water cell which would absorb but a very small fraction of the power of the sun's rays. In fact, a comparison of the transmission curves of water and of glass and of the radiation curves of bodies of the sun's temperature and those of incandescent filament temperatures show that water is almost as good a transmitting medium for the sun's radiation as is glass for the radiation of an incandescent filament.

The effect here being commented upon is in no sense a new one though we have seen no direct statement of the marked difference in behavior of glass and water to solar and incandescent lamp radiation. This subject is one, however, which might well receive some attention, even in elementary physics courses.

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A POSSIBLE SOURCE OF LABORATORY FIRES

THE article by Julian H. Lewis under the above title in No. 2217 of SCIENCE reminds me of my own experience. Many years ago I was engaged in study of numerous petrographical slides and very often worked evenings by the artificial light of a kerosene lamp. With the purpose of whitening that light I used a glass ball about six inches in diameter filled with ammoniacal solution of copper sulfate. During the daytime this ball was always removed to the sill of the window in front of which stood my table. One bright day when I was busy with my microscoping I noticed a thin spray of smoke rising from the sill. Investigating the matter, I found that this was not the first occurrence because all the front side of the table above the sill was covered with charred lines burned out by the sun rays passing through the ball referred to. The danger of fire was not great in this case, because the ball was close to the window and the sun burned out thin lines, not concentrating the heating on a limited surface. But, anyhow, after that discovery, in the daytime the ball was kept under the table, and thereafter I was very careful not to leave any kind of bottle near the windows where those bottles could be hit by the direct sunlight.

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SCIENTIFIC BOOKS

SOME RECENT BOOKS IN THE PLANT SCIENCES

Pollen Grains. By R. P. WODEHOUSE. xv + 574 pp. 123 figs. 14 plates. McGraw-Hill Book Company, New York. 1935. $6.00.

A CENTURY has passed since two great men of science, von Mohl and Fritsche, were each apparently so impressed by the other's study of pollen structure that both sought fresh fields of endeavor. It remained for Hugo Fischer, in 1890, to lay the foundation of modern comparative pollen morphology. And since his time the topic has lain largely dormant until stimulated by the current interest in allergy and pollen analysis.

The work under review is that of a master. It is the result of industry, skill and cerebration of an unusual order, and was carried to completion in the scant leisure of a busy industrial life. In the measured opinion of the reviewer, it represents one of the notable achievements of American botany. To the clinician and the micropaleobotanist it is an indispensable handbook; to the student of phylogeny and morphogenesis it opens up new opportunities.

The book is divided into two main sections: (1) a general portion dealing with history and practical procedures and ending with a discussion of structural characteristics; (2) a taxonomic portion in which is figured, described and compared representative pollen of all the orders of gymnosperms and some thirty families of angiosperms.

The historical section supplies information not familiar to many modern botanists and is all the more valuable because so many of the original sources are now difficult to obtain.

The practical discussion is first-hand stuff. The author's own professional work, of course, deals with hay-fever and other allergic problems whose relation to pollen he presents. He has also had direct experience with the subject of pollen microfossils in his study of the Green River shales and his pollen analyses of peat from the Himalayas; but the valuable chapter dealing with pollen analysis has been contributed by Gunnar Erdtman, of Stockholm. This chapter discusses the limitations of technique as well as its procedures and should be read by every worker in the difficult, involved field of North American pollen analysis.

Probably Wodehouse's greatest contribution is in the field of pollen geometry and is based upon the spatial relations inherent in the tetrad pattern—the trischizoclastic system, as he calls it. This is set forth in his discussion of structural characters at the end of Section I and is, of course, documented in detail in Section II, dealing with taxonomy.

In the latter section his underlying evolutionary idea is the primitive character of wind pollination, its subsequent modification into insect carriage and the reappearance of wind pollination in many entomophilous groups of flowering plants. This is quite in keeping with current phylogenetic thought. Noteworthy fea-

tures are the establishment of homologies within the gymnosperms and between that group and the primitive angiosperms; also the brilliant discussion of the Compositae.

On the basis of pollen character, the author considers the Magnoliaceae to be primitive; that is one of his few exceptions to the Engler-Prantl phylogeny. And since convention demands that a reviewer sign off with some unpleasant testament of his good faith, this gives me an excuse to ask why in thunder the pollen of the Salicales and Amentiferae should be considered more primitive than that of the Rosales.

