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Three Myths About Red Autumn Leaves

Autumn gives us beautiful red leaves, but evolution can't tell us why.



The ruddy red color of fall leaves is produced by the chemical anthocyanin. Despite claims to the contrary, the red hue bestows no evolutionary advantage to trees, says Jack Schultz, professor of plant science and director of MU's Christopher S. Bond Life Sciences Center. Photo by Mary Fama.

Story by Erik Potter

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Across North America, the green leaves of summer will soon be painted a beautiful array of yellow, orange and red. And the story will be inevitably repeated, as in a recent [Slate](#) video, about how the crimson-colored leaves protect trees from insects and sun damage and how Americans are lucky to see so many of them compared to the perpetually yellow-hued Europe.

It's a wonderful tale — unless you're [Jack Schultz](#).

“This story always gripes me,” says Schultz, director of the Christopher S. Bond Life Sciences Center and professor of [plant sciences](#). He has studied leaf chemistry for 30 years and is convinced the story gets it wrong.

Myth 1

A popular position, expressed on [Wikipedia](#) and in the Slate story, is that anthocyanin, the molecule that gives leaves their red color, is only produced in the late summer and fall.

“That’s simply false,” Schultz says.

Leaf color is determined by the relative concentration of three chemicals: chlorophyll (green), carotenoid pigments (yellow) and anthocyanin (red).

Although anthocyanin has a high concentration in the fall, it is present other times as well, evidenced by the

red oak, which sprouts red leaves in the springtime.

Sugar is both the trigger and a necessary ingredient in producing anthocyanin. What Schultz's lab has shown is that small, new-growth leaves receive an adult-sized influx of sugar in the springtime before they receive enough protein from the roots to grow. The sugar builds up, triggers anthocyanin production and turns the leaves red. Then, as the leaves grow, the sugar concentration falls, and the red color fades to green.

Myth 2

There's an inclination in science, Schultz says, to see an evolutionary cause behind every trait: Trees produce red leaves in the fall, so there must be an evolutionary reason. Protection from insects and sun damage are two popular explanations.

Schultz's lab has studied how small leaves protect themselves from insects and has shown that when they're bitten by bugs they pull sugar from surrounding leaves to construct defenses. Any sugar that can't be used right away is stored as anthocyanin in the leaf, turning it red. But it's not an adaptive trait, Schultz says. "It's an imbalance in the amount of sugar and what the leaf can do with it."

There *are* chemicals in plants that can protect against bugs. If you remove the nicotine from tobacco, bugs will decimate the plant. An equivalent experiment has not been done in red oak trees, but it has been done in

Arabidopsis, a small weed that is the lab rat of plant science. The anthocyanin-free plant showed no greater susceptibility to insects.

Myth 3

Studies have shown that leaves on the outside of a tree canopy exposed to full sun all summer will turn brighter red in the fall than leaves on the interior or bottom of the canopy that are more shaded. That has led to the idea that the red leaf color must protect against sun damage, Schultz says.

Sunlight is a trigger for sugar production, which is a trigger for anthocyanin production, which produces red coloration. But the proof that the red color plays an active role isn't there. "Just because a red leaf is less damaged by light doesn't mean the red pigment was responsible," Schultz says. "Almost all these statements about the possible functions of anthocyanin are based on correlation and not causation." Schultz says.

Leaves Across the Water

Schultz's research hasn't focused on the colors of leaves in Europe versus North America or Asia, but he's skeptical of the claim. The study the Slate story is based on makes an evolutionary claim that the Ice Age killed off more insects in Europe than in North America, which lessened the need for red leaves on the continent.

“If it’s true that red fall coloration is less common in Europe, there are lots of reasons, and genes are one of them,” Schultz says. “But I don’t think it has anything to do with insects.”

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