THE VARIED COLOURS OF *VERBENA*

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THE garden *Verbenas* are very popular trailing plants of a perennial habit. They strike root as the shoots trail along the surface of the soil and meet with sufficient moisture. It is then possible to separate the rooted portions of the shoots from the parent and grow them independently. *Verbenas* are very serviceable as ground cover in shrubberies, for hanging baskets, for rockeries, for growing in beds and for pot culture. There are several species or varieties which have received distinctive names, *viz.*, amongst which mentioned *Verbena hybrida*, *Verbena erinoides* and *Verbena peruviana*. The flowers of *Verbena* are produced in great profusion. They stand up well above the foliage in large velvety clusters of elegant shape. *Verbena erinoides* is also known as the Moss *Verbena* as the plants cover the ground completely.

Books on gardening stress the wide range of colours exhibited by the *Verbenas*. In one book, we find illustrations of a cluster of intensely blue flowers of *Verbena hybrida* and of a cluster of brilliant scarlet flowers of *Verbena peruviana*. The author of another book goes so far as to say that "there are very few flowers which can beat the *Verbena hybrida* in the exquisite range of colours, varying from white through blue and rose to purple and dark purplish-blue, with shades of pink and pale yellow". It is evident, therefore, that *verbenas* would be excellent material to illustrate the relationship between the observed colour and the spectroscopic behaviour of flowers.

Blue *verbenas* would be of particular interest as they may be expected to display the spectral characteristics of Florachrome A. At the time of writing, however, they were not to be seen in Bangalore. A purple species of *Verbena* is however quite common, and when as is frequently the case, it has been planted over an extensive area, the ground covered with the flowers presents the appearance of a carpet of that colour. Though the individual flowers are small, a cluster of them presents a substantial area, and its spectral character may be readily determined by viewing the cluster through a pocket spectroscope. An absorption band covering the yellow region of the spectrum is a striking feature, while the green region is visible and by comparison appears fairly strong. The red and blue regions of the spectrum are seen with apparently undiminished strength. The colouring matter of the purple *verbena* is readily extracted by immersing the flowers in acetone. A spectrophotometric record obtained with a cell of one centimetre thickness containing the extract is reproduced as Fig. 1. The

