FLORAL COLOURS AND THE PHYSIOLOGY OF VISION

Part VI. Comparative Study of Three Cases

By Sir C. V. Raman

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In this part of this memoir, we shall consider three cases, each of which by itself exhibits very interesting features. But when these features are compared with each other, highly significant facts emerge.

The tree known botanically as *Solanum grandiflorum* and popularly as the large-flowered nightshade or potato tree grows under favourable conditions to a height of 30 to 40 feet and flowers all the year round. The full-grown tree presents an astonishing sight with its large leaves and the immense number of bunches of flowers appearing on all its branches, each bunch itself holding a great many flowers. The shape of the flower is shown in Fig. 1, which also exhibits the stalk carrying the flower and several other buds due to open in due course. The corolla has five lobes which are sharply pointed, while the anthers are large and yellow in colour. The illustration which appears facing page 135 of the volume entitled *Some Beautiful Indian Trees* published by the Bombay Natural History Society exhibits a characteristic feature of the flowering of the tree, *viz.*, that the corolla of the flower which has opened out last in each branch exhibits a colour which in its hue and its saturation resembles a spectral violet; but the flowers which have appeared earlier show a progressive fading away of colour, and finally, they appear as a pure white traversed by a few streaks which are but a faint shadow of the original intense colouring. The ribs joining the centre of the corolla to the pointed tips of the lobes are coloured a little differently from the membranes which they hold together. These membranes are thin and presents a crinkled appearance. The corolla appears of a deeper and darker colour when viewed by reflected light than when viewed with the flower held between the observer's eye and the source of light.

The floating leaves and the flowers of a water-lily (*Nymphaea caerulea*) on their long stalks in a large cistern of water make a most colourful exhibit in the sunken garden attached to the author's residence at his Institute in Bangalore. Each flower has four sepals and numerous petals within arranged

in regular order. The inner face of the sepals is of a purple colour, while the petals are definitely blue but with an unmistakable purplish tinge. The central part of the flower (sketched in Fig. 2) is of a brilliant golden-yellow hue, but the tips of the stamens are tinged with purple. The structure of the flower is exquisitely lovely, and its charm is enhanced by the colours and the attractive perfume which it exhales.

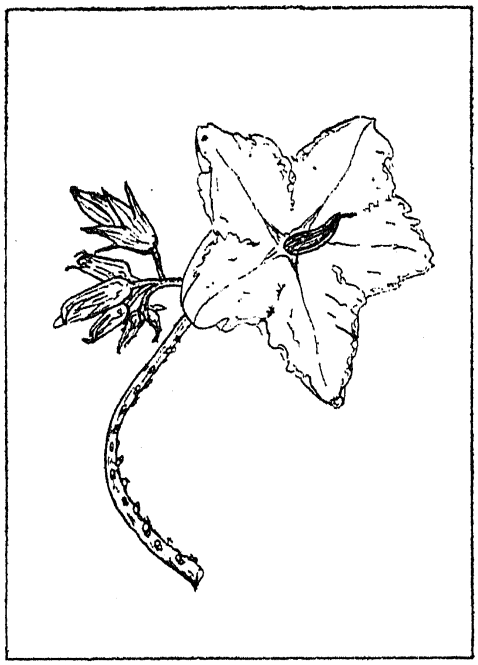

FIG. 1. Flower, buds and stalk of *Solanum grandiflorum.*

The luxuriant climbing plant, known to the botanist as *Thunbergia grandiflora* and popularly as "The Heavenly Blue" is to be found in gardens all over India. It can easily be recognised by its dense green curtain of foliage and the large blue flowers. Each flower consists of a longish stem, a thick green calyx and a long broad corolla. The calyx is contracted towards the base, pointed at the apex and nearly divides into two segments when the corolla emerges. This corolla is from two to three inches long. The tube is whitish outside, more yellow within and contracts upwards in the middle before dilating into a bell-shape which opens into five round spreading lobes. The base of each lobe, particularly the lower protruding one, exhibits streaks of a violet hue. The rest is of a lovely blue colour which rather resembles that of the Jacaranda flowers (Fig. 3 in the Text).

We shall first consider the spectral composition of the light responsible for the "Heavenly Blue" of *Thunbergia.* This colour, though vivid, is far

from being saturated. Actually, it is more violet than blue, especially in the case of the freshly opened flowers. The spectrum may be studied either by transmission or with the light diffused backwards towards the source. Similar features are observed in either case except that they are accentuated when seen by reflected light, owing to the absorption path being then effectively doubled. The spectroscopic observations show that the colour exhibited to our visual perceptions owes its origin principally to an absorption band in the yellow region of the spectrum between 570 mμ and 590 mμ. A distinct absorption is also noticeable around 630 mμ, with the result that the orange of the spectrum between 590 mμ and 620 mμ stands out as a bright band with darker regions on either side. A slight dimming of intensity in the spectrum around 540 mμ in the green sector is also detectable. It may be remarked that these features closely resemble those noticed with the flowers of the Jacaranda and discussed in the fifth part of this memoir. The similarity in hue is therefore not surprising.

