

## Floral colours and the physiology of vision— Part IX. *Hibiscus* and *Bougainvillea*

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(Memoir No. 137 of the Raman Research Institute, Bangalore-6)

Received July 6, 1963

By reason of the spectacular character of their displays of colour, as also by reason of their ease of propagation and maintenance, both *Hibiscus* and *Bougainvillea* have attained great popularity as garden plants in tropical and sub-tropical climates. Much attention has been given to these plants by horticulturists at Bangalore to the creation of new varieties exhibiting colours different from those presented by the original species. A wealth of material has in these circumstances, been available to the author for a critical study of the floral colours of both of these plants with the aid of the spectroscope. It is not proposed here to present anything in the nature of a detailed report on the subject. Only a few essential features of interest regarding the general nature of the relationship between the perceived colours and their spectral composition will be set out.

*Hibiscus syriacus*, so named by Linnaeus, is a species distinct from *Hibiscus rosa sinensis* and is better suited for colder climates. It is however quite at home in the climate of Bangalore. It flowers profusely, its blooms being of a purplish-blue tint which shows up very well against the green foliage of the plant. Figure 1 in the text illustrates the shape of the flower. In view of the findings reported in the previous parts of the memoir, the reader will not be surprised by the statement that the colour of the *Hibiscus syriacus* blooms arises solely by reason of an absorption band appearing in the yellow part of the spectrum. This is so weak that it is barely detectable in the transmission spectrum of a single petal of the flower. But with two petals held together, thereby doubling the absorption path, the cut-off in the yellow shows up clearly.

The spectrograms reproduced as figure 1 in plate I are intended to illustrate the foregoing statements. The red end of the spectrum appears at the left of the picture in each case. Figure 1 (a) and (f) are the spectra of the light source recorded for the purpose of comparison with the other spectrograms which are those of the flower petals of *Hibiscus syriacus*. Figure 1 (b) and (c) are spectra recorded with a single petal and two different exposures, while (d) and (e) were similarly recorded with two petals held together. The absorption band in the yellow which gives rise to the purplish-blue colour of the flower is clearly exhibited in figure 1 (d) and (e).

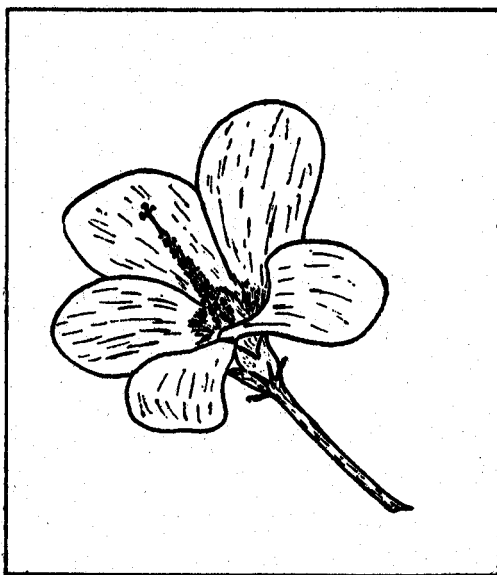


Figure 1. Flower of *Hibiscus syriacus*.

*Hibiscus rosa sinensis* is a widespread shrub with bright shining thick foliage. It is constantly in bloom with large brilliant rose-scarlet flowers which have pretty columns of pistil and stamens projecting from their centres as shown in figure 2 in the text. Spectroscopic examination at first sight suggests that the entire spectrum except the red and orange is cut out by the petals of the flower. A more careful examination reveals, however, that the absorption is complete only in the wavelength range between 500 and 550  $\mu$ , and that there is an appreciable transmission of the blue and violet sectors of the spectrum. These features are shown in the spectrographic records of the transmission by a single petal reproduced as figure 1 (b), (c), (d) and (e) in plate III which were obtained with progressively increasing exposures, figure 1 (a) being a comparison spectrum of the light source employed.

*Hibiscus* hybrids of the *rosa-sinensis* type are forthcoming in which the flowers have varied colours. The transmission spectra of three of these are reproduced as figure 2(b), (c) and (d) in plate I, these being respectively of red, yellow and orange hybrids, while figure 2(a) and (b) are comparison spectra of the light source. It is significant that the red hibiscus (figure 2 b) shows an absorption only in the green sector of the spectrum, while the blue and violet sectors come through without appreciable loss.