Most appropriately, the book is dedicated to R. A. Harper.

PAUL B. SEARS

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Production of Field Crops. By T. B. HUTCHESON, T. K. WOLFE and M. S. KIPPS. xvii + 445 pp. 110 figs. McGraw-Hill Book Company, New York. 1936. $3.50.

THE first edition of "Production of Field Crops," which appeared in 1923, followed the outline for a "standard introductory course in field crops," as adopted by the American Society of Agronomy. This outline was developed to present the fundamental underlying principles of crop production before dealing with individual crops. The object was to avoid repetition of such knowledge that is common to all crops, as choice of good seed, seedbed preparation, germination and growth, tillage, fertilization and harvesting and storage. The authors were very successful in the first edition, as indicated by the favorable reception given it by colleges and schools throughout the country.

In the second edition the same general plan of organization is followed. The first section, which includes 19 chapters, deals with general information pertaining to production of all crops; the next section of 7 chapters discusses cereal or grain crops, while a section of 3 chapters is given over to legumes for seed, and another of 3 chapters to forage crops. Sections of 2 chapters each on root crops and fiber crops follow. The last 3 sections, each of 1 chapter, deal with tubers, sugar plants and stimulants.

The book is unique in that it sets forth in broad general outlines the fundamental facts underlying the production of crops. The size of the text has been reduced without material injury to its scope so as to better meet the needs of a one-semester course. This has been brought about by a reduction in illustrative tables rather than subject-matter.

At the end of each chapter a list of thought-provoking questions has been added. These are designed to stimulate outside reading.

The second edition has been revised to include important new knowledge which has accumulated during the past thirteen years.

The authors have continued the excellent use of maps showing regional distribution of crops, making it possible to emphasize crop ecology. A limited number of charts and drawings have been used to advantage. The book is illustrated with well-chosen photographs which in the main show characteristics of individual crops. The second edition is more of a text-book and less a reference book than the first. We believe it will serve a wide purpose in advancing an understanding of the fundamental problem in crop production.

A third author—M. S. Kipps—has collaborated with Hutcheson and Wolfe in the preparation of the second edition.

W. L. BURLISON
J. J. PIEPER

UNIVERSITY OF ILLINOIS

Growth Hormones in Plants. Authorized English translation of *Die Wuchsstofftheorie und ihre Bedeutung für die Analyse des Wachstums und der Wachstumsbewegungen der Pflanzen.* By P. BOYSEN JENSEN. Translated and revised by GEORGE S. AVERY, JR., and PAUL R. BURKHOLDER, with the collaboration of HARRIET B. CREIGHTON and BEATRICE A. SCHEER. xiv + 268 pp. 64 figs. McGraw-Hill Book Company, New York. 1936. $3.50.

THIS book represents a reworking of the subject rather than a direct translation of the German. The text has been expanded and the subject brought up to date by the inclusion of much recent work.

The text-figures have been increased from twenty-six to sixty-four, greatly augmenting the interest of the text thereby. Noteworthy are several full-page figures which present in pictorial form such subjects as an historical outline of early discoveries concerning plant hormones, an outline of recent contributions to our knowledge of plant growth hormones, the *Avena* coleoptile technique for testing growth hormone content, etc.

In addition to the citations in the original, the revision presents nearly 200 new titles, which deal directly with plant hormones, and a useful bibliography of more than 100 titles of works (not discussed in the text) which pertain to other hormones and similar substances affecting plant growth (animal hormones, biox, vitamins, etc.).

A historical account of the development of the subject from Darwin down to the present occupies the first chapter. The second chapter is devoted to the techniques for the detection and quantitative determination of growth substances. A third chapter presents the methods of preparation of growth substances from plant and animal sources, the structural constitution of the auxins, the physical and chemical characteristics

of the auxins prepared from plant materials, and the physiological properties of the auxins, their derivatives and other compounds. The occurrence and formation of growth substances in plants and animals are treated in a fourth chapter.

Other chapters deal with the transport of growth hormones and their significance for normal plant growth, bud development, tumor formation, phototropism, geotropism, traumatropism and thigmotropism.

