

What is Nature Doing with Colour?

Laura Liska



Autumn colours with the familiar sequence: green, yellow, orange, red.

The year before I began my research on the colour of leaves, I did a simple experiment. In August I cut branches off a dozen species of trees and laid them on the floor of my study. I hoped their green leaves would turn the same gorgeous colours as the leaves outdoors would, come October. Worst case, I thought, they would just turn brown. To my amazement, nothing happened. As the corresponding leaves outside went through all the spectacular autumnal hues, the leaves indoors simply stayed green – a dull, papery green as they dried out, but green nevertheless. And they stayed green for almost two years before eventually turning pale grey-brown and falling apart.

It was from this little experiment that I discovered that living trees lose their leaves differently – different colours, different patterns, at different times and at different rates. This is not passive, not just death by disintegration; this is an activity that expresses itself in colour.

All leaves on all trees eventually fall off. Some trees, like conifers, remind me of my cat, with their shedding of little brown needles all year. Others lose leaves sequentially along their branches, new leaves growing before old ones drop off. But only deciduous trees lose all their leaves at the same time and stay bare for part of the year. And only in temperate zones do deciduous trees change colour.

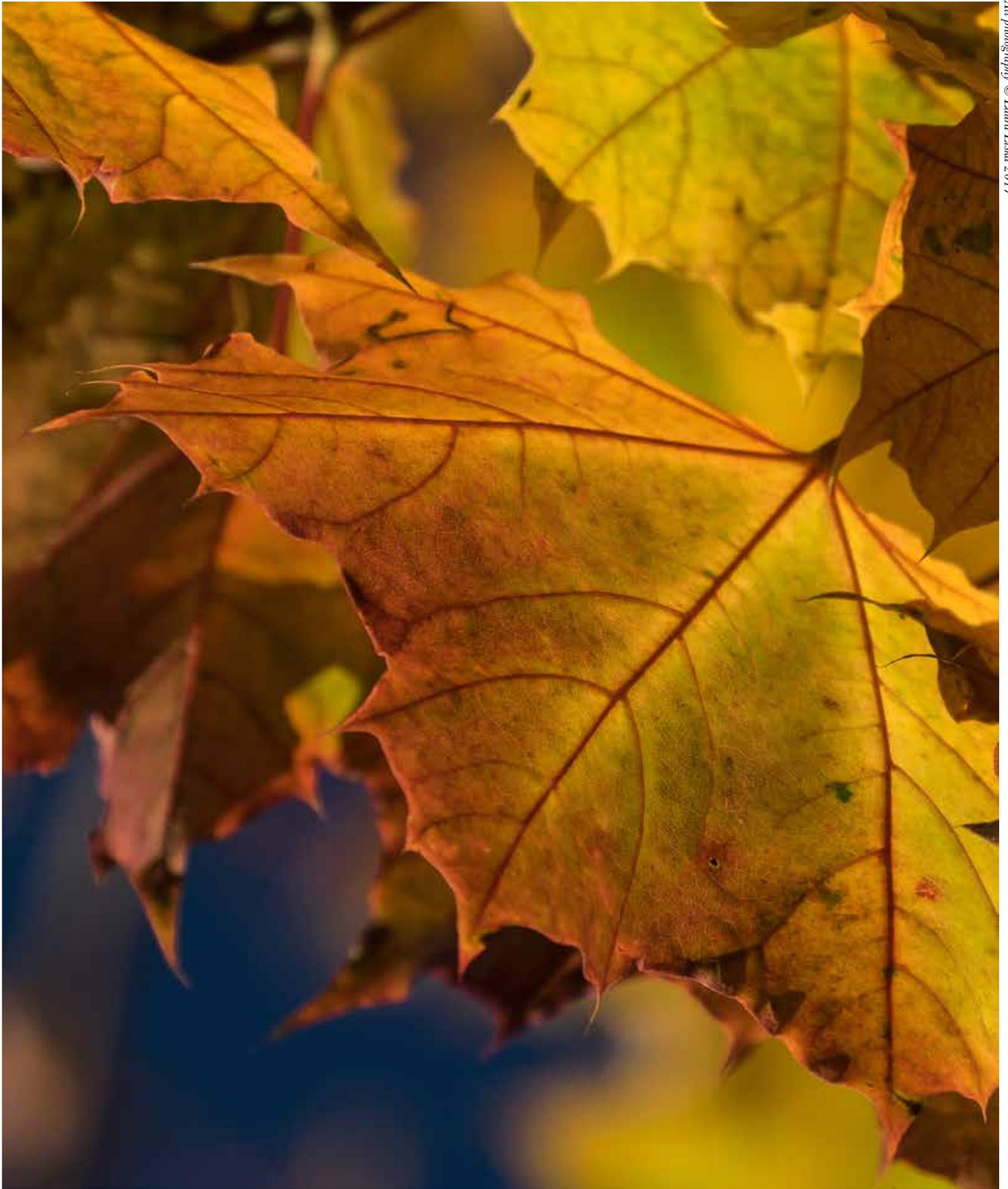
In these zones, the end of the season of growth and ripening is announced by colour moving across the land from north to south (in the northern hemisphere) and from higher to lower altitudes. Geography plays a role; each location is a bit different. I experienced this firsthand one October when I flew from Europe to America, taking off from a golden landscape only to land, ten hours later, in a very similar but surprisingly red one. Weather also has an effect; every year is a bit different. Periods of clear, sunny autumn days with chilly nights, for instance, bring out more intense colours.

