Getting the Blues

www.bryanpfeiffer.com

Although they measure barely an inch across, the azures (in the genus *Celastrina*) cause a mile of consternation among lepidopterists. Even as these butterflies present sparks of blue, their taxonomy remains cloudy and controversial. I won't resolve it for you here. Instead, I'll tell you some of what we know or suspect about these blues, including revelations from recent research in Canada. Along the way, you'll discover how butterflies can expand our knowledge of nature, and maybe even allow you to witness evolution happening in your own backyard.

Just One Word: Plasticity

The first thing to remember is that butterflies — perhaps more so than birds and other flying things — are very much creatures of their environment. Their bond with plants is one of the great alliances in evolution. A Monarch gets its toxins from the milkweed it ate as a caterpillar, for example, and a Bog Copper lays her eggs only on cranberry leaves because that is all her caterpillars can eat. No milkweed or cranberries? No Monarchs or Bog Coppers. Or, as a butterfly might see it: I eat, therefore I am.

Most butterfly caterpillars are picky eaters like this, some relying on a diet of a single host plant — and nothing else. For the most part, it produces order for us among butterflies: distinct, recognizable species eating their own particular plants.

Not so the azures.[1] They're a beautiful mess. The little blue butterfly too often known simply as "Spring Azure" has been a moving target with multiple identities for at least three decades. In the field, we recognize among azures a complex of three or more distinct varieties — or phenotypes.[2] They differ mostly in the dark spots and blotches on the underside of the hindwing. This is not the random variation of a Dalmatian, for example, but

[1] Although this paper features members of the genus *Celastrina*, which belong to the Polyommatinae, known commonly as "Blues," that subfamily includes many other genera. So, technically, we're only Getting *Some of* the Blues in this account — the blues known as Azures. The distinction, I suspect, would not have troubled Stevie Ray Vaughan, to whose memory and music I dedicate this paper.

[2] At one point, these varied forms were considered a single species, *Celastrina ladon*, with three subspecies. More recently, some taxonomists recognized at least three separate species. And I'm not yet including a fourth species, Summer Azure (*Celastrina neglecta*), in this grouping, which I'll get to later.

rather distinctive forms with specific patterns of spots and blotches or varying shades of blue above.

This kind of variation actually isn't so odd in nature. Many species break into regional or continental subspecies whose appearance varies somewhat by location: Savannah Sparrows breeding on the island of Cape Sable, Nova Scotia, and wintering on dunes and beaches of the East coast, are paler (more sand colored) than all the other Savannah Sparrows breeding in grasslands across the continent. White-tailed Deer on Long Pine Key in Florida are the size of German shepherds — still a legitimate White-tailed Deer, mind you, but only smaller: a "mini-me" adapted to vanish (and survive) behind waist-high shrubs. So it goes, evolution by means of natural selection, also driving diversity *within* a species.

What's odd about our Spring Azure is that its varied forms basically cohabitate — we often find them together in the same places at the same time of year (or pretty close to the same time). They're *sympatric,* which means "of the same fatherland." This is somewhat odd (and one of the reasons I'm writing about azures).

What's also odd (but happens often enough among Lepidoptera) is that a butterfly's appearance or behavior can change *from one season to the next.* A Mustard White in spring has dark veins on the underside of its hindwing, for example, but its offspring, flying in summer, show faint veins below. Same species, different appearance by season. The Monarchs you see flying around in spring here in the Northeast live as adults for about five weeks; so will their offspring in summertime. But something odd happens to Monarchs in the fall: they don't live for five weeks — they live for about eight months and they migrate to Mexico (and part-way back toward us next spring). Same species, different life according to season.

All sorts of things can drive this kind of change in appearance or behavior in animals: temperature, day length, diet, the presence of predators, or who knows what. The point is that species aren't as fixed as you might think. They can be shaped or molded, like soft plastic, depending on what they encounter in their environments. We call this variability *phenotypic plasticity*. It's very cool. How cool?

