and its functions, the leaf and its functions and the stem and its functions, respectively. In the chapter on the leaf, and in several diagrams, photosynthesis is presented in a way that might give the impression that it is the function of leaves and of no other part of a plant. Thus, on page 20, under "Metabolic processes," photosynthesis is not mentioned in the list of physiological activities that "are not confined to any one organ," although, as the author of course well knows, taking spermatophytes as a whole, photosynthesis may be the function of roots, stem, leaf, perianth or any other green organ. For this reason some botanists think it preferable to treat of photosynthesis (and other activities) as a process which may go on in any organ, or even in plants without "organs" (*e.g.*, *Pleurococcus*)—a function, in fact, not of an organ but of a tissue, chlorenchyma.

Chapters VII (metabolism) and VIII (growth) are followed by an ecological chapter, "The plant and its environment." Here the more usual definition is given of the various tropisms as movements. Phototropism, for example, is defined as "any movement which is a specific reaction to the stimulus of light"; geotropism as "any reaction to the stimulus of gravity." To the reviewer it is preferable to regard the tropisms, not as movements or reactions, but as properties of the plant or organ by which it can detect any unilateral stimulus. It may or it may not respond, by a motion, depending on whether one kind of stimulus (*e.g.*, light) is overpowered, so to speak, by another kind of stimulus (*e.g.*, gravity), or whether response is mechanically hindered. The bending of a stem in the direction of the brightest illumination is a *reaction*, not a tropism. The author, however, is in good company in defining these terms as he does, and this comment is not for the purpose of pointing out an inaccuracy or error but is only propaganda for another and preferable (?) definition of terms.

Chapter X, on reproduction, is followed by one chapter on heredity and variation and one on evolution. Heredity is defined (p. 206) as the "tendency for offspring to display the particular characteristics which distinguish their parents." Here, again, the author is in fairly good company, but some students of heredity regard this definition as more or less misleading, if not, indeed, incorrect. The author's figure 128, in the same chapter, shows types of four successive generations of ferns as illustrated by leaf character. The "tendency" here is evidently toward unlikeness, instead of likeness, and yet all that the generation represented by each leaf had to start with was *inherited* from the parent from which it so widely differs. Is it not preferable to define heredity as all that an individual receives from its parents (*i.e.*, all it has to start with—the organization of the fertilized egg)? The *expression* may or may not resemble the parent; there may even be no *tendency* at all to resemble the parent, but quite the contrary.

Chapter XIII, on the plant kingdom, is followed by the last four chapters on the thallophyta, the bryophyta, the pteridophyta and the spermatophyta, respectively. The term Pteridophytes is used in its older signification as including horsetails and club mosses as well as true ferns, but this, probably, will not disturb the majority of botanists.

The illustrations illustrate (which is not the case in some texts), the typography and general make-up of the book are attractive, and the book should appeal to beginning students. Teachers are sure to welcome it as a valuable addition to botanical texts and a real contribution to botanical pedagogy.

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## LABORATORY APPARATUS AND METHODS

### A NEW PHOTOELECTRIC CELL

In continuation of a previous investigation described at the meeting of the American Physical Society in Chicago in November, 1922, an abstract of which appeared in the *Physical Review*, 21, p. 210, 1923, the influence of very thin films of alkali metals has been studied. It has been found possible to control the flow of photoelectrons and of thermions by actuating invisibly thin films of alkali metals by light.

Remarkable photoelectric phenomena have been observed with a two-electrode photoelectric cell consisting of a glass tube supplied with a bulb at each end. Each bulb has inside a hemispherical deposit of metallic potassium and a platinum electrode connected with the sensitive layer. Care was taken that the connecting tube itself separating the bulbs had no visible deposit on its wall. When the bulb with its electrode connected to the negative side of a battery is illuminated, it shows the usual photoelectric effect; if, however, the transparent connecting tube is also illuminated, the deflection of the galvanometer inserted in the circuit increases considerably. The illumination of the positively charged anode has no perceptible influence in either of the mentioned cases. If the positively charged potassium layer had the property of reflecting the electrons as observed by Langmuir (Science, November 16, 1923) for caesium on nickel electrodes, a decrease of the photoelectric current should be expected when the anode is illuminated. No such action of the positively charged potassium layer was observed.

The relation between the photoelectric current passing the transparent connecting tube and the potential applied was observed for the case, when only the cathode was illuminated and also when both the cathode as well as the connecting tube were illuminated. Table 1 gives values observed with a cell, the controlling tube of which was about 8 cm long and 2 cm in diameter.

