## Determinants of Plant Growth

**The Shoot Apex and Leaf Growth.** A Study in Quantitative Biology. R. F. WILLIAMS. Cambridge University Press, New York, 1975. viii, 256 pp., illus. $18.95.

Williams believes that contemporary analyses of growth and morphogenesis of the shoot tip of plants overemphasize biochemical and physiological mechanisms, and he sets out to demonstrate that physical constraint is an effective determinant of growth and form. His analysis is based on serial transverse sections from which he reconstructs "three-dimensional" models of the shoot tip. In the reconstructions successive sections are indicated by contour lines, producing what one of his colleagues has called "Michelin-type" drawings. By starting at seed germination and sampling at frequent intervals, Williams has been able to measure size and shape changes in the terminal meristem and in each leaf and to derive quantitative values for growth with a degree of precision that has not previously been attained. He has done this for the vegetative shoot tip of 13 species and the inflorescence of one. All the data are from his own work or that of his collaborators and students; many of them are published here for the first time.

Perhaps the most remarkable of his findings is that the relative growth rate of a newly emergent leaf rises to a peak and then declines as the leaf makes contact with its older neighbors in the bud. Its further growth is then constrained by its continued contact with these other leaves. This conclusion, which is central to his assigning priority to physical forces in development, has not been tested experimentally, but one could easily do so by removing outer leaves from a bud and measuring growth rates of the remaining unrestrained leaves. Williams's approach throughout is analytical, not experimental, but the results are presented in a way that leads the reader to devise experimental tests.

Perhaps less successful is his attempt to account for the position at which new leaves emerge in terms of physical forces. He observes that leaves are tightly packed together in the bud and supposes from this that new leaves arise at positions where packing and constraint are least. This is a restatement of an earlier hypothesis that leaves arise in the first available space. Williams considers the alternative hypothesis, that leaves arise as the centers of growth fields that can be specified in biochemical terms, to be unsatisfactory. However, the kinds of apices that he has examined, in which new leaves do emerge close to older ones, are probably not a sufficient basis for making a choice between these hypotheses. There are other apices, such as those of *Selaginella*, *Dryopteris*, and *Nuphar*, in which leaves are widely spaced at initiation. In these, leaf position cannot be defined in terms of physical contacts and constraints.

*The Shoot Apex and Leaf Growth*, like its predecessor in this series, *Analysis of Leaf Development* by R. Maksymowych, could not be used alone as a text for a course. Its scope is too restricted and its viewpoint too personal, since it deals almost entirely with the researches of its author and his associates. Nevertheless, its illustrations are among the best available for giving a conception of the changing shape and size relationships of the parts of a growing apex, and the method of shoot tip reconstruction, although it appears to require an enormous amount of effort, is useful for anyone interested in shape and volume changes in organs that are too small to measure in conventional ways.

IAN SUSSEX

*Department of Biology,*
*Yale University,*
*New Haven, Connecticut*

## Hemoglobinopathies

**Man's Haemoglobins.** Including the Haemoglobinopathies and Their Investigation. Second edition. H. LEHMANN and R. G. HUNTSMAN. Lippincott, Philadelphia, 1975. xii, 478 pp., illus. $32.

**Proceedings of the First National Symposium on Sickle Cell Disease.** Washington, D.C., June 1974. JOHN I. HERCULES, ALAN N. SCHECHTER, WILLIAM A. EATON, and RUDOLPH E. JACKSON, Eds. National Institutes of Health, Bethesda, Md., 1974 (available from the Sickle Cell Disease Branch, NIH, Bethesda). vi, 414 pp. DHEW Publication No. (NIH) 75-723.

Hemoglobin was one of the first proteins to have its three-dimensional structure solved by x-ray crystallography, and it has received more attention from research workers than any other single protein. Thus at a time when basic research is under scrutiny some disappointment may be justified if the wealth of information we have about hemoglobin cannot be applied in some constructive treatment of the hemoglobin pathologies. The situation is especially acute in the case of sickle cell disease, which afflicts far more people than any other well-defined molecular disease, apparently as a result of the survival advantages conferred by the enhanced resistance to *Plasmodium falciparum*, the parasite of malignant malaria, that is associated with sickle cell trait. Taken together the two books under review provide a fairly complete view of the extensive work on hemoglobin and its variants (in Lehmann and Huntsman) and the latest efforts to understand and treat sickle cell disease (in Hercules *et al.*).

*Man's Haemoglobins* focuses on the discovery and structures of the variants of human hemoglobin. Beginning with hemoglobin S many variants have been studied during the last 25 years, and the list now numbers over 200. The implications of the resulting body of information for medicine, biochemical genetics, and anthropology are discussed in detail. Considerable background is presented in each of these areas. For example, individual chapters are devoted to protein synthesis, to protein chemistry, and to elementary genetics. The emphasis in each of these treatments is on the variants of hemoglobin. Sickle cell hemoglobin receives the most attention, but other abnormal forms and the thalassemias are discussed in detail and a list of all known hemoglobin variants is presented. The final part of the book is a description of techniques used in the study of abnormal hemoglobins, such as detailed recipes for electrophoresis.

Lehmann and Huntsman's book is very much a "natural history" of the hemoglobins and includes many anecdotes; humor and tangentially related photographs of works of art are also interspersed with the scientific material, so that the book has an unusual flavor for a scientific monograph. The humor may appear to many as from another era, but to some extent so is the naturalist's approach taken by the authors. Although strong and up to date on the structure and distribution of abnormal hemoglobins, the book is weak on their physical-chemical properties. A number of important parameters in the characterization of hemoglobins, such as the kinetics of oxygen binding, are ignored completely, and the few mechanistic details that are presented suffer from a too-literal acceptance of some speculative hypotheses presented by Perutz in 1970. No mention is made of the allosteric model, which has provided the basis for interpreting many functional properties of hemoglobin and its variants. A token four-page chapter on x-ray diffraction does not do justice to the subject. Thus the book should be viewed principally as a resource on the more medical side of hemoglobin abnormalities. Considerable space is devoted to the treatment of several hemoglobin diseases, with a major section on approaches to sickle cell disease. However, research on the sickle cell