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XXXVI.—*Remarks on Associations of Colour and the Relations of Colour and Form in Plants.* By G. Dickie, M.D., Professor of Natural History, Queen's College, Belfast*.

Relations in the form, structure, number and position of organs are familiar to every botanist. *A priori* it might have been inferred that order prevails in the distribution of colours; that there is no mere fortuitous relation, but that all must be subject to law. This is not only the fact, but there are, besides, obvious indications of a relation between the colour and form of organs.

In April and May 1853, the facts to be here recorded were first observed and demonstrated to scientific friends in Belfast. Professor M'Cosh, in a lecture before the Natural History Society in May 1853, intimated that he had for some time entertained a belief in the existence of complementary colours in the vegetable kingdom. The results of my own observations were embodied in a paper read at the October Meeting of the same Society in that year. It would seem, however, that certain associations of colour have been long known to artists who have cultivated the special department of flower-painting. Any relation, however, between form and colour appears to have escaped notice, and even erroneous ideas have been promulgated respecting this point. Thus Ruskin, in his 'Lamps of Architecture,' states that "the natural colour of objects never follows form, but is arranged on a different system;" and again, "colour is simplified where form is rich, and *vice versâ*." "In nature," he further says, "the boundaries of forms are elegant and precise; those of colours, though subject to symmetry of rude kind, are yet irre-

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gular—in blotches." All these statements are far from representing the truth.

Without alluding to differences of opinion which have been recently published regarding the law of harmonious colours, it may be sufficient to allude briefly to the views usually entertained by physicists and most generally adopted. White or compound light consists of three simple colours called primaries, viz. yellow, red, and blue; combinations of these yield secondaries;—yellow and red give orange, yellow and blue give green, red and blue give purple. Combinations of secondaries yield tertiary colours,—green and orange give citrine, purple and green give olive, orange and purple yield russet.

A primary and secondary, together containing all the primaries, are complements to each other; for example, yellow and purple; red and green; blue and orange. The presence of all the colours either separate or combined (which form white or compound light) is a physical want of the organ of vision.

The artist recognizes a melody of colours, that is, gradations of hues and shades, and speaks of harmony when complementary colours are present. A white line (or black) between two colours not complementary subdues discord. There is a correspondence between the depth of any hue and that of its complement; for example, red-purple and yellow-green are associated. Every association of colour in the organic world may be regarded as an actual embodiment of results, which cannot be otherwise than in strict harmony with those great principles which have guided the plans of the Great Author of nature.

It is worthy of notice, that colour is the foundation of one of the more recent classifications of Algæ, that of Professor Harvey. They are divided by him into red, green, and olive; among the red series are comprehended many which present various tints, of purple for example, and in the olive series not a few are yellow-green. All this is in strict accordance with the views just adverted to.

Among the family of the Mosses the red or red-purple teeth of the peristome are associated with the green or yellow-green capsule; the same is true of the different parts of their stems and leaves.

In flowering plants the cases are so numerous, that only one example or two need be recorded.

Primula vulgaris.

Young leaves { stalk, red-purple.
leaf, yellow-green.

Caladium pictum.

Leaf { centre, red or red-purple.
border, green or yellow-green.

Coleus Blumei.

Leaf { centre, red or red-purple.
border, green or yellow-green.

Victoria Regia.

Leaf { lower surface, red-purple.
upper surface, yellow-green.

Taxodium sempervirens.

Young shoots, yellow-green.
A year old, red-purple.
Older still, citrine.

In this last instance, as well as in many others, advanced growth seems to be accompanied with greater composition of colour. In the curious pitcher-like organs of *Sarracenia, Nepenthes* and *Dischidia,* we find that red-purple and yellow-green are associated.

In the flower, similar associations are the rule.

Ranunculus repens.

Corolla, yellow.
Calyx, purple spots.

The same may be observed in many other species of the same genus.

Hieracium pilosella.

Flower, yellow.
Those of the circumference variegated with purple.

Anthyllis vulneraria.

Corolla, yellow.
Tip of calyx, purple.

Saxifraga ligulata.

Corolla, white with purple spots.
Anthers, yellow.

Kalmia (species).

Ten spots of *purple* on the corolla at points in contact with the yellow anthers.

Juncus compressus.

Anthers and pollen, yellow.
Ovary and stigma, purple.
Perianth { edge, russet.
centre, dark green.

Strelitzia Reginæ.

——— *juncea, &c.*

Sepals, orange.
Petals, blue.

In most Orchideæ we find constant associations of yellow and purple.

We need not expect to find in a corolla or any other organ pure red and pure yellow, or blue and red, *in contact with each other*.