The bougainvilleas are climbing plants which grow vigorously. Their actual flowers are small and inconspicuous, and the decorative value of the plants consists in the fact that the flowers are enclosed in large and brightly coloured

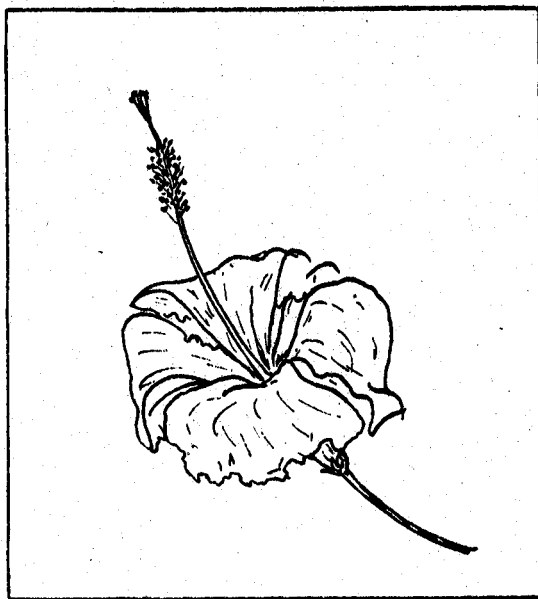
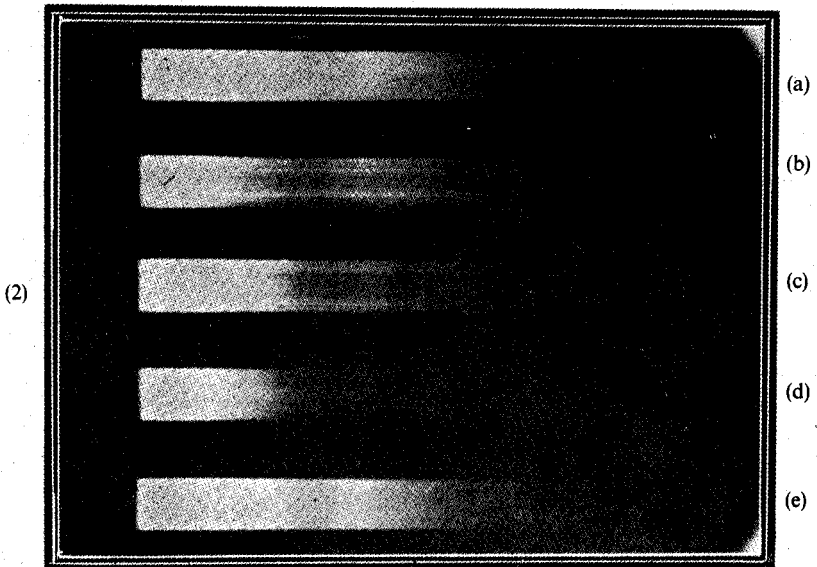
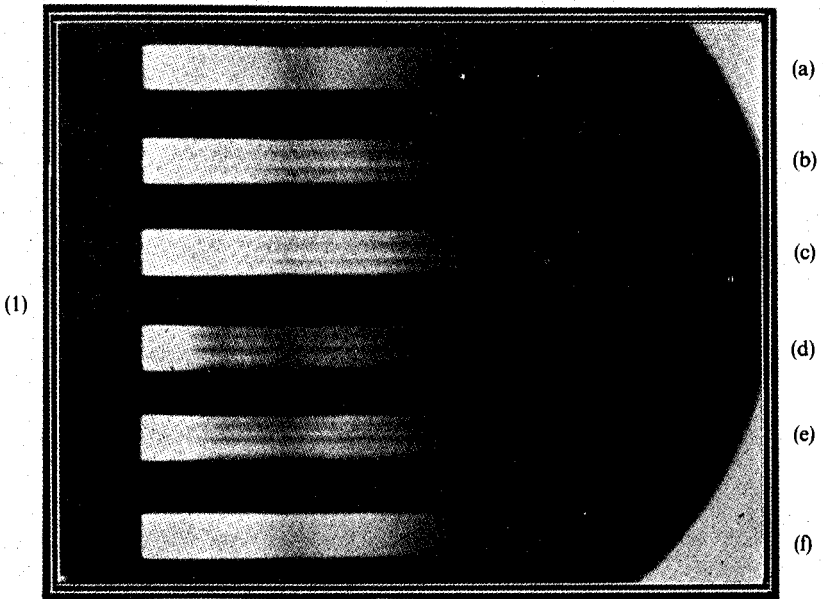


Figure 2. Flower of *Hibiscus rosa sinensis*.

bracts. If allowed to climb up a tree, the bougainvillea rapidly covers it up, so much so that the entire tree appears in due course as a blaze of colour. The number of varieties which have been developed from the naturally occurring species is quite large. Indeed, the collection at the Government Botanic Garden at Bangalore (better known as the Lalbaugh) includes specimens of which the colour exhibited by the bracts bears no resemblance whatever to the original colours. For example, specimens are forthcoming of which the bracts are white, yellow or orange. The bougainvilleas may be classed according to the colour of their bracts into three groups, (a) the purple bougainvilleas, (b) the red bougainvilleas and (c) hybrids exhibiting other colours. We shall comment briefly on the facts revealed by a spectroscopic examination of the available material.

