

# Colorful caterpillar chemists may signal new useful plant compounds

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Though caterpillars of the moth *Periphoba arcaeii* will eat a wide variety of plants, they have also evolved a defense mechanism previously only seen in insects that specialize on eating toxic plants. They incorporate toxins from the tropical plant *Vismia baccifera* and advertise their unpalatability with brilliant green bodies covered in toxin-tipped hairs. Credit: Raudsepp-Hearne, et al. / Smithsonian Tropical Research Institute

Scientists at the Smithsonian Tropical Research Institute (STRI) in Panama compared the diets of two caterpillar species, expecting the one that exclusively consumed plants containing toxic chemicals would more easily incorporate toxins into its body than the one with a broad diet. They found the opposite. The new finding, published in the *Journal of Chemical Ecology*, flies in the face of a long-held theory that specialist insects are better adapted to use toxic plant chemicals than non-specialists.

The discovery opens new avenues for understanding plant-insect coevolution—an ongoing [arms race](#) of [plants](#) producing new defense chemicals and [insects](#) finding ways around them. Toxic plant chemicals also have potential medical applications against microbes or cancer cells.

The tropical plant *Vismia baccifera* protects itself by producing a number of repellent chemicals, including three compounds that are toxic to living cells. Few plant-eating insects can stomach such a cocktail, but for those that can, the advantages are clear—less competition for a meal, and a chemical toolkit they can use in their own defense.

Skipper butterfly, *Pyrrhopyge thericles*, caterpillars only eat plants in the genus *Vismia*. The caterpillars of a large moth, *Periphoba arcae*, have a much broader diet, including *Vismia* plants and many others. Brightly colored caterpillars, one with flamboyant stripes, and the other blue-green with bristles, teach predators to associate their striking looks with toxicity—a defensive warning system known as aposematism.

"Brightly colored plant-eating insects help us to identify plants containing compounds active against important human diseases," said Todd Capson, a former associate scientist at STRI, who oversaw visiting researcher Ciara Raudsepp-Hearne, the lead author of the new study. The work documents the first known occurrence of *Vismia* chemicals in butterflies and moths.

The researchers analyzed several life stages of the two caterpillar species for the presence and concentration of plant toxins called vismiones. While two vismione compounds are found at a ratio of 1:6 in the plants, in the specialist butterfly caterpillars the compounds were barely detectable, and at roughly equal ratios. Meanwhile, the generalist moth caterpillars contained significant quantities of the rarer of the two compounds, suggesting that they were able to actively store this plant chemical in their own bodies. Both caterpillars' fecal matter revealed a 1:2 ratio of the plant compounds, indicating that their bodies might uptake compounds selectively or convert molecules of one type over the other.



The bright stripes and bristles of this skipper butterfly caterpillar, *Pyrrhopyge thericles* warn predators that it packs a toxic punch, thanks to an exclusive diet of

toxic plants of the genus *Vismia*. Credit: Raudsepp-Hearne, et al. / Smithsonian Tropical research Institute

"We know very little about just how each plant-eating insect handles these chemicals—how they store them or eliminate them," said STRI staff scientist and study coauthor Annette Aiello. Some insects might isolate the compounds so they do not cause them harm, while others might convert the molecules into forms that are harder for scientists to detect. Insects that process harmful toxins without damaging their own cells have a survival advantage. For a generalist species, said Aiello, "the ability to sequester toxic [compounds](#) might be an early evolutionary breakthrough," the first step along the pathway to becoming a toxic plant specialist.

Previous work suggests that the presence of plant-eating insects sporting bright warning colors may signal plants containing potentially useful chemicals. And while specialist insects share an obvious history with their host plants, the new study suggests that generalist insects also may play an important role in the chemical arms race that drives plant-insect coevolution. "The study of insects with generalist diets can sometimes yield results that are just as rewarding as the study of specialists," Capson said.

**More information:** *Journal of Chemical Ecology*,  
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