The addition of a summary at the end of each chapter and a good index increase the usefulness of the work.

As the first comprehensive review in English of the literature of plant growth hormones, this book will be of immense value not only to American botanists but to scientists in general who are interested in the subject but have been unable to read its extensive and scattered literature.

CARL D. LARUE

UNIVERSITY OF MICHIGAN

Flora of Jamaica. By WILLIAM F. FAWCETT and ALFRED BARTON RENDLE. Vol. VII, Dicotyledons, Part V. By SPENCER LE MARCHANT MOORE and ALFRED BARTON RENDLE. ix + 303 pp. 100 figs. The British Museum (Natural History), London. 1936. 15/

STUDENTS of the West Indian flora have long awaited the publication of Volume VII, Part V, of Fawcett and Rendle's "Flora of Jamaica" as a guide to the identity and distribution of the epigynous Sympetalae of that island, which by reason of its location is an important point in working out the tropical North American flora. The work, as was expected, follows along the same lines as the previously issued volumes in its conservative tendencies as to generic aggregates. As in the case of the other volumes, the illustrations are excellent and the key-characters clearly defined. It is with regret that we note the Lobeliaceae still included in the Campanulaceae when there are such clearly distinguishing characters for the two families. It should be noted that the majority of the Rubiaceae and all the Compositae are the work of the late Spencer Moore, and the families Caprifoliaceae, Campanulaceae and Goodeniaceae and six small genera of the Rubiaceae are the work of Dr. Rendle.

E. J. ALEXANDER

THE NEW YORK BOTANICAL GARDEN

Methods in Plant Physiology; A Laboratory Manual and Research Handbook. By WALTER E. LOOMIS and CHARLES A. SHULL. xviii + 472 pp. 94 figs. McGraw-Hill Book Company, New York. 1937. $4.50.

THIS book meets in an excellent way the long-standing demand for a single text to present in an organized way the customary experimental approaches to plant physiology and the essential analytical techniques of routine investigations, information which students have hitherto been obliged to garner from widely scattered sources.

The book comprises twenty-three chapters and a comprehensive tabular appendix. The first thirteen chapters contain the directions for a well-organized series of laboratory experiments on water relations, nutrition, photosynthesis, translocation, respiration, growth and movement. Directions are accompanied by brief but lucid explanations of purposes underlying experimental operations. Each experiment is supplemented with a few highly objective questions and citations to related literature.

The authors have included several experimental procedures not found in ordinary laboratory manuals. Worthy of mention especially are Heinicke's flowmeter method of gas analysis, the use of Guthrie's color standard in Schertz's quantitative estimation of chlorophyll, a unique technique for study of the "dark phase" reaction of photosynthesis, and a generous list of useful micro-chemical tests on tissue sections. The use of trees in studies of nutrition and translocation reflects the desire to make the experiments of use to students of horticulture as well as to avoid the numerous pitfalls of immediate response to physiology.

Chapters 14 to 22 of the manual contain directions for the more common chemical, physical and statistical analyses employed by plant physiologists. Especially well treated are the chemical procedures for ash, nitrogen and lipid determinations. Extremely useful techniques for quantitative studies of osmotic pressure, surface tension and specific conductivity are given along with explanations of the principles involved in the usual types of apparatus employed. The last chapter, by Professor George W. Snedecor, presents an excellent survey and mathematical treatment of bio-statistics as these relate to the validity of experimental data and their interpretation. The text concludes with a most useful appendix of thirty-three ready reference tables of physical, chemical and mathematical constants commonly required for analytical work.

It is evident that the manifold objectives of this book represent a new departure in college texts. The economy of time and effort in having a plant physiology laboratory manual, a quantitative physico-chemical analysis, a bio-statistical handbook and ready reference tables of physical constants between the covers of one book will definitely assure its wide-spread use and thereby justify the originality of the authors as well as recompense the publishers for their courage in under-

taking the sale of something really new in the way of botany text-books. Though originally intended primarily as a reference text, its general usefulness will without doubt lead to its adoption as a text in colleges and universities. The authors have employed a succinct yet animated and lucid style of writing.