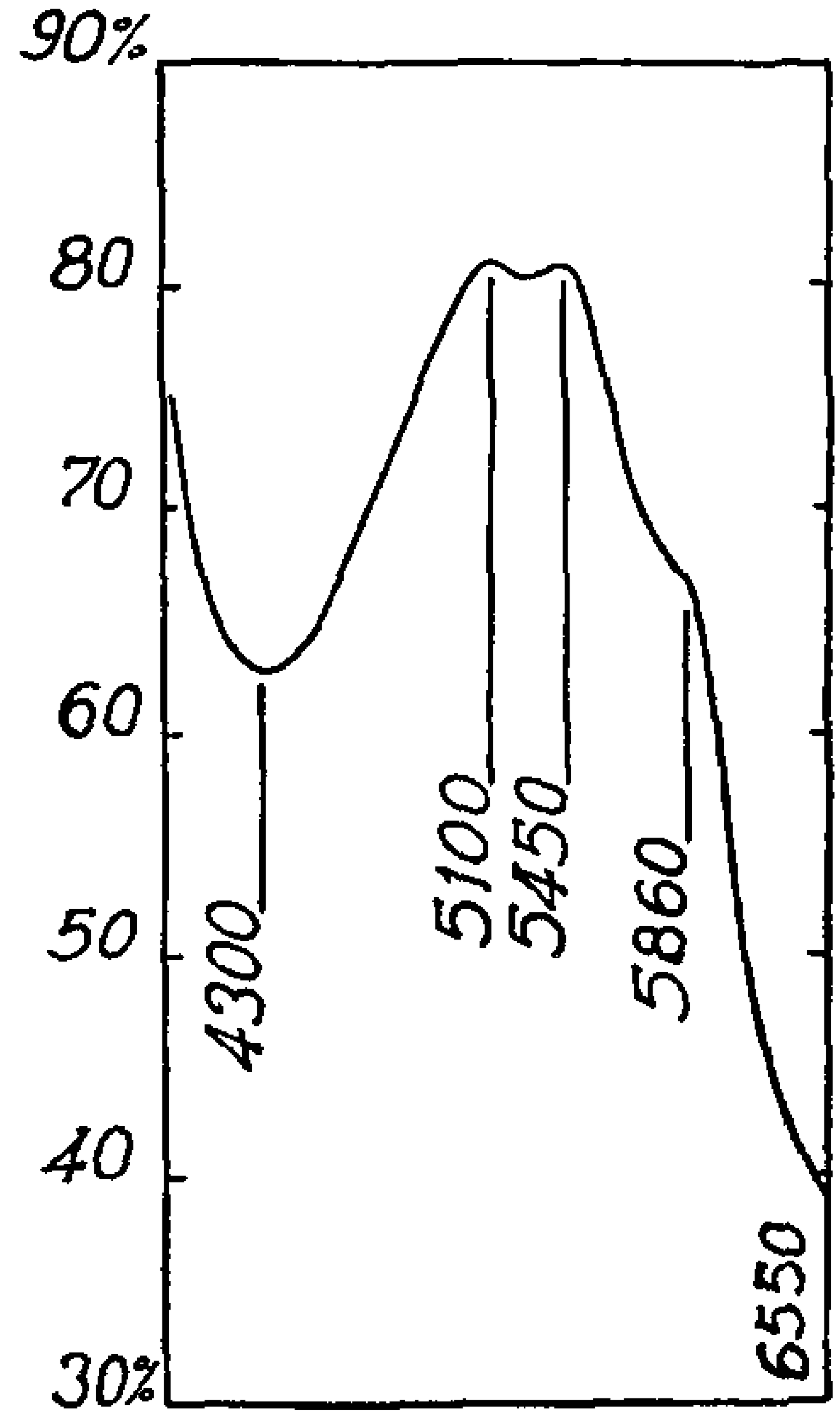

FIG. 1. Absorption Spectrum of acetone extract from purple *verbena*.

record exhibits three peaks of absorption, one of which appears in the yellow region of the spectrum and the other two respectively in the green and the green-blue regions. These spectral characteristics may be identified as those of Florachrome B. The purple *verbena* furnishes an excellent example of the role that the absorption of the yellow plays in the perception of a purple hue.

In the author's garden at his Institute in Bangalore, a variety of *Verbena* is to be seen, the colour of the flowers of which may be described in general terms as being red. But it is highly variable, varying from a deep purplish-red to quite a pale pink. These differences appear partly to be due to a gradual fading away of the individual flowers, since those nearer the centre of the cluster which are the latest to open have the deepest colour, while the outermost are the palest. Spectroscopic examination of the individual flowers in a cluster reveal that the absorption appearing in the spectral region between 500 mμ and 600 mμ which is responsible for the observed colour is very weak in the flowers which appear a pale pink, and is almost complete in those which exhibit a brilliant colour. The relative intensity of the absorption appearing in the green sector from 500 mμ to 560 mμ and in the yellow sector from 560 mμ to 600 mμ is also highly variable. The observed colour appears to be most saturated when the yellow sector is completely absorbed. This is indeed a general feature in all floral colours.

The spectrophotometer record reproduced above was made in the Instruments Section of the Indian Institute of Science to the authorities of which the author's thanks are due.

CELLULAR HETEROGENEITY AND METABOLIC ADAPTATION IN THE FLIGHT MUSCLES OF DRAGONFLIES

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It is well known that the vertebrate skeletal muscle consists of two basic types of fibre, red (Type 1) and white (Type 2). In the pigeon pectoralis muscle, the red fibres are characterized by their small diameter, higher content of myoglobin, fat, mitochondria and, lipolytic and oxidative enzymes. The white fibres have larger diameter, higher content of glycogen and glycolytic enzymes. The former are adapted for aerobic metabolism and metabolize fat as the chief fuel. The latter are adapted for anærobic metabolism for metabolizing glycogen. The pigeon pectoralis muscle consists of only the red and white fibres, the intermediate forms that are found in other vertebrate muscles being absent. The white fibres are present in the periphery of the muscle fasciculus and the red fibres which have a greater blood supply occur towards the interior. The pectoralis muscle of the sparrow on the other hand, consists of only the red fibres. The fibres in the superficial region of this muscle, however, have been shown to contain more glycogen and phosphorylase and less fat and succinic dehydrogenase than the fibres in the deeper part of the muscle. Thus the pigeon and sparrow pectoralis muscles represent in avian flight musculature, two lines of evolution in cellular architecture and functional adaptation. Similar parallelism in the evolution of the pectoralis major muscle in bats has also been indicated.[1,2] Recently, Kallapur[3] reported the occurrence of two types of fibre, one larger and more sudanophilic than the other in the leg muscle of two species of cockroaches *Blatella germanica* and *Periplaneta australasiæ*. The former type of fibre resembles the third type of fibre, large, red, and containing high concentrations of fat, lipase and succinic dehydrogenase described by Nene and George[4] in the avian supinator muscle.

In the case of the flight (basalar and dorsoventral) muscles of dragonflies too, parallel trends in the nature of their fibre composition as observed in the pectoralis muscle of some birds and bats could be recognized.[5] The two types of fibre, the small (20–30 μ in diameter) and the large (40–70 μ in diameter) in the dragonfly *Pantala flavescens* may be compared to the red (Type 1) and white (Type 2) fibres respectively of the pigeon pectoralis muscle. There is, however, a difference between the pattern of distribution of these fibre types in the muscles of the two animals. In the pigeon muscle, the large white fibres mostly occur at the periphery of the muscle fasciculus, and in the muscle as a whole, the superficial region has a considerably larger population of white fibres than in the deeper part.[2] In the flight muscle of *Pantala flavescens*, however, the large fibres show a scattered distribution. The fibre composition of the flight muscles of the two dragonflies *Aeshna* sp.[6] and *Anotogaster sieboldii*[7] correspond to that of the pectoralis of the sparrow.[5] In *Anotogaster sieboldii*, the peripheral fibres in a fasciculus have been shown to contain lower levels of oxidative enzymes than the deeper fibres.[7] The fibre composition of the flight muscle of *Brachythemis contaminata* is similar to that of the