The Color of Flowers

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When we contemplate the extraordinary diversity of colors offered to us by the numberless flowers and fruits, ranging through all possible gradations from the purest white to the most intense black, we can do no less than admire so surprising a wealth of color-shades, and are naturally prompted to imagine that chemical processes influence their tone and effect the manifold changes. Although we are able to pursue the chemical processes occasioning changes of color in the mineral kingdom—we know, for instance, those occurring during the conversion of the white color of silver chloride into black—those in the living plant, whereby equally striking changes are effected, are unfortunately hidden from our scrutiny. For instance, we do not know the process which causes the immature fruit of the prune-tree to pass from the brightest of green, through the most varying gradations of color into light red, and finally deep dark blue; although we know that during the process of maturing the percentage of starch is by the aid of the vegetable acids of the fruit gradually converted into sugar, still, this phenomenon is not sufficient to throw light on so extraordinary an alteration of hues. To the operation of light is ascribed an essential influence in determining the vegetable colors; but that vegetable pigments can also be produced without light is shown by the yellow turnips, carrots, alkanet-roots and other roots, all of which develop their colors within the soil. Not only the light in general, but also its volume, appear to exert an influence upon the intensity of these pigments and their hues. This fact is confirmed by the intense and lively colors of flowers blossoming upon high mountains, and the increase of the flower pigment of the same species of plants with the augmenting elevation, with otherwise the same properties of soil and location. This increase of the pigments, such as is observed upon the Alps and other high mountains, stands most assuredly in connection with the stronger sun radiation at great height. It has further been proved that, under the influence of the almost uninterrupted duration of light during the short Scandinavian summer, many garden flowers of Central Europe gradually increase in intensity after having been acclimatized in Norway. Imported seeds of winter wheat, corn, peas, and beans, grow darker from year to year, until they have finally assumed the hue of native productions. Not alone do flowers, seeds, fruits, and vegetables, become more aromatic in the northern latitudes, through the long constancy of light in summer, but their color also deepens, while the production of sugar decreases from the insufficient quantity of heat. Thorough experiments will reveal the effects of electric light upon vegetation, and we have no doubt that interesting results will be obtained in time, with regard to the influence of this light upon the pigment of flowers.

Our knowledge of the chemistry of vegetable pigments is not yet sufficiently advanced, for which reason the effect of artificial influence upon the color-tone of flowers has not yet received its merited attention. According to my view, tannin is an important factor in the generation of vegetable colors; it is found in almost every plant, the petals not excepted, and by the action of the most varying reagents—alkalies, earths, metallic salts, etc.—it assumes the most manifold hues from pale rose to deep black. A darker color, therefore, is produced in flowers rich in tannin, when manured with iron-salts, since, as everybody knows, tannin and iron-salts dye black, and produce ink. A practical use has been made of this fact in the raising of hortensias and dahlias. The former, which in ordinary soil blossomed pale-red, became sky-blue when transplanted into soil heavily manured with iron ochre, or when occasionally watered with a dilute alum solution. English gardeners succeeded in growing black dahlias by similar manipulations. It is well known to every florist that a change of location, that is, a change of light, temperature, and soil (replanting), occasionally produces new colors, whence it may be deduced that an interrupted nutrition of the flower may, under circumstances, effect a change of color. We see no valid reason why the well-authenticated fact of the change of color produced by manuring with iron oxide, thereby changing the nutrition of the plant, should not be practically employed by the hothouse gardener. Another very singular and successful experiment, in producing a change of color in a bird, has recently been made. A breeder of canary-birds conceived the idea of feeding a young bird with a mixture of steeped bread and finely pulverized red Cayenne pepper. Without injuring the bird, the pigment of the spice passed into the blood, and dyed its plumage deep red. The celebrated ornithologist Russ believes that the color of the plumage of birds might be altered according to desire, by using appropriate reagents.