Of the primaries, blue is the least common, and in fact, generally speaking, may be called *very rare*; many so-called blues being blue-purples: transmitted light shows this. Pure blue being so uncommon in any organism, Professor M'Cosh suggested to me that this is compensated for in the atmosphere, and I may add, in the ocean too. Yellow is probably the most general of the primaries, in the flower at least; the most common association is therefore yellow and purple. We can now understand why yellow is the usual colour of the pollen, and some exceptional cases seem to confirm this; in the Turn-cap Lily for instance, the decidedly red pollen is associated with the green filaments of the anthers.

The statistics of colour in different natural orders have not been fully examined; it may be remarked, however, that purple and citrine prevail in the flowers of the Grasses, and russet and dark green in the Junci. In the Fir-tribe and its allies, secondaries and tertiaries are common, such as the purple and citrine scales of young and old cones, the russet and dark green in the stems and leaves respectively; at the same time the copious yellow pollen must not be lost sight of.

In examining this subject, we must keep in view that the colour of the flower may have its complement in that of other organs, as stem, leaf, &c. It sometimes happens that one of the associated colours is not visible to the eye at all times. The inside of a nearly ripe fig is red-purple, the outside yellow-green; the same is true of the pericarp in some species of Pæony. In some Cactaceæ the yellow corolla is succeeded by a purple fruit.

The newly ripened cone of the *Pinus Pinaster* is citrine; when the scales open, the complementary purple is revealed at the base of each. In the fruit, fixed relations of colour are probably too familiar to require illustration. In certain varieties of the Apple, red and red-purple, green and yellow-green of various hues and shades are associated. In some varieties of Pear, yellow-green, red-purple and citrine occur together.

Direct exposure to light, although usually, and in general correctly admitted to have a direct relation to intensity of colour in organisms, appears not to be necessary in every instance; the plant, however, must receive the light at some part or other in order to produce that depth of colour observed in the coats of seeds, the interior of fruits, and in the tissues of subterranean organs.

In conclusion—

1. *The primaries, red, yellow, and blue, are generally present in some part or other of the plant.*

2. *When a primary occurs in any part of a plant, its complement will usually be found in some other part* (*or at some period or other of the development of the plant,* as was suggested to me by Professor M'Cosh).

Observations on the same subject in the animal kingdom have occupied my attention during the past twelve months; Birds, Mollusca, and Radiata present associations of colour not less remarkable than those here recorded.

The relation between colour and form may now be examined, and the remarks, for the present, have reference to the parts of the flower.

When the calyx and corolla are equal in size and similar in form, the flower is regular; differences in size and form are found in irregular flowers. For example, the Violet has an irregular flower, that of the Wallflower is regular; a Primrose has a regular flower, a Snapdragon presents an example of irregularity. Such expressions are equally applicable to monocotyledonous and to dicotyledonous plants, to polypetalous and gamopetalous corollæ.

LAW 1. *In regular polypetalous and gamopetalous corollæ the colour is uniformly distributed, whatever be the number of colours present.*

That is to say, the pieces of the corolla being all alike in size and form, have each an equal proportion of colour. The common Primrose is an example where one colour only is present. In the Chinese Primrose the same holds where two colours (one the complement of the other) are present; the eye or centre is yellow, the margin purple. These two colours in this regular flower are uniformly diffused, that is, each piece has an equal proportion of yellow and of purple respectively. In *Myosotis, Anagallis, Erica, Pyrola, Gentiana,* &c., we have instances. All corollifloral Exogens with regular flowers are examples; the same is true of certain Thalamifloræ, as Papaveraceæ, Cruciferæ, &c. In *Iberis coccinea,* belonging to Cruciferæ, we find unequal size of petals, but equal distribution of colour, because regularity of flower is the law in that family.

Calycifloral Exogens with regular flowers are also examples, as Rosaceæ, Cactaceæ, &c.

LAW 2. *Irregularity of corolla is associated with irregular distribution of colour, whether one or more colours are present.*

The odd lobe of the corolla is most varied in form, size, and in colour.

When only one colour is present, it is usually more intense in the odd lobe.

When there are two colours, one of them is very generally confined to the odd lobe. Sometimes when only one colour is present and of uniform intensity in all the pieces, the odd lobe has spots or streaks of white. This piece of the corolla therefore in irregular flowers is distinguished from the others not merely by size, form and position, but also by its colour.

Papilionaceæ present examples of this law; a few instances may suffice.

Cytisus Laburnum.
4 petals yellow.
5th yellow with purple veins.

Lathyrus pratensis.
Much the same as *Laburnum.*

Trifolium pratense.
Odd lobe distinguished from the others by its darker purple veins.

Kennedia monophylla.
4 petals purple.
5th yellow eye and purple margin.

