

INSIDE JEB

Sick caterpillars lose appetite to avoid food poisoning



A tobacco hawk moth caterpillar. Photo credit: Kurtis Turnbull.

It's that time of year: half of us are nursing colds and the other half is hoping to avoid them. One of the first things to go when you get sick is your appetite, which seems counterintuitive when you are gearing up for a fight and should require more energy. Shelley Adamo and colleagues from Dalhousie University, Canada, explain that several theories have been proposed to explain why animals may starve themselves when they are poorly. However, they say, 'these hypotheses do not fully explain the phenomenon, especially for some animal groups'. Puzzled by the contradiction, the team came up with another suggestion: might sick animals go off their food to avoid food poisoning? They explain that the systems that help animals to deal with toxic compounds in their food and the immune system share components, so they wondered whether sick animals lose their appetites to avoid the risk of poisoning when their immune system has had a head start.

Adamo, Laura McMillan and Dylan Miller decided to test their theory on tobacco hawk moth caterpillars, which thrive on toxic nicotine-packed plants

and go off their food when they get ill. Adamo also outlines the challenges faced by starving caterpillars, saying, 'It slows their development, and the longer they spend as caterpillars, the more likely they are to be eaten by a predator. Also, the less they eat, the smaller they will be as adults, reducing their reproductive success. These heavy costs suggest that the loss of appetite must provide a powerful benefit'.

First, the trio fed caterpillars a small (non-lethal) dose of permethrin, an insecticide, followed by an injection of dead bacteria (*Serretia marcesens*), to trigger the immune system as if the insects were fighting an infection. The team found that the caterpillars were much more vulnerable to the infection when they were already dealing with poison in their system. Next, they switched the challenges, injecting the caterpillars with live bacteria – to initiate an infection – before feeding them a non-lethal dose of insecticide. This time the caterpillars succumbed to the small amount of poison and died within a matter of days. The caterpillars were unable to withstand the combination, but why?

Knowing that the compound glutathione is an essential component of both the caterpillar's immune defence and its ability to detoxify food, the team wondered whether the two systems were competing for the same resource. Measuring the levels of the essential compound in the blood of caterpillars that had been either poisoned or infected, the trio saw their glutathione levels fall and the insects became ill. However, when the trio boosted the caterpillars with an injection of glutathione, they fared far better, surviving a combined infection and poisoning that would otherwise have proved fatal.

Realising that the loss of glutathione from the caterpillar's blood had increased the insect's vulnerability to the insecticide, the team investigated which detoxification components might have been affected by the loss of glutathione. Tracking the activation and inactivation of essential genes that are involved in removal of toxins from the caterpillar's body, the team found that caterpillars that were under simultaneous attack were unable to mobilise two key detoxification genes 'thioredoxin and GST1' leaving the caterpillars vulnerable to the insecticide.

So it appears that ill tobacco hawk moth caterpillars lose their appetite to avoid the consequences of consuming toxins when their immune defences take priority. Adamo says, 'I think this study sheds light on a very old problem – why we lose our appetite when we get sick', and adds, 'Eating when ill is risky'.

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McMillan, L. E., Miller, D. W. and Adamo, S. A. (2018). Eating when ill is risky: immune defense impairs food detoxification in the caterpillar *Manduca sexta*. *J. Exp. Biol.* **221**, doi:10.1242/jeb.173336.

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