

Inconspicuous leaf beetles reveal environment's role in formation of new species

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This is Scott Egan, left, and Daniel Funk with willow leaf beetle, left, and maple leaf beetle. Credit: Composite by Michael Smelzer, photos by John Russell, Vanderbilt University

(PhysOrg.com) -- Unnoticed by the nearby residents of St. Johnsbury, Vermont, tiny leaf beetles that flit among the maple and willow trees in the area have just provided some of the clearest evidence yet that environmental factors play a major role in the formation of new species.

At Vanderbilt University, graduate student Scott Egan and his adviser Daniel Funk, associate professor of biological sciences, obtained this new evidence from an experimental study published online this week in the early edition of the [Proceedings of the National Academy of Sciences](#).

Funk has investigated this odd group of leaf beetles (which resemble unappetizing caterpillar pellets) for 15 years. In recent years he and Egan have used Vermont populations that associate with red maples and Bebb's willows to investigate how divergent ecological habits promote speciation. Their past observations have suggested that such "maple leaf beetles" and "willow leaf beetles" may be in the process of dividing into two new species: Each prefers to feed and lay eggs on their own "host plant," where they grow and survive best. Although there is some intermixing, the beetles show a decided preference for mates from the same host. While maple and willow beetles are visually indistinguishable, the current degree of their divergence is highlighted by the willow beetles' willingness to starve to death rather than feed on the maple leaves readily consumed by their maple beetle cousins.

This research has established these inconspicuous beetles as an important example of how ecological factors contribute to evolutionary divergence and the origin of Earth's millions of species. "Without this process, life would not have the incredible number and variety of species that we take for granted," says Funk.

Although such ideas were raised just after Darwin wrote his famous book, *On the [Origin of Species](#)*, most 20th century research focused on the role of genetic factors and geographic isolation in promoting speciation. More recently, however, studies consistent with "ecological speciation" have begun to accumulate. The current paper combines ecological, genetic and geographic information to build an in-depth case for the importance of environmental factors in the formation of new species.

The new study goes beyond past investigations by showing that the hybrid offspring produced by mating these beetle types with each other in the lab grow faster than their willow parent but slower than their maple parent when raised on maple leaves, and faster than their maple

parent but slower than their willow parent when raised on willow leaves. Evolutionary biologists consider growth rate as a measure of survivability or fitness. So the hybrids' lower fitness reduces opportunities for genetic exchange between beetle types by way of matings between surviving hybrids and the maple and willow beetles themselves. As a result, it promotes the "reproductive isolation" that pushes the two groups toward becoming distinct species.

In addition, the scientists examined what happens when the hybrids mate with pure willow beetles and pure maple beetles. The hybrids all receive half their genes from one parent and half from the other. So, when a hybrid mates with a willow beetle, the genome of their offspring, called backcrosses, have 75 percent willow beetle and 25 percent maple beetle genes. Similarly, when a hybrid is mated with a maple beetle, the genome of their offspring is 75 percent maple beetle and 25 percent willow beetle.

"If the lower fitness of the hybrids were simply caused by overall genetic incompatibility, then both backcrosses should use the two tree types equally well," says Funk. "On the other hand, if genes involved in adapting to one tree type or the other were the cause, then maple backcross individuals should do better when raised on maple than on willow and willow backcrosses should do better on willow than on maple."

When the researchers measured the growth rates of the willow and maple backcrosses, that is exactly what they found. This agreement provides extremely strong support for the interpretation that these beetles are undergoing ecological speciation, Funk says.

The maple and willow beetles for the study were collected from the same habitat, where the branches of their coexisting host trees commonly intermingle, providing ample opportunity for interbreeding

between beetles types. Indeed, a study by the same authors published last year in the journal *Evolution* used molecular approaches to demonstrate that enough interbreeding is going on at this site to thoroughly intermix most of their genes. However, it also showed that natural selection was still forcing the two groups apart by acting specifically on a minority of the beetle genes, those that were associated with the use of one tree or the other.

This reflects the true power of natural selection, which has driven these beetles to become so intimately adapted to their host plant environment, promoting their speciation along the way. "It's not a coincidence that plant-feeding insects are among the most ecologically specialized and the most species-rich groups on the planet," says Funk.

Source: Vanderbilt University ([news](#) : [web](#))

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