Field Notes – Fall Equinox
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BANKING THE GAINS OF SUMMER

Deciduous trees have been manufacturing carbohydrates out of thin air plus water all summer—and this has fueled the growth of their roots, trunks, and branches. Now they've gotten the photoperiodic memo that it's time to scale production down to zero in short order, while packing up the essential components of carbohydrate manufacturing equipment for winter storage.

The Plants' Problem: The manufacturing equipment—the core of which is proteins (enzymes) and ribonucleic acids (DNA, RNA), molecules high in nitrogen—is exquisitely sensitive to damage by sunlight. Organic nitrogen, in the form of amino acids, is a precious commodity in plant physiology. Elemental nitrogen cannot be absorbed from the air or the soil; it needs to be processed in the soil by microorganisms before it is available to roots. Once acquired, it is capital to be conserved. So here's the problem:

Once the photosynthetic production has slowed down, and chlorophyll begins to break down into its components, all of the proteins involved in the resorption and transport machinery for organic nitrogen are vulnerable to high-energy solar radiation that could zap the bonds in amino acids and send nitrogen back to the atmosphere as a gas.

The Plants' Solution: Remember the accessory pigments—the yellow xanthophylls and the orange carotenoids that developed in early spring to protect the chlorophyll in young leaves from the harmful rays of the sun? They have been present in the leaf all along, masked by the chlorophyll. Now that the green pigments are breaking down, the yellow and orange ones hang in just long enough to do the job of protecting nitrogen transport process from high-energy light.

American Chestnut (*Castenea dentata*) leaves, Gay City, September 19

(There are no mature, reproducing American chestnuts in Gay City, but there are many, many stump sprouts of small-tree stature.

Witch Hazel (*Hamamelis virginiana*) leaves, Gay City, September 19

(The witch hazel shrubs are dispersing their fruits, preparing to shed their leaves, and preparing to flower, all at the same time.)

Black Birch (*Betula lenta*) leaves, our yard, September 24

(The birches have the most golden leaves of all!)

In some species, like Red Maples, red pigments— anthocyanins—have also been present in some tissues all summer long, and they are now revealed, as well as the xanthophylls and carotenoids.

Red Maple leaves, Chamberlain Pond, Sept. 19

But in most tree and shrub species that turn red, the pigments that appear in the fall are manufactured de novo, just for the short season between active photosynthesis and leaf fall. Remember when there was a tinge of pink to the first leaves unfurling in the spring, like these blueberry leaves?

Highbush Blueberry (*Vaccinium corymbosum*), May 8, 2020

Those pigments protected the new leaves from excessive radiation as they unfurled from their buds. As soon as they had served their purpose, the anthocyanins were resorbed by the leaves (in most species), and photosynthesis continued without their help.[i]

Now they are manufactured again to protect thin leaf tissues from excessive radiation. The brightly colored leaves remain connected to their twigs (and the whole phloem transport system) until they have finished transporting as much of their precious capital to the roots as possible. Then they get the hormonal signal to create an "abscission layer" – a layer of cells that prevents movement of solutes in or out of the leaves – and they fall.

Hop River, September 23

Amazing, isn't it, that all this chemical brilliance would happen even if there were no humans to see it?! And also amazing that the colors appear first where sun exposure is the highest—along roadsides, and power lines, and at the edges of lakes and streams—and thus where we can enjoy the show most easily?

THE AWESOME AUTUMN REDS

There are lots of different kinds of anthocyanin molecules, and they absorb light differently depending on their structure and on the pH of the solution they're in, the temperature they're exposed to, and the other kinds of pigments they associate with.[ii] Thus the tremendous variety of color in pink, red, and purple flowers; red and blue fruits and berries; and red and purple autumn leaves!

Black Tupelo (*Nyssa sylvatica*), Chamberlain Pond, September 19

Black tupelo is an undistinguished tree in the summertime. It's not common in the woods; it tends to like wet soils, so it grows near ponds and lakes. I've been overlooking it most of my life. But it is one of the first native trees to go red in the fall, and then it's glorious. Its fruits are blue, another expression of the presence of anthocyanins.

Highbush Blueberry (*Vaccinium corymbosum*), Chamberlain Pond, September 19

Like the tupelo, blueberries produce anthocyanins for fruit color as well as fall leaf color.

Poison Ivy, Chamberlain Pond, Sept. 19

If only poison ivy didn't cause such a nasty allergic reaction on human skin! It doesn't have this effect on birds, deer, squirrels, snakes, or insects. I read that "scientists speculate urishiol evolved as an antimicrobial defense agent . . . protecting the poison ivy plant against infection."[iii] Whoa! I'm glad the majority of plants never got the idea to protect themselves this way.

