Delphinium 'Blue lace'

Flowers Seen as Blue

William Cullina

When I stumble out of bed in the morning and head for the clothes closet, I usually pick out some sort of blue. Blue denim, blue flannel, blue cotton, a thick blue wool sweater, too. It's a soothing color we associate with coolness and calm. It is the dominant hue in the majestic stained glass cathedrals of Europe --an evocative, mystical blue of oceans and sky. We cherish blue flowers in part because it is so uncommon. Horticulturists are notorious for bestowing the title of blue on all manner of violets and purples. Perhaps this bit of chromatic license is forgivable, for blue is really in the eye of the beholder. Yesterday the glorious fringed gentians outside my window appeared like royal purple satin in the sun. Today it is cool and overcast, and the blooms simmer closer to cobalt curled up against the cold.

When plants began to colonize the land, plant pigments evolved to help screen plant tissues from the deadly power of ultraviolet radiation. Pigments suffuse leaves and stems and do for the plant what melanin does for us; absorb or reflect the ultraviolet wavelengths of light. (The ozone layer, which protects us from most UV radiation today, did not form until oxygen released through photosynthesis by early land plants was converted to ozone in the atmosphere.)

Helianthus mollis

It was only later in evolutionary time that brightly colored flowers began to appear. As flowering plants enlisted insects and birds in their reproductive efforts, pigments that originally screened them from the sun began to serve a different purpose – alerting and guiding pollinators to receptive flowers.

The color of a flower is often a good clue as to what might pollinate it. Yellow and white are sort of default flower colors because they are highly reflective and easily seen by a number of potential pollinators. White, sweetly fragrant flowers that shine even in moonlight attract night-flying moths and bats. Yellow is certainly a common flower color in meadows and prairies in mid to late summer and fall, when bees, wasps, and flies are most numerous. However, the color they see is not the gold or chrome yellow that we perceive. Bees and many other insects can see ultraviolet light, an ability that likely evolved early on, when the only pigments available for floral advertisement where the ones that reflect ultraviolet light. Yellow pigments (and many white ones as well) look blue-violet or blue-green in ultraviolet light. What we see as a plain white or yellow bloom is revealed to a bee as a complex diagram complete with lines and patches that serve as landing guides to efficiently move bees to nectar and pollen. Some overly hybridized flowers bred for human purposes and not insects' abilities can be very confusing to six-legged visitors. I have watched a honeybee stagger aimlessly on a florist's lily. What to me was a lovely pattern of white, yellow and pink spotting on an ivory background was incomprehensible to the bee. It was as if someone had pulled out all the street signs and rearranged them randomly, and the bee could find no guidance to the nectar in the flower's throat.

Red is probably the easiest color for us to see. A small red object stands out at a great distance, so it is no wonder that red and orange are the colors of warning and caution on our highways and byways. Birds see red very clearly as well, explaining why many bird dispersed fruits and hummingbird-pollinated flowers are crimson or scarlet. Most red pigments are derived from a group of flavenoid pigments called anthocyanins (a few plant families, like the Cacti and Portulas, achieve brilliant reds and purples with another group of pigments called betalins). The word anthocyanin comes from the greek *anthos,* for flower, and *kyanos*, for blue. One of the fascinating things about this group of pigments is -- through a bit of cellular wizardry -- the color they express can be either brilliant red or sultry blue. Most of the pigment is contained in vacuoles (sacks) within the cell, and the pH of the vacuolar fluid affects the expression of color. Simply put, an acid environment will yield red and an alkaline blue or purple. Which brings us back (finally!) to the subject of this article: blue flowers. Changes in cellular pH help explain why some flowers like those of Virginia Bluebells can change from fairly bee-invisible pink in bud to bee-attracting sky blue when the flowers are receptive. A quick change in acidity helps the bees to perform at their maximum efficiency – through a simple trick of chemistry trick that would make any office manager proud. Delphinium petals contain an anthocyanin called delphinin, which changes from bluish red in acid to blue to violet in basic solution. – providing the intrepid gardener with a simple home pH paper substitute. This also explains why blue roses remain the elusive holy grail of hybridizers. A rose's cellular fluids are stubbornly acid, so despite having the proper pigments for blue, the best anyone's been able to breed is a rather muddy violet *Rosa*.

