Proc. Indian Acad. Sci. **A58** 92–95 (1963)

Floral colours and the physiology of vision—Part X. Flowers exhibiting band spectra

SIR C V RAMAN
(Memoir No. 137 of the Raman Research Institute, Bangalore-6)

Received July 10, 1963

In earlier parts of the memoir, we have already encountered several cases in which the absorption of the flowers manifests itself as a single dark band and others in which it appears as two dark bands in regions not very remote from each other in the spectrum. In the present part of the memoir, we shall concern ourselves with particular cases which came to light in the course of the author's studies and in which the absorption exhibits a sequence of fairly well-defined dark bands traversing the spectrum in an ordered succession. The origin of these band-systems is obviously a matter of considerable interest. But we shall concern ourselves principally with the relation between the observed positions of the absorption bands and the colour manifested by the flower to our visual perceptions.

We shall commence with the case of the flowers of the twining creeper *Clitoria ternatea* exhibiting a bright blue colour. Figure 1 (b) in the text illustrates the shape of the flower, the blue colour appearing all around its extended margin. The absorption sepctrum of the flower recorded with three different exposures are reproduced in figure 2 in plate I, alongside of the two comparison spectra of the light-source appearing at the top and bottom of the figure. Three dark bands can be seen in the spectrum; their centres being located respectively at about 630, 575 and 525 mμ. The first of the three bands appearing in the orange-red is the most intense, the second in the yellow is less intense but is also fairly well defined, while the third band in the green is both weak and diffuse. The striking blue colour exhibited by the flower is evidently ascribable principally to the intense bands appearing at 630 and 575 mμ.

The second case we shall consider is that of the flowers of the ground orchid known as *Aerides multiflorum* whose flowers are located in considerable numbers along elongated stems which emerge from the plant alongside of its leaves. The shape of the individual flower and of the stalk carrying it is shown in figure 1 (a) in the text. The flowers have a vivid purplish-red colour. The absorption spectrum responsible for this hue has been recorded with three different exposures in figure 1 in plate I, following which a comparison spectrum of the light-source is

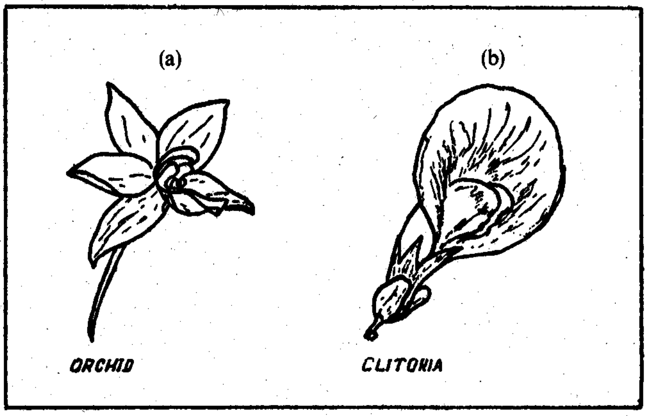


Figure 1. Flowers of *Aerides multiflorum* (a) and *Clitoria ternatea* (b).

also shown. Three dark bands are exhibited, the first two located at 590 and 545 mμ being particularly intense and well defined, the third band at 505 mμ being both weak and diffuse.

Another orchid which shows a similar absorption is known as *Aerides crispum.* This bears flowers in great numbers along arching spikes. A front and a back view of the individual flower is shown in figure 2 below in the text. Part of each flower exhibits a purplish-red hue and the absorption spectrum of this region as seen visually is very similar to that represented in figure 1 in plate I. Two other orchids bearing purple flowers, viz., *Spathoglottis plicata,* and *Cattleya* (hybrid species) also exhibit similar spectra.