Swainsonia purpurea.
4 petals purple.
5th white eye on purple ground.

Even when the odd lobe of a papilionaceous plant is smallest,—not a common case,—it may be distinguished by its colour; for instance, in *Brachysema acuminatum* the odd lobe is comparatively small, but has yellow eye and purple margin.

Irregular gamopetalous corollæ also present examples of this law.

Ajuga reptans.
Corolla { 4 divisions purple.
5th has yellow spot on inner surface.

Thymus Serpyllum.
Corolla, generally red-purple.
Two pale spots on odd lobe.

Galeopsis Tetrahit.
Odd lobe has generally two colours, yellow and purple.

Numerous other examples from Labiatæ might be quoted.

Among Scrophulariaceæ we may instance the following:—

Euphrasia officinalis.
Corolla purple, generally.
Odd lobe has yellow spot.

Digitalis purpurea.
Has white on odd lobe.

In some species of *Schizanthus* and *Collinsia* we find purple the prevailing colour; the primary, yellow, appears in the odd lobe.

In some genera with irregularity of flower often less marked than in the examples alluded to, it is worthy of notice that the two divisions on each side of the odd lobe frequently partake of its characters as regards colour, half of each resembling the odd piece; *Viola, Gloxinia, Achimenes, Rhododendron,* &c. are examples. In some Thalamiflorous Exogens with irregular flower, as *Pelargonium* and *Tropæolum,* we find that the two upper pieces are usually largest, and present also the greatest variety in depth of colour. In the Horse-chestnut there is a very decided relation between the size of the petals and the intensity of the colour. On each petal there is usually a crimson spot at the junction of the limb and claw; the size of this spot and its intensity are in direct relation to the size of each petal; the two upper being largest, the two lateral smaller, and the odd piece least of all.

It may therefore be stated, that *in some Thalamiflorous Exogens with irregular corolla, owing chiefly to difference in size of the petals, the largest are most highly coloured.*

Law 3. *Different forms of corolla in the same inflorescence often present differences of colour, but all of the same form agree also in colour.*

The Compositæ are illustrations of this: when there are two colours, the flowers of the centre have generally one colour of uniform intensity; those of the circumference agree together also.

The common Daisy has all the tubular flowers of the centre yellow, and all the ligulate flowers of the ray are white, variegated with purple. A yellow centre with purple ray is a common association in compound flowers, for instance, in species of *Aster, Rudbeckia,* &c.

The same general laws prevail in Monocotyledons as in Dicotyledons. In the former the calyx and corolla generally resemble each other in structure and shape, and in colour also; hence an dea entertained by some that the perianth is single, relative osition having been overlooked. In Dicotyledons we generally find a greater contrast between calyx and corolla as regards colour.

The law of the contrasts is therefore simpler in Monocotyledons than in Dicotyledons.

The former may be symbolized by the triangle, 3 and 6 being the typical numbers in the flower; the latter by the square or pentagon, 4 and 8, 5 and 10 being the prevalent numbers.

The simplicity of figure corresponds with simpler contrast of colour in the one, while greater complexity of colour and of structure are in direct relation in the other.

In families of Monocotyledons having regular flowers there is regular distribution of the colours, for instance, in Amaryllidaceæ, Liliaceæ, &c.

Orchidaceæ are notable examples of the other law, that irregularity of form and of colour are associated. In a large proportion of this family the colours are yellow or yellow-green, and purple or red-purple; the latter being confined to the part of the corolla usually called *lip*.

Proceeding on the principle, that since plants of all epochs of the earth's history were constructed on the same general plan, so the same associations of colour, and of colour and form, must have prevailed also, we shall glance finally at a few conclusions which may be derived from this source.

During the earlier periods when Acrogenous Cryptogamia were abundant, the secondary and tertiary colours, as russet, purple, citrine, green, must have prevailed.

During the reign of Gymnosperms, when Cycadeæ and Coniferæ were numerous, the secondary and tertiary colours must still have given a sombre aspect to the vegetable world.

From the commencement of the Chalk formation there appears to have been a very marked and progressive increase of Angiospermous Dicotyledons, which form at least three-fourths of existing vegetation. Among them we find the floral organs with greater prominence in size, form and colour; and such prominence of the "nuptial dress" of the plant, to use the quaint expression of Linnæus, is peculiarly a feature of species belonging to natural families which have attained their maximum in man's epoch, and are characteristic of it.

XXXVII.—*On* Linaria sepium *of Allman.*

By Charles C. Babington, M.A., F.R.S., &c.*

At a meeting of the Royal Irish Academy, held June 6th, 1843, the occurrences at which are reported in the 'Proceedings' of that body, Dr. G. J. Allman described what he supposed to

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