Hydrangea macrophylla 'Forever and Ever Pink' turns a range of blue, pink and lavender in acidic soils

While some blue flowers contain only straight anthocyanins, others a mix in colorless anthoxanthin that combines to bring out blue-violet (a term pollination biologists call co-pigmentation). Others form complexes with metal ions like iron or aluminum to achieve true blues. The well known propensity of Hydrangeas (*Hydrangea macrophylla*) to bloom blue in acid soils and pink in alkaline is not directly determined by acidity (cellular or otherwise), but by the fact that at low pH, aluminum and iron ions are much more soluble in the soil and available for uptake by the plant to be incorporated into floral pigments.

All of this does not help to explain the rarity of delphinium blue flowers in nature. Perhaps it is because it is really the ultravioletly enhanced appearance that is most important for attracting insects, and blue violet or purple is more effective in this regard. Indeed, many true cobalt blue flowers (*Salvia azurea*, for example) have evolved for hummingbird, not insect pollination (like us, hummingbirds are blind to ultraviolet). It seems in the end it is to the hummingbirds that we owe a hearty and heartfelt hurrah – not only for giving us the crimson of Cardinal flower (*Lobelia cardinalis*), but the true blue of *Lobelia siphilitica* as well. It is not simply the color either, for they are attracted to bright or intense coloration – another floral trait we find so appealing.

In compiling a list of native wildflowers *en bleu*, I could come up with only a few that I would consider true cobalt. Besides the *Lobelia*, western Delphiniums and Salvias, there are several Penstemons, including *P. serrulatus*, that bloom this shade. Deep blue is a color not squandered on Gentians, and a few, like the difficult Pine Barren and Prairie Gentians (*G. autumnalis* and *puberulenta*, respectively) are a shocking, deepwater blue. More common is the Baby blue of Quaking Ladies (*Houstonia caerulea*) and Bluestars (*Amsonia* spp.). Other notable sky blue species are: *Gentiana saponaria* (Soapwort Gentian) *Mertensias*, including Oysterleaf and Virginia Bluebells, and finally, many of the Blue-eyed Grasses (*Sisyrinchium* spp.).

Even more abundant are wildflowers that are loosely described as blue by cyano-deprived horticulturists but might be more accurately be called deep blue violet. In our gardens, these include: *Aconitum uncinatum* (Wild Monkshood), *Camassia leichtlinii* ssp. *suksdorfii* (Camas Lily), *Campanulastrum americanum* (Tall Bellflower), *Delphinium tricorne* (Wild Dwarf Larkspur), as well as other gentians, including the Closed Gentians (*Gentiana andrewsii* and *clausa*) and the glorious Fringed Gentian (*Gentianopsis crinita*). Finally, there

Sisyrinchium campestre

are the host of light violet-blue flowers, including the *Polemonium reptans* var. *villosum* (Jacob's Ladder) featured on the cover of this magazine. The list of flowers with this shade is as it is a perfect color for insect eyes to see. To it I would add:

Clematis occidentalis (Purple clematis), *Delphinium exaltatum* (Wild Larkspur), *Eupatorium coelestinum* (Mist Flower), *Linum perenne* ssp. *lewisii* (Prairie Flax), *Phlox diva*ricata (Blue Wood Phlox), *Ruellia humilis* (Wild Petunia), *Scutellaria* species (Skullcap), and *Stokesia laevis* (Stokes' Aster), to name a few.

It is, then, one of the beautiful accidents of nature that the color perception we humans developed evolved independently in birds and insects. If, like most mammals, they could only see shades of gray, thing of how drab our world would be. No kaleidoscopic butterfly wings, bird feathers, or beetle carapaces, and worst of all – no luminous, magnificent, brightly decorated flowers.