SCIENTIFIC BOOKS

Organographie der Pflanzen Insbesondere der Archegoniaten und Samenpflanzen. By DR. K. GOEBEL. Erste Teil—Allgemeine Organographie. Dritte Umgearbeitete Auflage. G. Fischer, Jena, 1928. 642 pp., 621 text-figures.

THIS is a day of early specialization of research in narrowly restricted botanical fields, often by workers who have had but a year or two of introductory courses covering the general field. At such a time the comprehensive discussion here presented by von Goebel of the structure, the space relations and ontogenetic development of plant organs, as well as that of their correlations in function, should prove a broadening and steadying influence of much importance, on botanical investigators in many fields. It is of value not merely to the plant organographer and physiologist, but is of still more value perhaps to the experimental morphologist and to the plant pathologist, the latter of whom more often than not lacks the sort of knowledge of the structure, behavior and interdependence of the plant's organs under normal conditions that can be gained from von Goebel's book. Nowhere else in modern botanical literature can the botanist turn for so authoritative a general treatment of the whole subject of plant organography.

This volume—"Allgemeine Organographie"—with the two or more special volumes on bryophytes, pteridophytes and spermatophytes that are to follow, will constitute a compact encyclopedia of the main features of plant organography, largely observed or verified by von Goebel and his students, during a half century of unusually prolific botanical research. Beyond this, von Goebel's interpretations of the significance of the different structures and the different types of development described are suggestive and stimulating, and may at times indeed be provocative of keen disputation. In the "Organographie" we not only become acquainted with a whole series of observations that are of interest to the causal morphologist, but find many which are also of direct concern to the horticulturist and orchardist.

As compared with the second edition of this "General Organography" this third edition is enlarged by 139 pages and by 160 additional figures. Three fourths of the new pages and ninety-one figures have been added to Chapter III, "Die Symmetrieverhältnisse der Pflanzen." Most of this added space is devoted to a series of new paragraphs on polarity in the spores and sporelings of the thallophytes and in the spores and embryos of archegoniates and seed plants. About twenty pages each have been added to Chapter II, "Organbildung auf den verschiedenen Stufen des Pflanzenreichs," and to Chapter VI, "Die Abhängigkeit von Organbildung von inneren und aüseren Faktoren."

This volume, like its earlier editions, is noteworthy for its illustrations. Many of these are drawings or photographs made by von Goebel himself in far corners of the earth, and they illustrate very aptly the subjects discussed in the book. Other figures are clear diagrammatic presentations of interesting features of the spatial relations of organs, or of the comparative development of the same part in different related species, as, for example, in the instructive figures 40 and 41, which show the shifting of the region of most active growth in the floral axis of certain Rosales. Altogether more than five sixths of the excellent illustrations in this volume (504 of a total of 621) are original with the author. Many of the remaining figures were made by students in Goebel's laboratory.

Shortcomings may be pointed out in the "Organographie" by the cytologist or the plant anatomist who is seeking physical or biochemical explanations of the origins of plant organs and plant tissues. It is true, nevertheless, that he will find recorded here a large number of significant observations regarding the effect on the structure attained by the mature plant, of the inherent qualities of the plant itself and of the various environmental influences that may stimulate or inhibit its development. Many unsolved problems also are here either clearly stated or in other cases roughed out, ready for immediate attack by the trained worker prepared to apply to them the conceptions and the methods of the physiologist, the biophysicist and biochemist for their more or less proximate solution.

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SPECIAL ARTICLES

PHOSPHORUS COMPOUNDS OF MUSCLE AND LIVER

I. MUSCLE

EMBDEN and Schmidt[1] have recently made the highly interesting discovery that the adenosine phosphoric acid isolated about two years ago from voluntary muscle[2] is not identical with that obtained from yeast nucleic acid. Among the chemical properties by which the two may be distinguished the difference in resistance to hydrolysis by acid is particularly striking. The muscle nucleotide ("myoadenylic acid") is hydrolyzed (by 0.1 N sulphuric acid at 100°) only

[1] G. Embden and G. Schmidt, *Z. physiol. Chem.*, 181: 130, 1929.