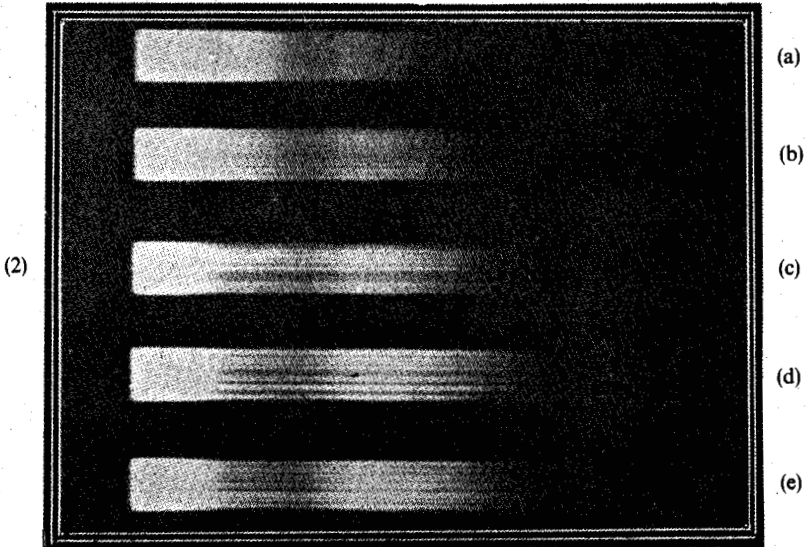
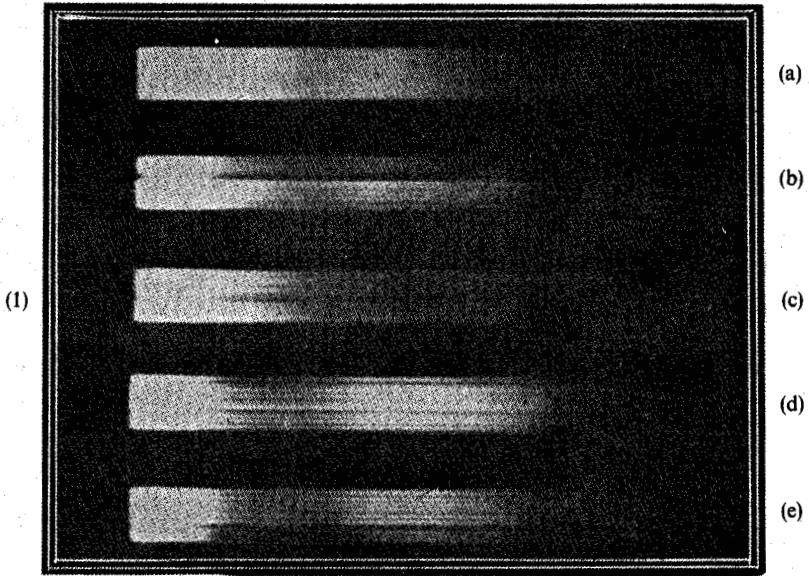
The purple bougainvilleas are characterised by a remarkable degree of transparency of their bracts to the entire visible spectrum *except* in the range of wavelengths between 560 and 590  $m\mu$ . Their colour, in fact, is attributable to a specific absorption in this region, in other words, of the yellow sector of the spectrum. The individual varieties, e.g., *Bougainvillea formosa*, which have been developed in which the purple tint is very delicate, show this absorption only weakly, whereas it is highly pronounced in those exhibiting purples of saturated hues.

The red bougainvilleas owe their colour to an absorption which manifests itself in the wavelength range between 500 and 560  $m\mu$ , in other words, covers the green sector of the spectrum. The blue and violet sectors are however transmitted more