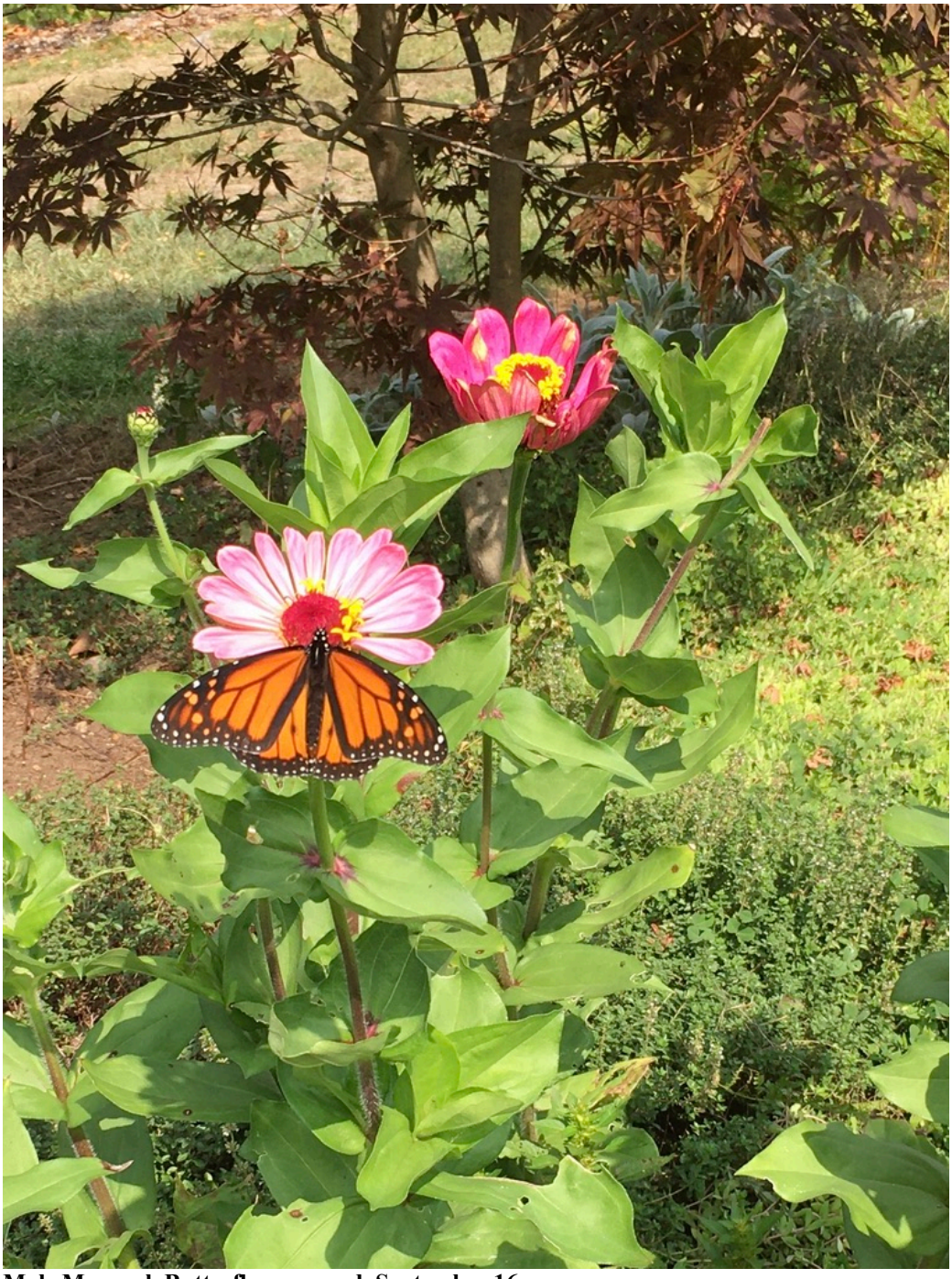
Virginia Creeper (*Parthenocissus quinquefolia*) leaves, Chamberlain Pond, September 19

Another vine protecting transport out of red leaves and into its long, long stem.

Red Maple (*Acer rubrum*), Chamberlain Pond, September 19

Sugar Maple (*Acer saccharum*), Townsend Road, September 23

BUTTERFLY NOTES



Male Monarch Butterfly, our yard, September 16.

The male Monarch has two spots on its hindwings. The female doesn't.

I haven't seen any Monarchs since I took this photo. Last year, I saw them into October. Did they leave with the first frosts?

BIRD NOTES

Hummers, chipping sparrows, and phoebes are still here. Cormorants still on the Lake.

CRICKET AND KATYDID NOTES

Still heard every day.

BUMBLEBEE NOTES

I find some bumblebees still active on goldenrods and asters, though in smaller numbers than at the midpoint of September.

NOTE

The fall has just begun. Only a few tree species have turned color at this point. There's a lot to look forward to in the next month. Keep looking and learning and enjoying.

ENDNOTES

[i] "Nature's Swiss Army Knife: The Diverse Protective Roles of Anthocyanins in Leaves," Kevin S. Gould, *Journal of Biomedicine and Biotechnology* 2004(5): 314-320. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1082902/

[ii] "Anthocyanidins and Anthocyanins," Food and Nutrition Research 2017: 61(1): 1361779. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5613902/

[iii] A Poison Ivy Primer." John Barrat, *Smithsonian Insider*, 12 August 2014. https://insider.si.edu/2014/08/poison-ivy/