Apart from chemical operations, there are also physical ones which, I believe, influence the color of flowers. It is a well-known fact that a most intimate relation exists between color and form. We know very well that the minute division of a pigment exerts a great influence upon its shade of color: a solid piece of vermilion does not possess the pale-red hue of the finely pulverized article; it is dark brown, and only shows a high red when scratched with a hard body, the color increasing with a continued comminution. Mercury oxide, while deep-red in a crystalline condition, becomes light orange-yellow upon continued pulverization. Deep dark-blue smalt can be converted into a perfectly colorless powder by being pulverized and washed, and no one would recognize it as being identical with the coarsely grained original article. Gold-powder, in its most minute division, does not possess the known yellow color of the metal, but a bluish-green shade, and at first glance would not be held to be metallic gold until the blue-green powder, when fused, reassumes its yellow color. When we introduce a film of gold between two transparent pieces of glass, and hold it against the sun, the rays of the latter will shine through with a bluish-green color; this transparency of gold, however, only occurs when the film is 1/2000 of a line, or less, in thickness. It is indisputable that in the two instances mentioned here the appearance of color depends upon the minute mechanical division of the pigment, and with this is also connected the alteration in the color of solid bodies, when converted into gas or air. In a gaseous (therefore a very minutely divided) condition, black iodine becomes violet, yellow sulphur red, blue indigo purple. All these instances, to which numerous others might easily be added, prove the intimate connection between color and form. According to my opinion, some similar process, as far as regards form and division, possibly occurs in vegetable nature, and exerts its influence upon the multiplicity of color-shades.

Flower pigments, almost without an exception, are so inconstant and transient that they can not be employed in our industries. They, the children of light, separated from a vital union with the plant, no longer resist the effect of light—they wither and bleach in it. This is unhappily true with the most universally found of all—the leaf-green (chlorophyl). If this pigment could by some means be changed into a fast dye, the poisonous Swinefurt, or Paris-green, would have seen its last days. What an incomparable color is contained in the safflower (*Carthamus tinctorius*), which, although used as a beautiful rose in the dyeing of silk, is unhappily of an unstable nature! The same is true of the splendid yellow of the flowers of the wild *Reseda luteola*. This plant, in spite of the instability of its color, is cultivated in France, England, and different parts of Germany. The white color of various flowers—lilies, roses, and others—is generally produced by a white cellular juice, but may also be due to a white pigment, *artholeucine*, suspended in the colorless cell-juice. These white flowers would offer most suitable material for researches, if the experimental conversion of colors were undertaken. When undecomposed light is reflected by a body, its color appears to us as white. White, therefore, is no actual color, but simply a union of all colors, or the collective rays of light in an unseparated combination. By an alteration of the chemical combination in the plant, by means of an appropriate manure, it becomes possible to cause the fibers of the white petals no longer to reflect upon our eye an undivided white, but a divided colored ray. The yellow or orange coloring-matter of flowers, *anthoxanthine*, generally arises from the conversion of the chlorophyl. It occurs most frequently in the form of minute grains; sometimes also dissolved in the juice. Two anthoxanthines, therefore, must be distinguished in flowers—*xanthine*, which is not soluble in water, and *xantheine*, which is. The former dissolves with a gold-yellow color in alcohol and ether, is not affected by alkalies or dilute acids, but is colored green or deep indigo-blue by concentrated sulphuric acid. The soluble xantheine is by alkalies changed into brown. In the blue, violet, and red flowers (cornflower, hyacinth, violet, larkspur, sword-lily, rose, in the leaves of the red poppy, etc.), the pigment is found dissolved in the flower juice almost without an exception. The red pigment of the rose, dahlia, peony, and other flowers, as well as that of violet flowers, is, according to recent observations, only a blue colored into red (anthocyanogen), by vegetable acids or acid salts. This is plainly proved by the acid reaction of the juice of red flowers, and the occasionally feeble alkaline reaction of blue petals, as I have universally found, with only a few exceptions.

When contemplating the boundless diversity of the hues of flowers, the very natural question involuntarily arises within us: For whom does the flower blossom in the solitude? For whom does it bloom in all its lavish beauty? No human eye beholds it, and yet it is arrayed in a pomp of hues unsurpassable in the dreary solitude, regardless of human applause. Nevertheless, we must not accept the unnoticed wealth of these manifold hues as due to accident; there is nothing accidental or superfluous in creating Nature, although we fail to perceive its purposes; Nature never wastes its energies in aimless, purposeless productions. As the song of the bird ceases when its plumage is adorned with lustrous, pronounced colors, so also are the colors of the odorous flower found to be more modest when compared with the scentless one, dazzling in the gorgeous brightness of its hues. This well-known, generally correct fact must not be treated as unworthy of consideration or due to accident. The firm belief of a definite, well-arranged connection of all earthly occurrences is deeply implanted within our breast. A well-defined law governs the varied hues of flowers, as offered us by the munificence of Nature, and it will, ere long, be revealed unto the eye of the student.

The truth of the celebrated saying of Justus von Liebig, "The knowledge of Nature is the path that leads us to the admiration of the Creator," is also verified here in the soundless laboratory of the colors of flowers.—*Westernmann's Monatshefte.*