

The Lakeshore Guardian, 2009 November
Thumb Habitats
Autumn Leaves
by Bill Collins

Finding yourself well into the fall of 2009, another winter looming, perhaps you have again contemplated brilliant autumn colors and wondered just exactly why they happen. On the surface, the answers are fairly simple, but some of the details are still a mystery.

Much of the fiery color we see in autumn is actually present in the leaves all summer long. It is simply masked by the dominant greens of chlorophyll, the pigment that allows most plants to produce sugars through photosynthesis, providing the basic food that sustains them. During shorter, cooler autumn days, chlorophyll in the leaves is replaced at a slower and slower rate so that the masking effect of the green color is eventually eliminated, letting other pigments show through.

Yellows, oranges, and some browns are mostly the result of pigments called “carotenoids”, named for the well-known carotene pigment that makes carrots and many other things orange. Did you know that the wild ancestors of the cultivated carrot likely came from Afghanistan, and that modern orange carrots, as opposed to the old white, yellow, red, and purple varieties, were developed in the Netherlands in the 17th Century and became a symbol of Dutch independence? Generally, carotenoids absorb blue light, providing energy for photosynthesis, but reflect the yellow and orange colors we see them as. In this way, carotenoids help protect chlorophyll from damage due to excessive light exposure.



Red Maple leaves showing yellow carotenoids. Photograph by Bill Collins.

Native trees in our area that tend to exhibit strong yellow and orange colors include aspen (poplar), birch, willow, Sassafras, Tuliptree, ash, hickory, and Sugar Maple. Many shrubs and herbs can also show the same colors.

Red leaf colors are usually the result of pigments called “anthocyanins”, the word derived from Greek, “anthos” meaning flower, and “cyanin” from “kyanos” meaning blue. Anthocyanins can appear purple or blue, depending on acidity, and are responsible for colors in a wide variety of flowers and fruits. Purplish leaves are rare, and the only blue I recall seeing in Michigan flora are the occasional leaves of Deadly Nightshade. Some of the highest anthocyanin levels recorded are in the seed coat of Black Soybean, purple corn, the fruit of Chokeberry, a native wetland shrub in the Thumb, red grapes, and the peel of dark eggplant.



Red Maple leaves showing red anthocyanins. Photograph by Fred Fuller.

Unlike carotenoids, anthocyanins are not present in most tree leaves during the summer but are usually produced in the fall. As the days shorten, phosphates and other nutrients involved in the processing of sugars in the leaves move into the stems. In the absence of phosphates, anthocyanins are produced by a complex chemical breakdown of sugars in bright light. The most intense anthocyanin colorations are produced when autumn days are cool and bright, and the nights remain above freezing.

Like carotenoids, anthocyanins are also important in protecting leaves from light damage during low temperatures. This is thought to help trees and other plants reabsorb nutrients from leaves, especially nitrogen, during cooler weather in preparation for winter. This same process occurs in many young plant leaves as they emerge in spring.

Native trees and shrubs in our area that tend to exhibit strong red colors due to anthocyanins include Red Maple, oak, cherry, dogwood, sumac, and Poison Ivy. When both carotenoids and anthocyanins are visible, autumn leaf colors can be very deep and vibrant.

Fall colors are displayed largely in the temperate forests of the Northern Hemisphere, including North America, northern Europe, the Caucasus Mountains, Russia, China, Korea, and Japan. For various reasons, the most intense fall color displays seem to be in the North Woods of New England, the Great Lakes region, and eastern Canada. One reason is that our forests contain a greater number of tree species than other temperate parts of the world.

There are a variety of theories as to how brightly colored autumn foliage might benefit trees. Whether it is just incidental to other processes is unclear. The yellows and oranges of carotenoids are probably just the last to go. Recent research has shown that maples produce anthocyanins in the fall through a different chemical process than other plants, apparently as a way to suppress the growth of other tree saplings around them with the anthocyanin content of their dropped leaves. Bright colors may signal good health and strong chemical defenses, similar to brightly colored animals, repelling insect parasites. In some species, color change corresponds with fruit maturity and so may attract animals to feed and spread their seed.

Maybe fall colors are just a way to promote tourism and give us a little warm feeling before winter sets in. If there is any autumn left, get out and enjoy it while you can.