TABLE 1

| V | $I_d$ | $I_1$ | $\Delta I$ | $I_1/I_d$ |
|---|---|---|---|---|
| 20 | 1.75 | 44.75 | 43. | 25.6 |
| 30 | 3.25 | 55.5 | 52.25 | 17.1 |
| 40 | 6.50 | 71.25 | 64.75 | 11. |
| 50 | 16.50 | 94. | 77.50 | 5.7 |
| 60 | 31.25 | 121. | 89.75 | 3.84 |
| 80 | 82.50 | 180. | 97.50 | 2.18 |
| 120 | 212. | 330. | 118. | 1.55 |
| 160 | 420. | 474. | 54. | 1.13 |
| 200 | 514. | 532. | 18. | 1.04 |
| 240 | 555. | 568. | 13. | 1.02 |
| 280 | 570. | 585. | 15. | 1.02 |
| 320 | 580. | 593. | 13. | 1.02 |

The first column indicates the potential difference in volts, under the action of which photoelectrons are driven from the cathode bulb, through the transparent glass tube to the anode bulb. The second column gives in arbitrary units the current $I_d$ flowing through the tube, when only the cathode bulb alone is illuminated. The third column gives the current I through the tube, when in addition to the cathode bulb the adjacent tube is also subjected to light, causing an increased current $I_1$. The increase $\Delta I = I_1 - I_d$ due to illumination of the tube is shown in the fourth column. The fifth column gives the ratio $I_1/I_d$ showing a rapid decrease with increased voltage. So, for instance, for 20 volts the current increases about 25 times when the tube is illuminated, but for 120 volts the increase is only 50 per cent. and for 200 volts only 4 per cent.

The values of $I_d$ and $I_1$ plotted show two saturation curves one above the other, the one with higher values of the current corresponding to the case when the connecting tube is illuminated. The increase of current due to the latter reaches a maximum for a voltage of 100 volts corresponding to the middle part of the saturation curve. The transparent tube is much more sensitive to variations of illumination than the sensitive layer in the cathode bulb. A shadow 1 millimeter wide cast from a wire across the cathode bulb does not affect the electron current, but the same shadow cast across the transparent tube causes a perceptible decrease of the galvanometer deflection. If the connecting tube is illuminated while the cathode bulb is in darkness, the current is nearly zero. It follows that the inner glass surface contributes very little to the total current. Its action consists in facilitating the passage of electrons from the cathode bulb into the anode bulb. The increase of current due to illumination increases with the length of the transparent tube subjected to light, showing a linear relation between the values of the illuminated area and the increase of current produced by the action of light.

The effect is selective, the increase depending on the wave length as well as on the intensity of the radiating source used for the illumination of the transparent glass tube.

The behavior of the transparent tube remains similar if as a source of electrons produced at the cathode thermions are used instead of photoelectrons. Table 2 gives values for a cell the cathode of which consists of an oxide coated filament 15 mm long heated with a current of 2 amperes.

TABLE 2

| V | $I_d$ | $I_1$ | $\Delta I$ | $I_1/I_d$ |
|---|---|---|---|---|
| 370 | .6 | 27. | 26.4 | 45. |
| 410 | 9.4 | 75.5 | 66. | 7.55 |
| 450 | 55.5 | 133. | 78.5 | 2.95 |
| 490 | 166. | 266. | 100. | 1.6 |
| 535 | 475. | 655. | 180. | 1.38 |
| 575 | 1182. | 1515. | 333. | 1.28 |
| 615 | 4860. | 5340. | 480. | 1.1 |

The tube connecting the two bulbs was treated with potassium vapor and then by heating the deposit was removed so that no visible trace of a film was left on the glass. Applying low differences of potential, very few thermions can pass the tube from the heated cathode bulb to the anode bulb. However, when the tube is illuminated the number of electrons reaching the anode increases considerably.

Whether the source of electrons passing the transparent tube is a photoelectric layer activated by light, or a filament activated by heat, in both cases the inner surface of the tube acts like a transparent grid controlling the flow of electrons by means of a radiating source. Several devices based on this principle have been investigated.

The investigation is continued and the influence of different photoelectric substances, of wave length, of the emission of electrons at the cathode, intensity of the controlling radiating source, and the optical properties of the transparent grid is studied.

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## SPECIAL ARTICLES

### THE BENEFICIAL EFFECT TO PLANT GROWTH OF THE TEMPORARY DEPLETION OF SOME OF THE ESSENTIAL ELEMENTS IN THE SOIL

THE fertility of a soil is reflected in a large measure by the amounts of essential salt elements present