The garden plant known as *Cineraria* is usually grown in pots and its flowers exhibit a wide range of beautiful colours. The absorption spectrum of the petal of a flower exhibiting a purplish-red hue recorded with three different exposures is reproduced as figure 1 in plate II, while that of another flower exhibiting a deep blue is similarly shown in figure 2 in the same plate. A comparison spectrum of

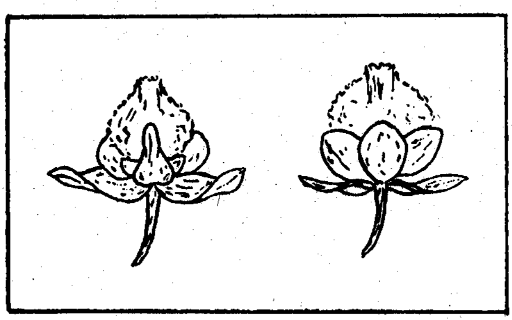
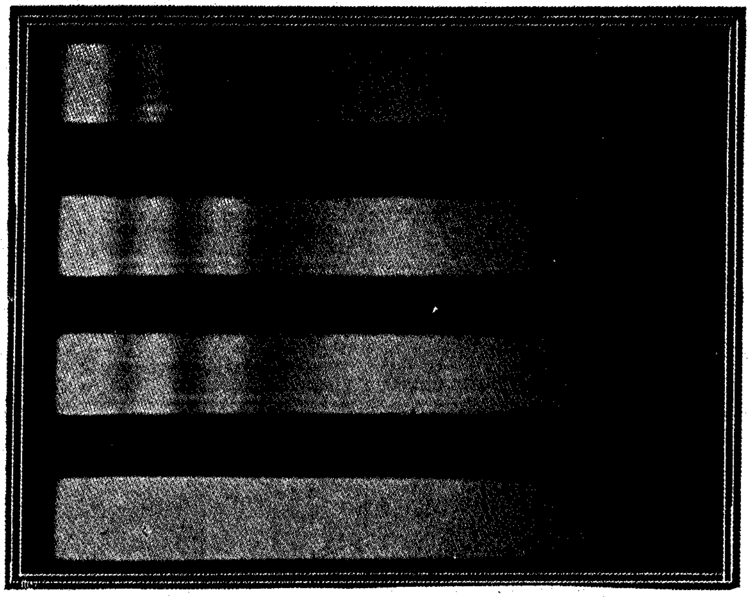
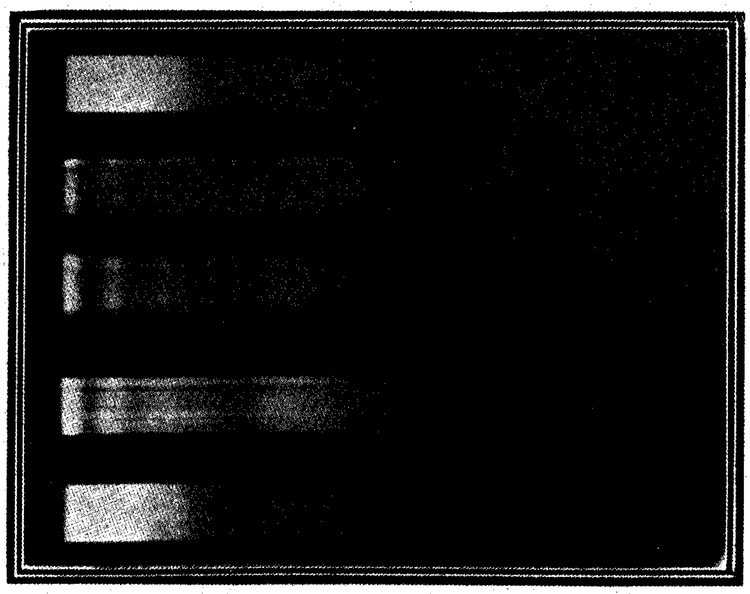


Figure 2. Flower of *Aerides crispum* (front and back views).