What is consistent from year to year is the timing. At a certain point when the sun is moving lower and lower across the sky each day, the landscape begins a symphony of differentiating colour. Light provides the tempo, warmth and weather the melody. Waves of amber and gold followed by copper and carnelian crescendo in places to crimson or carmine before fading to bronze and brown. Each tree – indeed each leaf – adds its unique colour-note to the symphonic splendor and every tree and leaf sings to the same tune: green to yellow to orange to red.

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We must not come to a standstill when confronted by individual phenomena in nature, especially those which are significant or striking; we must not dwell on them, cling to them, or view them as existing in isolation. Instead we should look about in the whole of nature to find where there is something similar, something related. For only when related elements are drawn together will a whole gradually emerge which speaks for itself and requires no further explanation. Goethe, *Theory of Colours*, §228¹

One evening, shortly after I began my research, I watched the sky turn sapphire blue as the sun sank. Thin white veils of clouds were gathering and when the sun met the horizon they began to glow. As they drifted north a breathtaking display of colour spread across the dark-



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Colour sequences in the evening sky at sunset, in summer rose leaves and in the rainbow poised between bright and dark.

ening sky – radiant yellow followed by rose-orange, fiery red and finally deep magenta. As the first stars sparkled through the inky indigo sky, the colour bowed out softly into greyness.

I had just witnessed the same colour sequence that the leaves go through! Another equally beautiful sequence had played out simultaneously in the sky: cyan to deep blue to an almost violet black. What could I learn from the sunset?

Red, orange and yellow are not a random sequence. They are the familiar “warm” colours of the painter’s palette – the earth pigments – and they appear in that order in the luminous bands of a rainbow on the edge of darkness. Cyan, blue and violet arise as counterparts, as complements – the painter’s “cool” colours – in the rainbow’s bands on the edge of brightness. Shine a small light in a dark room through a prism and both sequences are there, on the far wall. In the rainbow and through the prism, these spectra appear at borders between light and dark. When light slowly withdrew from the atmosphere that evening the same spectra appeared – one colour at a time – as light steadily gave way to darkness. Dawn and dusk are also a border between light and dark – a temporal one.

Alternating light and dark creates the fourfold cycle of the day from two pairs of opposites: midday and midnight, dawn and dusk. In the first pair there is either only light or only darkness and in the second there is a transition from one to the other. Alternating light and dark also creates the cycle of the year from similar pairs: summer and winter (when days have long periods of either light or darkness), spring and autumn (when there is a rapid shift from one day to the next as light overtakes darkness or darkness overtakes light). Only in temperate regions does the rhythmic exchange between light and dark last several months and give rise to a corresponding fluctuation in temperature between extremes. Changing light is the sun’s domain, changing temperature the earth’s – a response of material substance to an increase or decrease of radiant energy. Parallel transitions – light into dark and warmth into cold – one heavenly, one earthly – are the condition for leaves to express from life into death in colour: yellow, orange and red appear as light steadily gives way to darkness.

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The blue of the sky shows us the basic law of chromatics. Let us not seek for something behind the phenomena – they themselves are the theory. Goethe, *Maxims and Reflections*²

At the center of the rainbow, balanced between the yellow and blue of the border spectra, is the colour we usually associate with leaves, namely green. To observe the subtle dance of its hues in a leaf requires the better part of a year. Deciduous leaves come out in early spring,



Spring leaves containing the autumnal sequence in reverse: red, orange and yellow within fresh new green.



Summer greens shifting from yellow-green to blue-green.

containing the familiar sequence: red first, on tips and at margins, then orange and yellow tinting the fresh new green. The yellowish green shifts through pure green to bluish green as the leaf switches from expanding to maintaining itself through summer. Finally, in autumn, green fades away and the familiar sequence appears in reverse order. The annual colouring of a leaf is like dipping in and out of a rainbow – from darkness down through red, orange, yellow, to green at the center, a touch of blue, and back up through green, yellow, orange, then red, into darkness again.

What I observed about colour during the rhythmic genesis and decay of leaves is studied in chemistry in the processes of photosynthesis and senescence. I can't observe chemical processes directly, but I find interesting correspondences to my insights in what other researchers have discovered.

