Fruit fly pest meets its evolutionary match in parasitic wasp

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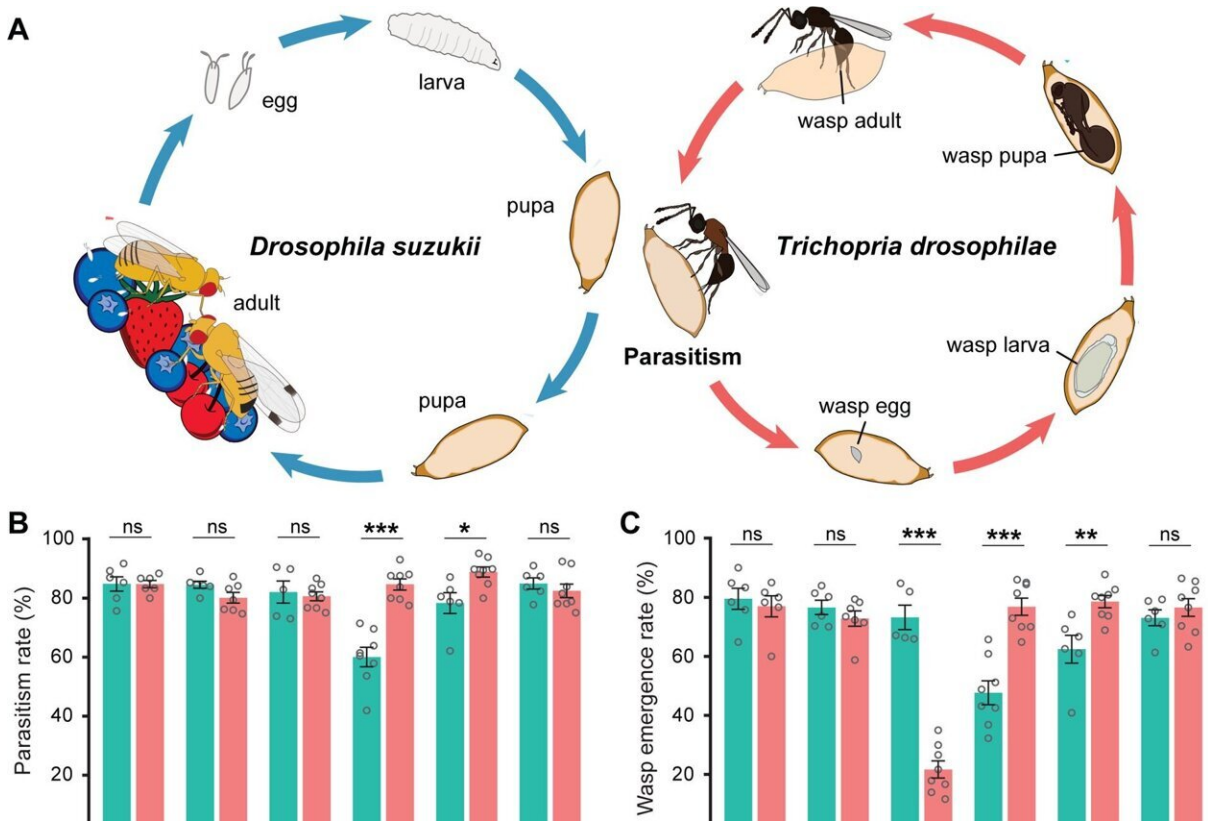

Chromosome-level assembly of a generalist drosophilid parasitoid genome. Credit: (2024). DOI: 10.7554/eLife.94748.1

A parasitic wasp that preys on the young of a prolific fruit fly pest demonstrates both molecular evolution and behavioral adaptations in the

face of ecological pressures, according to new research.

The study, published in *eLife*, is described by the editors as valuable work, with convincing evidence to suggest that the Trichopria drosophilae (T. drosophilae) wasp might be a potent biological weapon to control Drosophila suzukii (D. suzukii), a fruit fly that damages cherry, blueberry, peach, grape and other fruit crops worldwide.

The D. suzukii fruit fly originated in Asia but has spread around the globe over the past decade. It attacks a wide range of fruit and has taken a severe economic toll on fruit and wine producers. Despite the urgent need for biological controls, there are few fruit fly parasites that can circumvent D. suzukii's defenses.

"We set out to identify natural parasites of D. suzukii and learn how they overcome the pest's considerable defenses," says first author Lan Pang, a postdoctoral researcher at the Institute of Insect Sciences, Zhejiang University, Hangzhou, China. "Despite the great economic need for biological controls for this pest insect, previous search efforts have been unsuccessful in China."

To identify the natural parasites of D. suzukii, Pang and colleagues set up several traps in different locations across East China, including Hangzhou, Ningbo and Taizhou, where the species is known to be heavily distributed. They knew that if they could lure in the fruit flies, then their predators would also follow, so they filled the traps with the flies' favorite fruit snacks—bananas, cherries and grapes.

When the team looked in the traps, they found two species of parasitic wasps: T. drosophilae, which parasitises fruit fly pupae (the stage just before they become an adult), and Asobara japonica, which parasitises early-stage fruit fly larvae. Multiple studies have already established T. drosophilae as a successful parasite on the young of D. suzukii, but the

mechanisms that underlie this success have not been determined. This, combined with the fact that the team found a much higher number of these parasites in their traps, led them to focus on T. drosophilae for their study.

To understand how T. drosophilae overcomes D. suzukii's defenses, the team conducted a series of genetic, molecular and behavioral studies. Their analyses revealed that the wasps have evolved to produce both venom and specialized cells that stop the development of a fruit fly pupa and speed up the digestion of the pupa's body. Together, these two adaptations provide more nutrition to the wasps' young when they hatch within a pupa.

"Female wasps employ the straw-like organ they use to lay their eggs to 'taste' the fly pupa and determine if another species of parasite got there first," Pang explains. "They will move on if another parasite species's offspring is present because the other parasite would compete with its young for food."

Pang adds that interestingly, however, the wasps will lay their eggs on fruit fly pupae that already have other T. drosophilae eggs on them, even though only one young wasp would ultimately survive. The study showed having multiple T. drosophilae eggs on a single fruit fly pupa ensured it was eaten more quickly by the wasp larvae when they hatched.

"Doubling up likely leads to the additional introduction of venom and specialized cells to help the wasp larvae more quickly digest the pupa, maximizing the nutrition available, especially in older pupae with poorer resources," says co-senior author Shuai Zhan, a professor at the CAS Center for Excellence in Molecular Plant Sciences, Chinese Academy of Sciences, Shanghai, China. "This super parasitism may help compensate for the female wasps' inability to recognize young pupae as hosts for their young."

The study suggests the wasps could provide a useful biological control tool to protect vulnerable fruit crops from D. Suzukii.

"Our study demystifies how parasitic wasps weaponize themselves to overcome the formidable defenses of their hosts," concludes senior author Jianhua Huang, a professor at the Institute of Insect Sciences at Zhejiang University. "It also provides evidence of the intricate coordination between genetic, molecular and behavioral adaptations that drive the wasps' evolutionary success."

More information: Lan Pang et al, Coordinated molecular and ecological adaptations underlie a highly successful parasitoid, *eLife* (2024). DOI: 10.7554/eLife.94748.1

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