Take the dragonfly known as Dot-tailed Whiteface (*Leucorrhinia intacta*). Actually, take the eggs from a given female Dot-tailed Whiteface. Divide them in half. Raise one half in a simulated pond without any predators. Raise the other half under the same conditions, except include fish that prey upon whiteface nymphs. In the presence of fish, the nymphs grow longer spines (presumably for defense) than do the nymphs facing no such threats.[3] That's phenotypic plasticity.

Diet or Divergence?

Phenotypic plasticity might be lurking behind the various forms of Spring Azures. One hypothesis is that diet accounts for the forms. Azure caterpillars are omnivores. They eat various flowering shrubby plants: dogwoods (*Cornus spp.*), viburnum (*Viburnum spp.*), cherries (*Prunus spp.*), and others. But they also eat assorted plant *parts*: flowers, leaf buds, leaves, and even leaf galls. So maybe the various azure forms correspond to what the caterpillar eats. If you eat blueberries or viburnum as a caterpillar, for example, then you'll look like the Spring Azure with a dark patch in the middle of your hindwing. Eat leaf galls on cherries, then you might turn out to be a much paler form, without the dark central blotch or dark margins on the hindwing. Phenotypic plasticity in action. You are what you eat.

Then again, maybe not. Maybe we're seeing nothing less than evolution in action. Maybe during the last glaciation (about 12,000 years ago) the ancestral azures were driven apart into isolated populations, kind of like the breakup of the Soviet Union. This fragmentation can drive the formation of new species. Over time members of the disjunct populations change, owing to random, favorable mutations, and evolve to be different from one another, genetically distinct. Now, as the glaciers recede, bring those far-flung azures back together again (sympatry as Vladimir Putin might prefer). Only now the azures are so different that they can no longer interbreed. They have become new species living in the same place.

This is the point at which lepidopterists have gone to war. Some argue that the various azure forms are distinct species.[4] Others aren't so quick to split them up, calling them a species complex. Or maybe they are all still a work in progress, with the azures not yet sorting out their business — evolution unresolved, which I guess is

[3] McCauley SJ, Davis CJ, Werner EE. Predator induction of spine length in larval Leucorrhinia intacta (Odonata). *Evolutionary Ecology Research*, 10: 435–447

[4] Warren, A. D., K. J. Davis, E. M. Stangeland, J. P. Pelham, K. R. Willmott & N. V. Grishin. Illustrated Lists of American Butterflies. [15-IX-2016] <http://www.butterfliesofamerica.com/>

always the case with evolution, except that among the azures it is *way* unresolved.

Whatever the case may be, recent research[5] into azures in Ontario is a tour-de-force of scientific bravery and determination. B. Christian Schmidt and Ross A. Layberry, Canadian biologists, examined azures in scientific collections, in the field and in the lab. They gathered distribution data from museums specimens; they reared azures on various host plants from eggs to larvae to adult; and they investigated azures at the molecular level with DNA barcoding.

I won't go into the intricate details of their 30-page paper, which you yourself can download and read.[6] But suffice to say that some of it rocked my own notion of azures. That notion had recognized at least nine species of *Celastrina* across North America. My own (provincial) concern is the three (or more) of them living here in the New England and nearby Canada. Here in Vermont, owing mostly to the Vermont Butterfly Survey[7] and the fine work of Harry Pavulaan, an authority on this genus, the azures had broken down this way:

- ***Celastrina lucia* (Lucia Azure)** – Our first azure of the season in Vermont, flying as early as April, and the one often (not always) showing a darkish central patch and a dark terminal band on the hindwing (**d – f** in the image over there to the right).
- ***Celastrina serotina* (Cherry Gall Azure)** – Next in flight, without the dark patch, but often showing a darkish margin along the hindwing (like those in **g** and **j** in the image). The larvae are reported to feed on eriophyid mite galls on the leaves of black cherry and choke cherry.
- ***Celastrina neglecta* (Summer Azure)** – And finally, taking flight as the other two wane for the season, Summer Azure is clean white below with only sharp specks for its dark marking (**l – o** in the image).

Three species, fair enough.[8] Well, sorry, maybe not. Harry Pavulaan had suspected that other sibling species were lurking among the Lucia and Summer azures here in Vermont. We just didn't know for sure because we lacked enough data.

