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MINERAL NUTRIENTS IN RELATION TO FLOWER DEVELOPMENT[1]

By Professor W. F. LOEHWING

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FOR several years, the writer and his associates have investigated the role of mineral nutrients in relation to reproduction and sex expression in higher plants. From these and numerous other investigations, it is evident that the most profound metabolic and structural changes of the plant's entire life originate in the brief period between the origin of floral primordia and full bloom (Loehwing, 1938–39). Hence a detailed study, correlating chemical composition with histological structure in this particular phase of development, appeared to offer exceptional promise of valuable results, not only as to the functions of mineral nutrients in flowering but also as to their specific role in general developmental physiology.

Though interest in these investigations has centered primarily in the physiology of flowering, physiological studies obviously could not be confined to this phase alone. Only a continuous and detailed chronological inventory of the progress of events in root and shoot, from the vegetative, flowering and fruiting phase provides the requisite interpretative data. Because the most significant changes of the flowering phase are highly localized (Borthwick and Parker, 1939) the usual mass analyses of entire tops have to be supplemented with separate, sequential physico-chemical study of all formatively active zones of growth. For interpretative purposes, these data must be expressed in absolute amounts of the individual constituents as well as in the traditional terms of percentage composition. Determination of salts by actual weight is essential because of the fact that the relatively greater rate of carbohydrate and protein accumulation in plants tends to mask the critical changes in actual amounts of mineral matter. A progressively diminish-

[1] Address of the retiring president of the American Society of Plant Physiologists, Columbus, Ohio, December 28, 1939.

method is much to be preferred to recording through skull and scalp by electrodes pasted on the skin. Electrode artifacts, troublesome with this latter type of lead, never appear, localization is precise and the lack of resistance of skull and scalp with the needle, sufficient, in some animals, to make external recording impossible, permits one to record at very low amplification, thus eliminating instability and pick-up artifacts accompanying high amplification. The Victrola needles may be left *in situ* for a considerable period, a thing not possible with those externally applied to the skin.

The leads may be removed without reanesthetizing the animal by simply extracting each one by a firm jerk with a pair of pliers. This extraction appears to be painless. A drop of collodion placed on the small hole rapidly seals it off.

We have kept animals for several days with the leads in place and could have kept them longer. Some 50 electrode insertions have been made in a dozen animals without complications from infection. The electrode positions in the cortex could presumably be precisely determined if one wished in the freshly sacrificed animal by passing an electrolytic (D.C.) current through each lead in turn as cathode, thus producing a deposit of iron oxide at the point of contact with the cortex.

HUDSON HOAGLAND

CLARK UNIVERSITY

AN INEXPENSIVE MOUSE CAGE

IT is often desirable to keep mice in small groups when they are under observation. This requires a number of small cages, which should be easily cleaned, and, if possible, inexpensive. The following cage is suggested for its simplicity, ease of cleaning and cheapness. The materials used are few and obtainable at any hardware store. They are as follows: coarse wire netting, sometimes called hardware cloth, 8 inches × 22 inches, two tin pie plates, 8½ inches in diameter and about 20 inches of 24-gauge soft wire.

The ends of the hardware cloth are brought together to form a cylinder, 6½ inches in diameter. By overlapping the ends one inch and weaving a length of the soft wire in and out through the meshes of the cloth they can be made secure. This is best accomplished by weaving down one side and up the other of the overlapping ends so that the ends of the wire may be brought together near one point and twisted. The cylinder thus made will fit into the bottom of one of the pie plates. The other plate is now placed over the open end of the cylinder, thereby completing the cage.

As many as six mice may be kept in the cage at one time with no danger of them pushing off the top plate. Rats may also be kept in like manner, but it is suggested that a lead weight be soldered on the plate which is used for the cover. The plate used for the bottom should be covered with a piece of 25 cm filter paper, which absorbs moisture and assists the sides of the plate in preventing the scattering of food. To clean the cage the paper is removed and fresh put in its place. The mice will tear the paper to some extent, but if they are well fed this is reduced to a minimum.

A drinking fountain may be made by inserting in a small, wide-mouthed bottle a one-hole rubber stopper fitted with a short length of small bore glass tubing. A bit of rust-resisting wire, such as nichrome, should be fastened in the tube to assist in the flow of water when the mouse is drinking. The fountain should be hung inside the cage by means of a wire sling.

Any other dimensions may be substituted for these suggested so that larger or smaller cages may be made. The total cost of the cage described is about twenty cents, and a half dozen can be made in an hour.

E. WILBUR COOK, JR.

CENTRE COLLEGE

BOOKS RECEIVED

BAITSELL, GEORGE A., Editor. *Science in Progress.* Second series. Pp. xii + 317. 129 figures. Yale University Press. $4.00.

BAVER, L. D. *Soil Physics.* Pp. xi + 370. 70 figures. 4 plates. Wiley. $4.00.

Cambridge Philosophical Society, Proceedings. Volume 36, part 4. Pp. 387 + 512 + vii. Cambridge University Press, London. 10/6.

CISSEL, JAMES H. *Stress Analysis and Design of Elementary Structures.* Pp. x + 335. Illustrated. Wiley. $4.00.

COLE, LUELLA. *The Background for College Teaching.* Pp. xxiv + 616. 43 figures. Farrar & Rinehart. $3.50.

EISENHART, LUTHER P. *An Introduction to Differential Geometry; With Use of the Tensor Calculus.* Pp. x + 304. 21 figures. Princeton University Press. $3.50.

FRAENKEL, GOTTFRIED and DONALD L. GUNN. *The Orientation of Animals.* Pp. vi + 352. 135 figures. Oxford University Press. $6.00.

HEWITT, REDGINAL. *Bird Malaria.* Pp. xvii + 228. 33 figures. 13 plates. Johns Hopkins Press. $1.10.

Japanese Journal of Astronomy and Geophysics; Transactions and Abstracts. Pp. 330 + 51. Illustrated. National Research Council of Japan, Tokyo.

MARK, H. *Physical Chemistry of High Polymeric Systems.* Pp. x + 345. 99 figures. Interscience Publishers, New York. $6.50.

MOELWYN-HUGHES, E. A. *Physical Chemistry; An Introduction.* Pp. viii + 660. Illustrated. Cambridge University Press, Macmillan. $9.50.

PATTERSON, AUSTIN M. and LEONARD T. CAPELL. *The Ring Index: A List of Ring Systems Used in Organic Chemistry.* Pp. 661. Reinhold. $8.00.

SAULNIER, RAYMOND J. *Industrial Banking Companies and Their Credit Practices.* Pp. xxi + 192. National Bureau of Economic Research, New York. $2.00.

Science Reports of the Tôhoku Imperial University (Mathematics, Physics, Chemistry) First series. September, 1940. Pp. 163–314. 4 figures. Maruzen, Tokyo.

WILLIS, J. C. *The Course of Evolution by Differentiation or Divergent Mutation Rather than by Selection.* Pp. viii + 207. 10 figures. Cambridge University Press, Macmillan. $3.00.