[2] G. Embden and M. Zimmerman, *Z. physiol. Chem.*, 167: 137, 1927.

about one fifth as rapidly, as measured by the rate at which o-phosphoric acid is split off.[1]

That adenine (in nucleotide combination) is the source of the ammonia formed in muscle during contraction has been amply demonstrated by Embden and his collaborators. The physiological significance of this important work is presumably quite unaffected by the fact, which we now have to report, that myoadenylic acid is not a normal constituent of muscle (except perhaps in traces), but a decomposition product. Our first intimation that this might be the case developed from the observation that when a protein free muscle filtrate is treated with an alkaline solution of calcium chloride[3] a large part of the purine nitrogen comes down in the precipitate. The calcium salt of myoadenylic acid is soluble in water, and should consequently—if present—remain dissolved under these conditions.

The purine derivative precipitated by calcium has been isolated by (1) precipitation with mercuric acetate in the presence of 2 per cent. acetic acid, followed (after removal of the mercury) by (2) precipitation with calcium chloride and alcohol from hydrochloric acid solution, which yields an acid calcium salt. By repeating the entire process the acid calcium salt is finally obtained as a microcrystalline precipitate. The yield is not far from quantitative, and accounts not only for most of the purine nitrogen of muscle, but also for most of the acid soluble phosphorus not present as o-phosphoric acid, phosphocreatine or hexose monophosphate. In the case of cat muscle the yield of purified material may be the equivalent of nearly 50 mg of phosphorus per 100 gm of muscle.

The acid calcium salt is not well suited for analytical purposes, owing to the difficulty of removing all the water. It may, however, be converted to a silver salt—by precipitation with silver nitrate from nitric acid solution—and the composition of this product has been found to be $C_{10}H_{13}O_{13}N_5P_3Ag_3$. It contains, in addition to adenine and carbohydrate, three molecules of phosphoric acid, or two more than in adenylic acid. Two of the three molecules of phosphoric acid are readily removed by hydrolysis with acid, and this fact is doubtless sufficient to explain why Embden and Zimmerman[2] obtained a nucleotide (myoadenylic acid) which still retains the one resistant phosphoric acid group.

The new substance includes also the phosphorus which Lohmann[4] believes to be present in the muscle in the form of pyrophosphate, but whether or not it is an ester of pyrophosphoric acid remains to be determined.

II. LIVER

The greater part of the organic acid soluble phosphorus of liver may be precipitated from the protein free filtrate, after removing the inorganic phosphate with alkaline calcium chloride solution, by the addition of alcohol. Purification by dissolving in water and reprecipitating with alcohol finally yields a calcium salt, crystallizing in spherulites or aggregates of short needles, and having the composition $C_3H_7O_6PCa.1\frac{1}{2}H_2O$. It is the calcium salt of glycerophosphoric acid, which in spite of text-book statements has not—as far as we have been able to determine—been isolated from animal material before, at least under conditions which preclude its formation from lecithin and related substances.

Experiments are now under way which it is hoped will lead to some procedure for the quantitative estimate of free glycerophosphate in tissue filtrates. From present indications this substance appears to account for at least one third of the total acid soluble phosphorus of the liver.

The properties of the above-mentioned calcium salt, together with the fact that it gives an intense greenish blue color on applying the Denigès codeine test after oxidation with bromine,[5] and forms no insoluble double salt with barium nitrate,[6] identify it as α-glycerophosphate. This is of particular interest since all preparations of lecithin so far examined by means of these tests have been found to contain mainly the β form of glycerophosphoric acid.[7]

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[3] This is the first step in the isolation of phosphocreatine (C. H. Fiske and Y. Subbarow, *J. Biol. Chem.*, 81: 629, 1929) where it serves the purpose of removing inorganic phosphate and other products.

[4] K. Lohmann, *Biochem. Z.*, 202: 466, 1928; 203: 164, 172, 1928.

[5] O. Bailly, *Ann. chim.*, 6: 96, 1916.

[6] P. Karrer and H. Salomon, *Helv. chim. acta*, 9: 1, 1926.

[7] O. Bailly, *Ann. chim.*, 6: 215, 1916; P. Karrer and P. Benz, *Helv. chim. acta*, 10: 87, 1927.

BALANCED FERTILIZERS AND LIEBIG'S LAW OF THE MINIMUM

LIEBIG maintained that "by the deficiency or absence of *one* necessary constituent, all others being present, the soil is rendered barren for all those crops to the life of which *that one* constituent is indispensable."[1] This afterwards became known as the "law of the minimum," from which it must logically follow, as indeed Liebig himself announced,[2] that

[1] Justus Liebig, "Chemistry in Its Applications to Agriculture and Physiology," third edition, 1843.

[2] Justus Liebig, "Les lois naturelles de l'Agriculture," 2, second chapter, 1863.