Then came the Canadians and their work from Ontario — not too far from most of us in New England. Schmidt and Layberry have revised the status of *Celastrina* in Canada — close enough to us here in New England to be noteworthy. Among their extensive findings, at least two things stand out for folks in New England:

Male *Celastrina*

a – c = *Celastrina ladon* (Spring Azure); **d – f** = *Celastrina lucia* (Lucia Azure), spring generation; **g – k** = *Celastrina lucia* (Lucia Azure), summer generation; **l – o** = *Celastrina neglecta* (Summer Azure)

Source: Schmidt and Layberry

- ***Celastrina serotina* (Cherry Gall Azure)** is now gone from the Canadian fauna. Schmidt and Layberry found no evidence of Cherry Gall Azure as a separate gall-feeding species distinct from Lucia Azure (at least in Ontario). That's not to say that Cherry Gall Azure isn't a valid species, but the researchers suspect they're instead seeing a later-flying (second flight) Lucia Azure whose larvae feed on cherry galls.
- As a result, ***Celastrina lucia* (Lucia Azure)** appears to be bivoltine in Canada — that is it produces two generations of adults in one season. It is univoltine in boreal Canada and could be trivoltine in southern Canada. (We call that plasticity in voltinism, which is common among butterflies.)

So, if we were to apply this data to, oh, Vermont or Maine, for example, then we'd only have two azures to identify: *Celastrina lucia* (Lucia Azure), flying early in the season and then again in at least one or more generations per season; and *Celastrina neglecta* (Summer Azure), the clean pale one that we usually don't see until late July.

[5] Schmidt BC, Layberry RA. What Azure blues occur in Canada? A re-assessment of *Celastrina* Tutt species (Lepidoptera, Lycaenidae). ZooKeys 584: 135–164. doi: 10.3897/zookeys.584.7882

[6] http://zookeys.pensoft.net/articles.php?id=7882

[7] McFarland KP, Pfeiffer B. Vermont Butterfly Survey. Vermont Center for Ecostudies – Vermont Atlas of Life. http://val.vtecostudies.org.

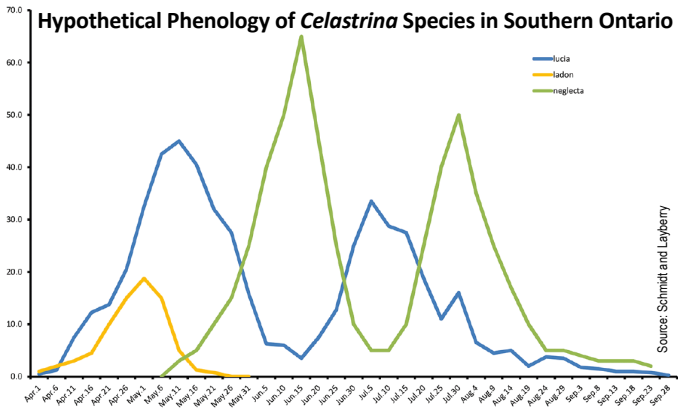
[8] As I mentioned in footnote 2, some researchers had lumped the first two on this list (*C. lucia and C. serotina*) into *Celastrina ladon* (Spring Azure). *Celastrina ladon* is a legitimate species, but still often conflated with the others in field guides. As you can see, it all remains unresolved.

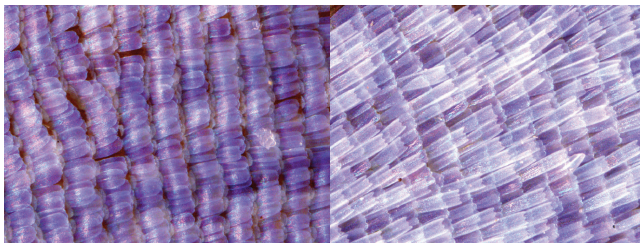
But, hey, these are azures, after all, which are nothing if not unsettled and unruly. And that brings me back to **Summer Azure** (*Celastrina neglecta*), the one that always seemed to behave and be most recognizable in the field here in Vermont: pale white below with sharp markings, and flying in summer as other azures wane. Summer Azure is actually an azure of summer *and of* late spring (although probably less distinctive in appearance when it files in June). Schmidt and Layberry present evidence of two generations of Summer Azure in Ontario — one from late May to late June and a second from late July to late August.

