Researchers find selective eaters less likely to be eaten

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A papilio glaucus larva munches on a leaf. New research suggests picky eaters are less likely to get eaten by predators such as birds. Credit: Mike Singer

New research has found that dietary specialization among herbivores, specifically caterpillars, indicates whether or not they are better able to hide themselves from predators such as birds. The research suggests those herbivores who dine on a wide variety of plants face an increased chance of being eaten by birds whereas those with a limited diet are less likely to be eaten.

The research titled, Herbivore diet breadth mediates the cascading effects of carnivores in food webs, and published recently in the *Proceedings of the National Academy of Sciences*, shows the far-reaching effects of herbivore dietary specialization on the ecological and evolutionary dynamics of carnivore–herbivore–plant interactions.

The research was led by Mike Singer, associate professor of biology and associate professor of environmental studies, at Wesleyan University. The collaboration included UNM Department of Biology Associate Professor Kenneth Whitney and four others.

A decade of research in the ecosystems of Connecticut forests by Singer reveals that caterpillars with finicky feeding habits avoid predation from birds, whereas those that feed generally on many plants become meals for baby birds. The "specialist" bugs are much better at survival the research concludes.

The research was conducted in three forests near Middletown. The birds in the study are mostly songbirds – warblers, titmice and chickadees birds, for example – and the trees are familiar in the New England landscape, broadleaf deciduous varieties of oak, hickory, maple, beech and cherry. The 41 types of caterpillars studied mostly become moths (if they're not eaten first).

Predicting the impact of carnivores on plants has challenged community and food web ecologists for decades. At the same time, the role of predators in the evolution of herbivore dietary specialization has been an unresolved issue in evolutionary ecology.

The researchers tested the role of herbivore diet breadth as a predictor of top-down effects of avian predators on herbivores and plants in a forest food web. Using experimental bird exclosures to study a complex community of trees, caterpillars and birds, the researchers found a robust

positive association between caterpillar diet breadth and the strength of bird predation.

Using mesh bags tied around tree branches and or small saplings, insects could come and go, but kept the birds were kept out. Each branch or sapling was paired with a nearby one of similar size, which the scientists didn't wrap up. During the four-year experiment, they counted caterpillars on the bagged and unbagged branches to see how many were normally eaten by birds.

Dietary specialization of herbivores drives the dynamics of this food chain," Singer explained. "Caterpillars with generalized diets are less likely than specialists to be camouflaged or to display warning colors or features to avian predators."

A familiar example of a dietary specialist is the caterpillar of the Monarch butterfly, which feeds exclusively on milkweed plants. This caterpillar accumulates toxins from its food-plants, rendering it unpalatable to birds and other predators. The toxic caterpillar is distinctively striped and colored as a warning to its enemies.

Whitney provided phylogenetic analyses which are needed to properly understand the relationship between two variables – in this case herbivore diet breadth vs. bird predation.

"You have to account for the evolutionary relationships between the species," Whitney said. "That is, you have to account for the fact that species A and B are more closely related to each other than either is to species C. If you ignore the evolutionary history, you can get the wrong answer about the strength of the relationship, and think that it is stronger or weaker than it really is.

"So, by building phylogenies or family trees for the species in our study,

and incorporating those phylogenetic relationships into the analysis, we have a lot more confidence that the results are real and meaningful," he added.

By controlling for evolutionary relationships of the various caterpillars, the research revealed the fingerprint of evolution, if not the actual hand of natural selection. . Several different lineages of butterflies and moths show the same link between specialized diets and reduced bird predation, a pattern called convergent evolution.

The work also sheds light on something called trophic cascades, in this case, the effect of predators on plants, mediated by herbivores. A tree's level of avian protection against leaf-chewing herbivores depends on the dietary diversity of different species of caterpillars living on the tree. A tree harboring mostly generalist caterpillars receives the most help from birds.

More information: Michael S. Singer, Isaac H. Lichter-Marck, Timothy E. Farkas, Eric Aaron, Kenneth D. Whitney, and Kailen A. Mooney. "Herbivore diet breadth mediates the cascading effects of carnivores in food webs". *PNAS* 2014 ; published ahead of print June 16, 2014, DOI: 10.1073/pnas.1401949111

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