelensis* (B.t.i.) and the plant extract Azadirachtin from the Neem oil tree have been tested in the laboratory. Whilst B.t.i. did not show any significant efficacy against SWD, Azadirachtin increased mortality rates up to 100%, but only when applying a concentration ten-times higher than recommended for other pest insects, whereas recommended concentrations could only achieve up to 20% mortality. Furthermore, SWD samples from affected countries are continuously screened for microbial and viral pathogens. Recently, microsporidia have been detected. These are obligate intracellular parasites infecting many organisms up to vertebrates. Microsporidia often cause chronic diseases with low mortality rates, mostly decreased fertility and fecundity, retarded developmental time and reduced fitness of host individuals. For biological control, these characteristics can be advantageous if a pest insect has rapid reproduction time and large offspring numbers or when control of the pest is complicated by its preference of hardly accessible habitats. In our screening, a microsporidium was detected in SWD samples obtained from USA. Its introduction to our German breeding line of SWD and its re-isolation was possible. Its characterization was initiated with molecular markers based on SSU rDNA that were amplified by PCR using universal primer pairs. Sanger sequencing of the PCR fragments suggested that the isolated microsporidium belongs to the genus *Tubulinosema* (Tubulinosematidae). For further species characterization, morphological examinations on tissue tropism and life cycle are conducted by light and electron microscopy. Infection experiments to evaluate median lethal concentration (LC50) as well as possible impacts on developmental times are ongoing.