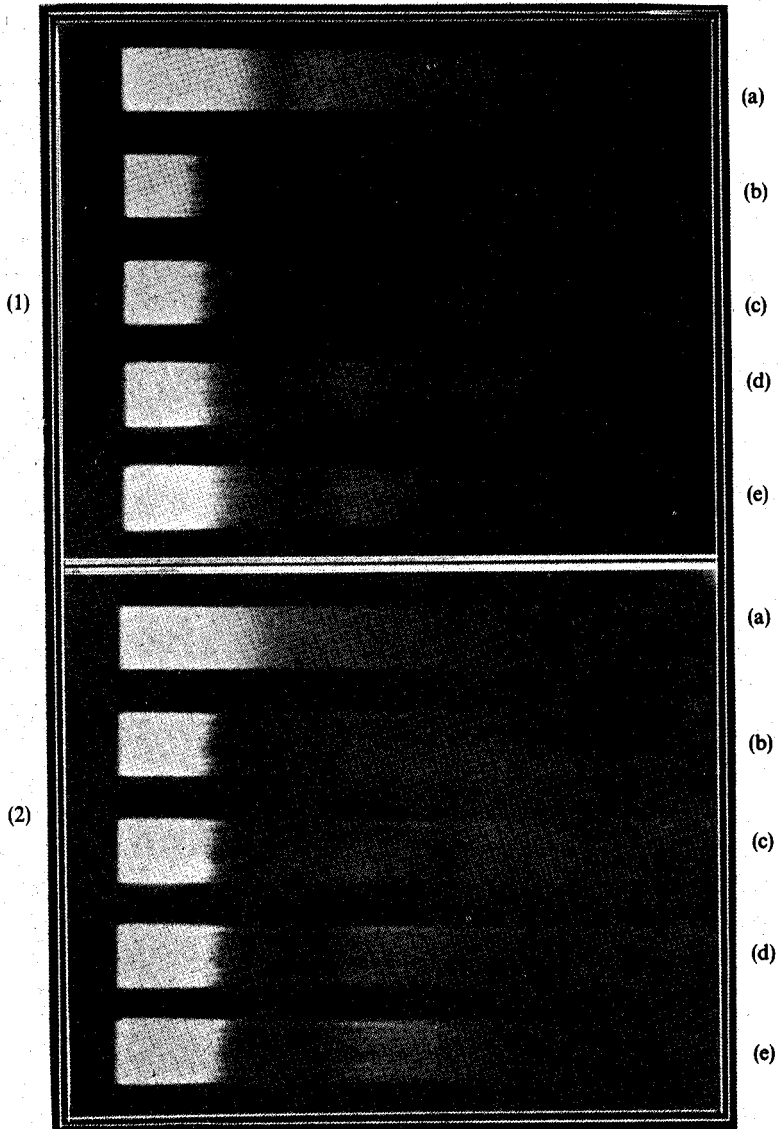


Figures 1 and 2. 1. Spectra of *Hibiscus syriacus* with comparison spectra. 2. Spectra of *Hibiscus* hybrids with comparison spectra.

Plate I



Figures 1 and 2. 1. Spectra of Purple *Bougainvilleas*. 2. Spectra of other *Bougainvilleas*: (d) rose-red; (e) deep red.



Figures 1 and 2. 1. Spectra of *Hibiscus rosa sinensis* with comparison spectrum. 2. Spectra of Pomegranate flower with comparison spectrum.

or less freely. The spectroscopic behaviour of the red bougainvilleas thus resembles that of the red roses. Indeed, some of the most spectacular of the bougainvilleas are those in which the absorption of the green sector is not quite complete and hence the bracts exhibit a brilliant colour resembling that of roses.

The hybrid varieties exhibiting other colours show absorption spectra of other types. It will suffice here to mention the behaviour of an orange-coloured bougainvillea. Its bracts exhibit a cut-off of the violet and blue sectors, with the result that a well-defined absorption edge appears at  $500\text{ m}\mu$  separating the regions of smaller and greater wavelengths. An absorption is also noticeable in the green sector, but this is much feebler.

Figure 1(b), (c), (d) and (e) in plate II are the transmission spectra of four purple bougainvilleas arranged in the order of increasing saturation of the hues exhibited by them. The low photographic sensitivity of the panchromatic film in the green of the spectrum is very evident in figure 1(a) which is a comparison recorded with the light-source employed. The dark band in the green thus resulting also appears in the four other spectra recorded with the bracts. This tends to obscure the fact that the purple bougainvilleas have no absorption in the green of the spectrum. The absorption appearing in the yellow and its increasing strength in the series can, however, be recognised in the spectra.

Figure 2 shows alongside a comparison spectrum of the source [figure 2(a)], the spectra of four other bougainvilleas. Figure 2(d) which is the spectrum of a bright-red bract and figure 2(e) of a bract of a deeper red colour are particularly significant. They exhibit the very interesting feature that the green of the spectrum is absorbed very strongly by these bracts, while the blue and violet of the spectrum are transmitted more or less freely.

### Summary

The spectroscopic behaviours of the flowers of *Hibiscus syriacus* and *Hibiscus rosa sinensis* are quite different. The purple colour in the former case is due to an absorption in the yellow and the red in the latter to an absorption in the green. The purple and red varieties of *Bougainvillea* show differences of the same general nature and having a similar origin.