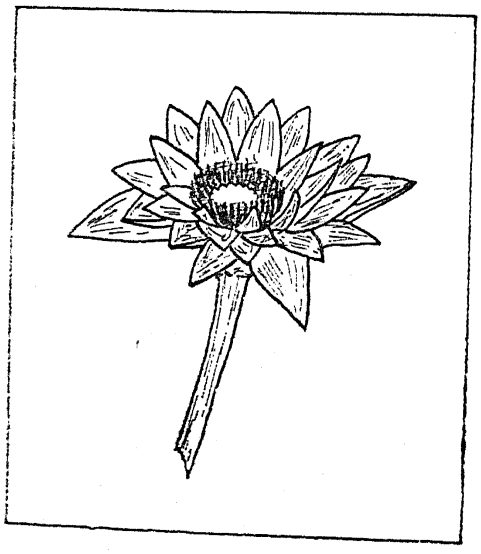

FIG. 2. The blue water-lily.

The absorptions which give rise to the perceived colour of the *Thunbergia* flowers are by no means easy to exhibit in spectrograms, partly because they are rather weak and also because of the non-uniform sensitivity of the panchromatic films. The results may, however, be improved by recording the transmission through two petals held together. Of the five spectrograms reproduced as Fig. 2 in Plate IV, Fig. 2 (*a*) is of the light-source put in as a comparison; Figs. 2 (*b*) and (*c*) are the spectra recorded by transmission through a single petal with two different exposures, while Figs. 2 (*d*) and (*e*) were recorded with two petals held together.

The spectrum of the blue water-lily is of a different character. Its perceived colour owes its origin to an absorption in the orange region of the spectrum between 590 mμ and 610 mμ, and another in the green sector between 550 mμ and 570 mμ. These absorptions are weak and it is, therefore, not surprising that the perceived colour of the flower is not of a saturated hue. Hence, both for visual observations and for spectrum photography, it is useful to hold two petals together and to accentuate thereby the strength of the absorption. Figures 2 (*a*), (*b*) and (*c*) in Plate II are spectrum photographs obtained in this manner, while Fig. 2 (*d*) in the same Plate is a spectrum of the light source put in for comparison.

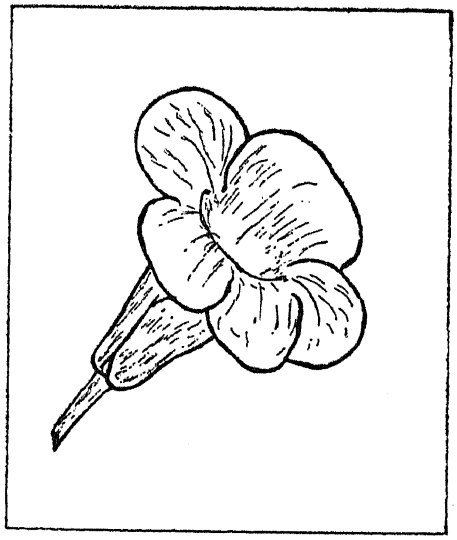

FIG. 3. Flower of *Thunbergia grandiflora.*

We shall now consider the most interesting of the three cases, *viz.*, the flowers of *Solanum grandiflorum.* The intensity of colour exhibited by this flower is most remarkable. Indeed, it is even more striking than the colour displayed by the "Morning Glory" described in the third part of this memoir. In the present case, however, the colour is violet instead of blue. The best way of observing the colour and examining its spectral composition is to view the flower in sunlight with the observer having the sun behind him. What is then seen through the spectroscope appears almost incredible. The entire spectrum from the extreme violet to the extreme red is seen and is scarcely distinguishable from the normal spectrum of sunlight except that the yellow sector is absent. A sharp absorption edge appears at 600 mμ; on the longer wavelength side of this edge, the orange sector appears with its full normal intensity, while towards shorter wavelengths, the intensity

increases more slowly and becomes normal at 570 mμ. There is a discernible drop of intensity in the red sector at about 635 mμ. An extremely weak absorption is also discernible in the green sector at about 545 mμ.

From the observations described above, it would seem that the absence of the yellow region in the spectrum of white light results in enhancing the visual effect of the violet end of the spectrum, so much so that the rest of it, including the blue, green, orange and red sectors, is blocked out or masked and prevented from entering into our visual consciousness. This is a surprising explanation to offer, but no other alternative suggests itself. The suggested explanation is supported by the facts already reported in the case of the "Morning Glory", except that in that case, we are concerned with the extinction of the orange region of the spectrum and an enhancement of the visual effect of the blue sector and the masking or blocking out of the visual effects of the green and red sectors.

SUMMARY

The spectral composition of the colours exhibited by the flowers of *Solanum grandiflorum*, *Nymphaea caerulea* and *Thunbergia grandiflora* has been studied. The results are surprising and an explanation is offered for them in terms of the masking or blocking out of the visual effect of the longer wavelengths in the spectrum by the shorter wavelengths, the necessary condition for which is the removal of the yellow sector, accompanied by a weakening in intensity of the red end of the spectrum.