(1)

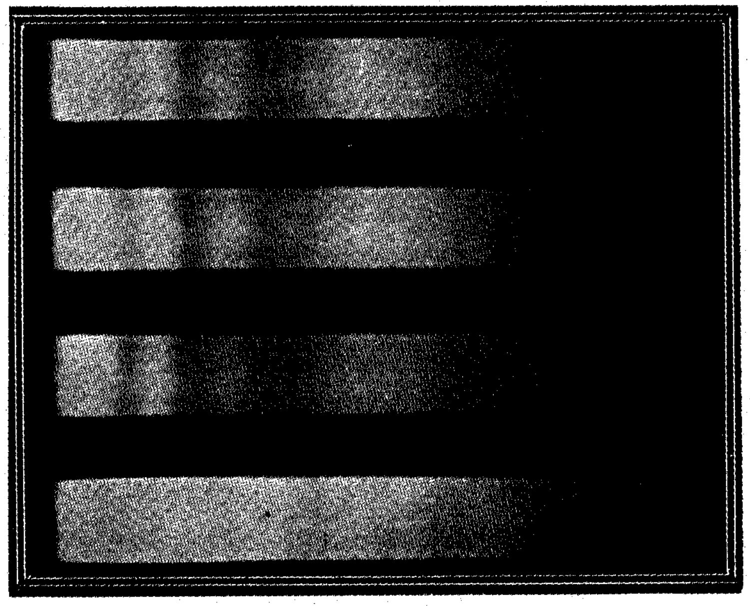


(2)

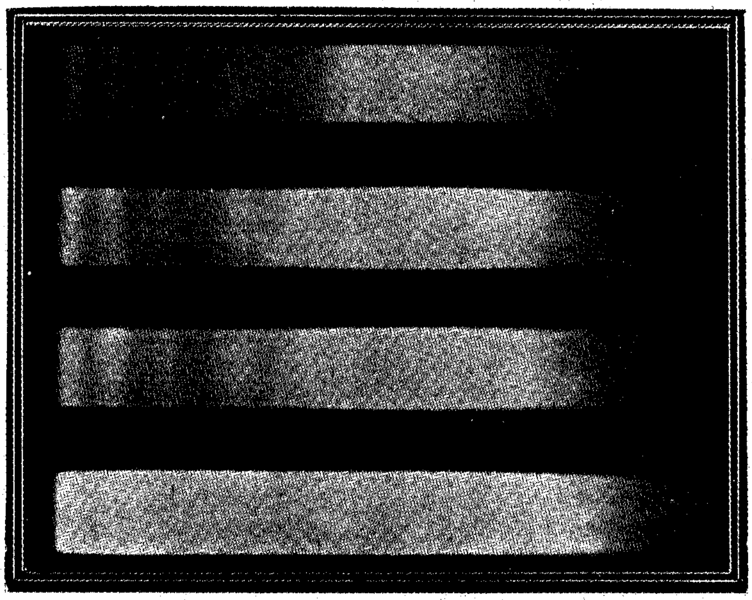


Figures 1 and 2. 1. Absorption spectrum of *Aerides multiflorum* with comparison spectrum. **2.** Absorption spectrum of *Clitoria Ternatea* with comparison spectra.

Plate I



(1)

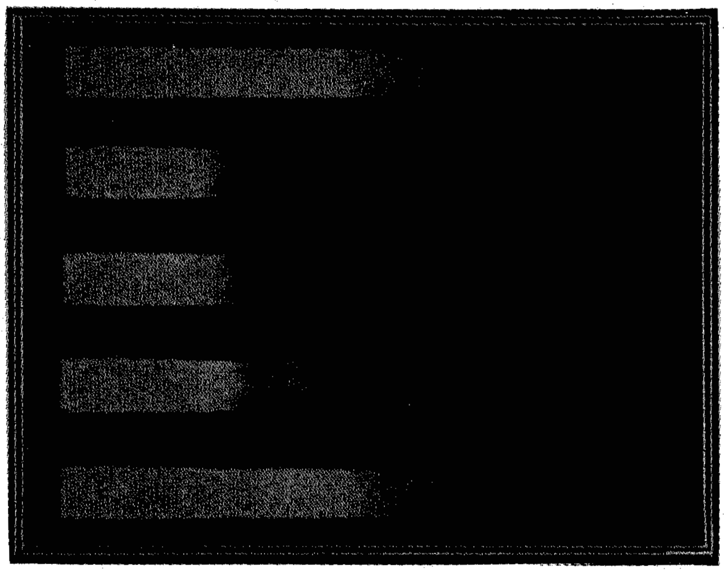


(2)