When conditions of light and warmth are favorable, one of the greatest life sustaining activities on the planet – photosynthesis – can take place inside the leaf: water from the earth and carbon dioxide from the air are transformed into the life-giving oxygen we breathe and the substance that trees are made from: sugars, which we eat. During the activity of senescence, the right conditions of light and warmth ensure that nutrients in the leaves move to woodier parts of the tree to support next year's leaves and what is left falls off to feed soil organisms that support the roots.

The pigment that gives a leaf its green colour, chlorophyll, is central to photosynthesis. In a truly elegant chemical process, energy for photosynthesis is repeatedly given up by and then restored to chlorophyll molecules. Yellow and orange pigments, xanthophylls and carotenoids, protect and assist the chlorophyll. They are always present, visible in flushing leaves, but eventually concealed by the green. During senescence chlorophyll breaks down quickly but the sturdier xanthophyll and carotenoid molecules take longer. Therefore, as the green dissipates the yellow and orange pigments become visible again.

Blue pigments don't exist in leaves at all, but we see an undeniably blue-green colour when fully formed leaves busy themselves providing what the tree needs for developing fruits and seeds. A thin waxy surface develops on the top side of a mature leaf and the slightly opaque or turbid layer scatters the reflected sunlight giving a blue cast to the underlying green, just as the atmosphere scatters sunlight, to give the blue of the sky.

Red pigments – anthocyanins – are not in the leaf throughout the year but only produced if conditions of light and warmth are not optimal. In spring they provide extra physical resilience for the emerging leaf. In autumn, at the end of senescence, they appear if the leaf is in direct sunlight and under duress. A sudden pronounced difference between day and night temperatures or an overnight frost bring red and a measure of tenacity to the leaf.

In diurnal cycles of light and darkness, in seasonal cycles of life and death, and even in the chemistry of pigments, colours give the reason for their appearance. I find it observing leaves. Green is life generating more life, continuously forming substance out of light. The essence of green is endless renewal – green begets green begets green. Yellow is life entering substance to create form and leaving substance now formed behind – yellow radiates in, radiates out. Blue is life sustaining inner activity from outside – blue embraces. And red is life protecting life at the edges of darkness – red stands firm.

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Thus, Goethe advances from observing color as an attribute of the phenomenal world to a study of the phenomenal world itself as it appears with this attribute. In his chapter on the sensory-moral effects of color he then finally proceeds to the observation of the higher relationship between the colored physical world and the world of the human soul. This is the rigorous, strict path of science – going from the subject as condition back to the subject as it finds its satisfaction in and with the world.

Rudolf Steiner, *Introduction to Goethe's Scientific Writings*³

The seasons, particularly autumn, when colour changes so dramatically, pose the question: what is nature *doing* with colour? And then, maybe, we wonder of colour: what is nature doing with *us*? I considered this question while reflecting on the significance of doing research: I find research has a quality of bringing light into darkness and, in the fluctuating moods of the researcher, a certain colouring.

Tiny, pale and shining, a leaf emerges out of practically nothing, enveloped in red – like the moment of wonder when nature kindles a tiny question in me, enigmatic and compelling. Light increases and the little leaf expands, radiant yellow-green. I engage the question and from every side new possibilities, new information, new questions fill me with excitement. Soon, the full-grown leaf withdraws into blue-green, absorbed with the business of trees:



Falling leaves.

green begetting green. I behold the object of my questioning from a place of cooler contemplation, looking at it from one perspective then another, thought begetting thought.

As light and darkness swap places, green retreats and golden yellow glows from the leaf. As my intellectual rumination gives way, insights arise from the effort. Summer warmth, now released, entices rusty orange from the leaf – the warm enthusiasm of colleagues beckons to me to share. Then the leaf, now valiant red, holds on a bit longer to ensure the tree ends the year nourished for the approaching cold winter. As for me, I resolutely shape my results into something finished, something to offer – a challenging activity of sifting through ideas, keeping some, rejecting others – but a final act without which my questions and my work have no real significance.

Finally the devoted little leaf browns and with a slight touch of wind, breaks away, dances in the air and gently floats to the ground to disappear into the blacks of the earth. Without that letting go, into winter, into darkness, there is no chance for new growth. I too must let go, releasing my thoughts and insights, and the words I've chosen to express them, into silence – the secret place where they find renewal and return to me refreshed and re-inspiring.

Notes

1 J. W. von Goethe, *Scientific Studies*, ed. and trans. D. Miller (New Jersey: Princeton University Press, 1995), 203.

2 Goethe, *Scientific Studies*, 307.

3 R. Steiner, *Nature's Open Secret: Introductions to Goethe's Scientific Writings*, trans. J. Barnes and M. Spiegler (Hudson, NY: Anthroposophic Press, 2000), 183.

Laura Liska is a naturalist photographer doing research with the Science Section at the Goetheanum in Switzerland. This essay is one of several emerging from almost two decades of wonder and delight combined with some serious research into leaves and Goethe's Farbenlehre.