That's fine, I suppose. Why not extend the summertime and its azures a bit — at least in Ontario? But what's also crazy is evidence[9] that late-summer larvae of Summer Azure from Ontario can become typical early-spring Lucia Azures adults the following year. Yeah, a Summer Azure caterpillar growing up to be a Lucia Azure butterfly. Go figure. Well, Schmidt and Layberry did figure — and they believe that the source of those early-spring Lucia Azures was not Summer Azure, but rather a summer (second) flight of Lucia Azures. Makes sense.

Finally, there indeed remains a butterfly called ***Celastrina ladon*** (Spring Azure) — the binomial and common name used (unfortunately) in the past for all these azures. That butterfly still exists, except that we're not really sure of its distribution, mostly because it's probably been misidentified over the years. *Celastrina ladon* is best identified (under a scope) by a characteristic overlapping scale pattern on the male forewing. The Canadians found four *Celastrina ladon* specimens from Ontario, all from the southern (Carolinian forest) region near Lake Erie.

But elsewhere lots of our azures have for years been lumped under the name *Celastrina ladon* (Spring Azure).[10] Having looked at all the Vermont azures collected during the Vermont Butterfly Survey, Harry Pavulaan did not find any *Celastrina ladon*.





scales of *Celastrina lucia* — Overlapping scales of *Celastrina ladon*

Closure? Not Yet

So if you're now ready to throw up your hands and toss away your butterfly net, fear not. Yes, of course, this stuff isn't resolved. (I warned you.) The Canadian researchers, despite their own exhaustive work, make a plea for more study. "Surprisingly, there are still many large gaps in our understanding of *Celastrina* taxonomy and biology," they write. Those gaps point to the value of museum specimens — and to new specimen collection when necessary.

Those gaps also allow us not to worry too much about names. Remember that much of what I'm writing here comes from Ontario azures. Your results may vary. I myself won't always know what to call the azures I encounter here in New England. I'll often enter them in iNaturalist or e-Butterfly.org as *Celastrina sp.*

But we can do more than pass these gems off as just another azure. Watch them a while. Find females laying eggs and note the host plant. We also still have lots of voucher specimens from the Vermont Butterfly Survey; let's hope some researcher might find them useful for additional work on this group. And I myself might collect a few more azures in the interest of science.

After all, have a look at the azure pictured on page 2 of this document. I photographed it in Peacham, Vermont, on 30 July 2016. I don't believe I've ever documented a butterfly that looks likes this so late in the Vermont summer. By most accounts, at that time of year, it should be *Celastrina neglecta* (Summer Azure). But that's no *neglecta*. No way. Not pale enough, and the marks are too big and diffuse. It looks more like *Celastrina lucia* (Lucia Azure) — a second flight. The mystery continues.

But more than anything, don't let the uncertainty about this beautiful mess keep you from searching for these butterflies, learning more about them, and enjoying their azure twinkles. Sometimes it's nice not to give a damn about what name we have put upon something this lovely. That it exists is simply good enough.

[9] Eberlie WJD. Rearing notes from Northumberland County. Butterflies of Ontario and Summaries of Lepidoptera encountered in Ontario in 1996. Toronto Entomologists Association. 29: 9-10.

[10] For example: http://www.naba.org/chapters/nabambc/construct-species-page.asp?sp=Celastrina-ladon and http://www.massaudubon.org/learn/nature-wildlife/insects-arachnids/butterflies/find-a-butterfly/(id)/29

Acknowledgments: Rick Cech and Guy Tudor write brilliantly on the azures (from which I've borrowed) in their masterpiece: *Butterflies of the East Coast: An Observer's Guide.* Chris Schmidt provided me with a priceless review of my account of his work with Ross Layberry.