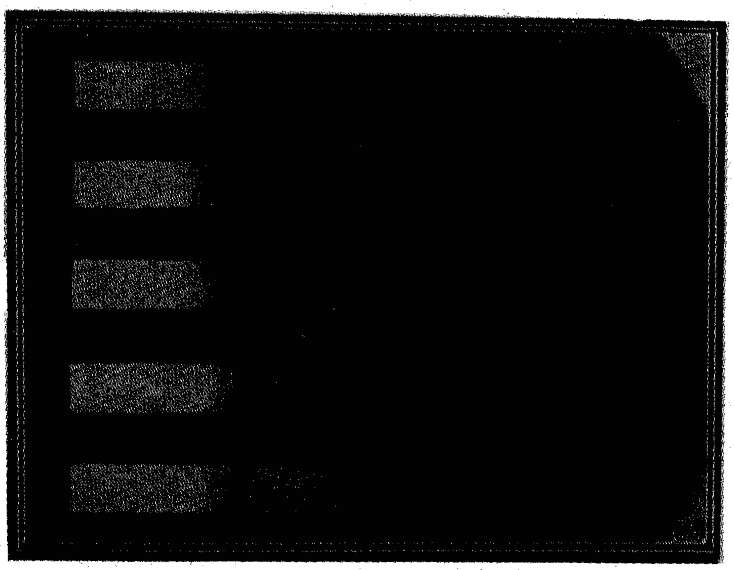
Figures 1 and 2. **1.** Absorption spectrum of *Cineraria* flower (purplish-red) with comparison spectrum. **2.** Absorption spectrum of *Cineraria* flower (deep blue) with comparison spectrum.

Plate II

(1)



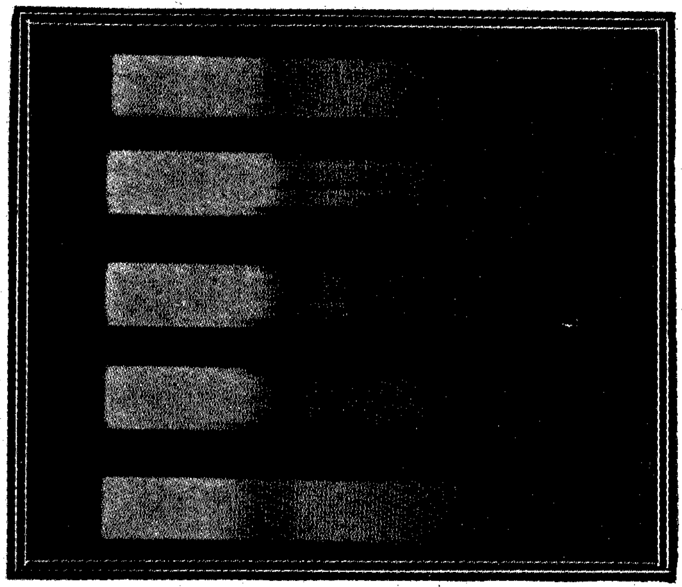
(2)