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SPECIAL ARTICLES

TUMOR PRODUCTION BY HORMONES FROM PHYTOMONAS TUMEFACIENS[1]

Phytomonas tumefaciens (Smith and Town.) Bergey *et al.*, incitant of crown-gall, was grown in a medium containing 2 per cent. dextrose and 0.1 per cent. bacto-tryptophane in distilled water, and in a medium containing, in addition, 1.0 per cent. bacto-peptone. Lacking salts, these media are simpler than those used by Brown and Gardner.[2] Cultures 2 to 4 days, three and twelve weeks old, also pellicles formed in the latter medium, were extracted with anhydrous peroxide-free ether, yielding crude waxy preparations. The most active extract was obtained from the former medium and organisms cultured twelve weeks. It was applied without wounding to hypocotyls of the red kidney bean (*Phaseolus vulgaris*) prior to straightening. For comparison, applications of 3 per cent. heteroauxin in anhydrous lanolin also were made in dosages of 0.005 cc and 0.01 cc with a tuberculin syringe. The dosages of bacterial extract were estimated at 0.0025 cc.

Control plants wounded by needle pricking, incision with or without insertion of mica or coverglasses, and complete transection of actively growing hypocotyls were set up to determine effects of moderate and severe wounding. Control inoculations with *P. tumefaciens*, with ether extracts of uninoculated media and with lanolin also were made.

Bacterial extracts applied unilaterally produced negative bending of 60° or less in from one to two hours. In three to four hours clearing appeared at the site of application, at and below which the hypocotyl first thickened down to soil level and later along all radii, though most abundantly at and below the site of application. Within eighteen hours thickening also extended a short distance upward. Temporary injury was evident in retarded straightening of the arch, elongation of the hypocotyl and development of the epicotyl. Later these general pathic effects were overcome. Whitish tumors appeared beneath and adjacent to the applications. In from three to four days local swellings marked sites of adventitious roots. Similar but more pronounced effects were produced with the heteroauxin-lanolin mixture. The dosages of 0.005 cc produced as marked early results as 0.01 cc dosages, but later effects were weaker. *P. tumefaciens* produced very small galls, the changes being less rapid than those effected by the extract and heteroauxin and the tissue firmer. Application of ether extracts of non-inoculated media and of lanolin gave negative results. Needle pricks caused slight local callus formation. Incisions, especially blocked ones, caused more wound tissue, especially above the incision and, at times, adventitious roots. The basal ends of severed hypocotyls swelled in from two to three days into massive calluses and later developed vigorous roots. The wound responses resembled those produced by extract and heteroauxin applications in intact hypocotyls but were less intense and better integrated than those incited by the latter.

The tumors produced by heteroauxin and bacterial extracts were initiated by cell enlargement, followed by cell division. Cell enlargement often was so excessive that adjoining cells in the cortex separated, forming cavities. These internal wounds led to development of loose callus. In addition or when cavities did not develop, cortical cells, including the endodermis, divided. The latter often was involved in development of extrafascicular vascular tissues[3,4] and roots. The vascular tissues, rays and pith also were activated.

Since transection, incision or application of heteroauxin or of bacterial extracts lead to similar effects in the hypocotyl, one may formulate the hypothesis that disturbance of the usual auxone concentration of the affected tissues is one of the causes of cell enlargement characterizing these effects. This disturbance, possibly a hyperauxony, gives hypocotyledonary cells opportunities to realize potentialities of cell enlargement, division and differentiation not stimulated to or inhibited from expression in the course of normal development.

In crown-gall formation this auxone disturbance probably is not a brief but a prolonged condition because the parasite not only produces heteroauxones and disturbs host correlations but also starts new abnormal growing centers, creating additional sites of autoauxone production. Growth substances obtained from *P. tumefaciens* produce effects similar to those of heteroauxin in the bean hypocotyl, but it can not be stated as yet that they are any of the known auxones.[5]

[1] Supported in part by a grant from the Rockefeller Foundation to the University of Chicago.

[2] N. Brown and F. E. Gardner, *Phytopathology*, 26: 708–733, 1936.

[3] K. Schilberszky, *Ber. d. Bot. Ges.*, 10: 424, 1892.

[4] E. J. Kraus, N. Brown and K. C. Hamner, *Bot. Gaz.*, 98: 370–421, 1936.

[5] After this article was submitted, a new lot of extract made possible application of the hydrochloric acid, ferric