INSIDE JEB

Warmer weather helps hornworms fight off parasitoids

A hornworm with parasitoid wasp cocoons. Photo credit: Katherine Malinski.

Why do we get a fever when we're sick? It turns out that bacteria, viruses and other microbes that make us sick can't handle the heat, and getting hotter is your body's way of getting rid of the sickness-causing organisms. But some animals can't heat up whenever they want; they need to wait for the weather to help them out. Some of these animals, like the closely related tobacco and tomato hornworms (*Manduca sexta* and *Manduca quinquemaculata*), have much larger organisms making them sick. A wasp (*Cotesia congregata*) lays its eggs inside the hornworms, which then develop inside and eventually emerge to spin cocoons and fly away as adults, killing the hornworm in the process. However, the frequent heat waves caused by climate change may be helping the hornworms fight off these parasites. This led Katherine Malinski, Christopher Willett and Joel Kingsolver of the University of North Carolina, USA, along with Clyde Sorenson and Elizabeth Moore of North Carolina State University, USA, to ask whether some hornworms can take the heat better than the wasps that parasitize them.

After the difficult task of finding hornworm eggs on the underside of tobacco leaves or using traps to collect adults, the team reared the resulting caterpillars in the lab alongside captive colonies of parasitoid wasps. The caterpillars were then parasitized by the wasps before experiencing a brief, 24 h heatwave of 40°C. When the wasps lay their eggs inside the caterpillars, they also inject a virus that stops the caterpillars from maturing. After the short heat wave, both species of hornworm grew past the time when wasps would typically emerge to form cocoons, suggesting that the heat is killing either the eggs or the virus inside the caterpillars. However, even though these hornworm species are nearly impossible to tell apart when they're young, they had different responses to the warmer temperatures when parasitized. Almost half of the tomato hornworms developed further after being parasitized than those kept at 25°C, and one even became a moth, whereas only 13% of the tobacco hornworms developed further than their parasitized counterparts that didn't experience a quick heat wave.

This suggests that the tomato hornworms are better at fighting off the parasites when the weather is hotter than their tobacco hornworm cousins. But is it the virus or the eggs that are losing the battle with the heat?

When the temperature was turned up, only one tomato hornworm had any cocoons, and none of the tobacco hornworms had any. So, the wasp eggs inside the caterpillars are not developing properly. But what is happening to the virus that stops the hornworms from developing? Although Malinski and colleagues point out that they don't have direct evidence for this, the fact that the hornworms are behaving like more developed caterpillars by wandering around and starting to dig for places to transform into adults suggests that the virus also can't take the heat as well as the soon-to-be hawkmoths.

Malinski states that these heat waves can have drastically different effects on closely related species. In this case, the tomato hornworms not only recovered from the parasites more often after their 24 h heat wave, but they also grew larger than their tobacco hornworm cousins if there were no parasites. She stresses that more studies should take this into account when predicting how climate change is going to affect animals around the globe. And although heat waves might be a good thing for the hornworms, they are potentially disastrous for the wasps and for the farmers who count on these same wasps to rid their fields of these caterpillars, which can devastate their crops.

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