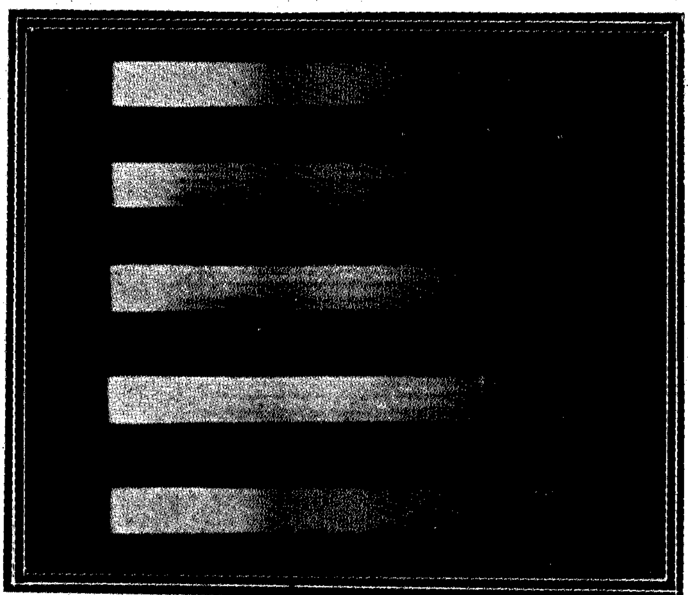
Figures 1 and 2. 1. Absorption spectrum of *Allamanda grandiflora* with comparison spectra. **2.** Absorption spectrum of *Clitoria ternatea* with comparison spectra.

Plate III

(1)



(2)



Figures 1 and 2. 1. Absorption spectrum of *Peltoforum ferrugineum* with comparison spectra. **2.** Absorption spectrum of *Oxalis acetosella* with comparison spectra.

Plate IV

the light source is shown below the three spectra of the flower in each figure. The striking similarity of the spectra shown as figure 1 in plate I and as figure 1 in plate II is noticeable. Likewise, figure 2 in plate I and figure 2 in plate II also exhibit a general similarity. These resemblances are not surprising in view of the fact that the observed colours in these cases are much like each other.

We shall proceed to consider some flowers which also exhibit band spectra in absorption, but in an altogether different part of the spectrum. Many trees, shrubs and climbing or twining plants have flowers exhibiting yellow hues, ranging from a pale straw-yellow to the deepest golden-yellow. In all these cases, it is evident on inspection that the petals exercise an absorption in the violet and blue sectors of the spectrum, the stronger such absorption is and the further it extends into the blue, the more intense the colour exhibited. Indeed, unless the yellow hue of the flower is of the palest, the absorption extends up to 500 mμ, thus covering the violet and blue completely; if the absorption is sufficiently intense, something in the nature of an absorption edge may be noticed at about 510 mμ. The individual petals of a flower are usually fairly thin, and it is therefore not to be expected that the extinction of the blue and violet regions would be total. Indeed if we make the observations in bright sunlight, we may expect to see a part of the blue in the spectrum coming through and this is indeed actually the case with many flowers, e.g., the gorgeous golden-yellow blooms of *Allamanda grandiflora*, the bell-shaped flowers of *Thevetia neriifolia* (the yellow oleander), the yellow panicles of the avenue tree *Peltoforum ferrugineum*, and so on. The photographic record of the spectrum extending to wavelengths shorter than 500 mμ made with adequately long exposures with these flowers exhibits a succession of dark bands.

Figure 1 in plate III shows this effect observed with *Allamanda grandiflora*. Figure 2 in the same plate shows the succession of bands observed with *Thevetia neriifolia*. The panicles of *Peltoforum ferrugineum* are very thin and it is therefore not surprising that they pass the blue of the spectrum rather freely and that the bands in this region are therefore recorded easily. Figure 1 in plate IV shows these features.

It is clear from the similarity of the features observed in the spectra of several different plant species that the band-structure is a specific property of the absorbing material present in the petal. In the case of the yellow flowers, this is presumably a carotenoid pigment.

Summary

The absorption spectra of the blue flowers of *Clitoria ternatea* and of the purplish-red flowers of the orchid *Aerides multiflorum*, have been recorded. They show a striking similarity with the absorption spectra of the petals of *Cineraria* exhibiting those colours. Various yellow flowers exhibit a banded structure in the blue-violet regions of the spectrum which they only feebly transmit.