To compare the above results with those obtained under the conditions specified by Kegeles and Gutter, photographs were also taken with the mercury vapor lamp, Type 103-F plates, and the No. 25 filter. The No. 25 filter was, for the present purpose, equivalent to the No. 105 filter used by Kegeles and Gutter. The results obtained in these tests (Fig. 2 *b*) are quite comparable to those of Fig. 2 *a* except that the exposure required with the mercury vapor lamp was about 60 times as long. For photographing test samples which are more pigmented or more opalescent than those used here, the length of exposure needed with the mercury vapor lamp may become prohibitive.

In further tests, in which direct comparisons of the I-N and 103-F plates were made, it was found that the two types of plates were practically interchangeable, either with the ribbon filament lamp or with the mercury vapor lamp. The I-N plates possessed three significant advantages, however, in that they showed clearer backgrounds, sharper images, and less halation when overexposed.

Finally, to compare the results obtained with infrared light with those obtained with green light, photographs were taken with the mercury vapor lamp, Type IV-G plates, and a No. 77 filter. It is clearly apparent from Fig. 2 *c* that with the green light a high contrast across the boundaries and an incomplete recording of the images resulted.

References

1. Treffers, H. P., and Moore, D. H. *Science,* **93**, 240 (1941).
2. Abramson, H. A., Moyer, L. S., and Gorin, M. H. *Electrophoresis of Proteins.* New York: Reinhold (1942).
3. Longsworth, L. G. *Ind. Eng. Chem.,* Anal. Ed., **18**, 219 (1946).
4. Kegeles, G., and Gutter, F. J. *J. Am. Chem. Soc.,* **73**, 3539 (1951).
5. Miller, G. L., *et al. Cancer Research,* **10**, 148 (1950).

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On the Evaluation of the Constants V_m and K_M in Enzyme Reactions

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Hofstee (*1*), discussing the evaluation of the constants, V_m and K_M, of the Michaelis-Menten equation, points out some disadvantages of the form of this equation proposed by Lineweaver and Burk (*2*). Hofstee's preferred equation (III) is identical, except for transposition of terms, with the form suggested by me in 1942 (*3*), namely:

$$v = V_m - K_M(v/s).$$

(I use Hofstee's symbols.) This form has the additional advantage in being that usually adopted for the regression equation. Statistical methods can then be readily applied to the evaluation of these constants, a matter of considerable difficulty with the equation of Lineweaver and Burk.

This formulation can also be used in the analysis of inhibition, the effects of which may be summarized as follows, using the classification of Ebersole, Guttentag, and Wilson (*4*), and putting $q = \left(1 + \frac{(I)}{Ki}\right)$

Type of inhibition	Slope	Intercept
II (competitive)	$q.K_M$	V_m
III (noncompetitive)	K_M	V_m/q
IV (uncompetitive)	K_M/q	V_m/q

Here the slope alone is sufficient to characterize the inhibition insofar as it is increased, unchanged, or decreased. This is not the case with plots of the type of Lineweaver and Burk, where the slope is unchanged in both Type III and Type IV. The error of the intercept is the error of the slope magnified by extrapolation and is therefore always greater. It is thus obviously advantageous to base conclusions on the slope, rather than on the intercept.

References

1. Hofstee, H. J. *Science,* **116**, 329 (1952).
2. Lineweaver, H., and Burk, D. *J. Am. Chem. Soc.,* **56**, 658 (1934).
3. Eadie, G. S. *J. Biol. Chem.,* **146**, 85 (1942).
4. Ebersole, E. R., Guttentag, C., and Wilson, P. W. *Arch. Biochem.,* **3**, 399 (1943–44).

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Root Illumination and Flowering

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The reception of the photoperiodic stimulus which induces or promotes the flowering of plants appears to be localized chiefly in leaves, although there is some evidence that both aerial stems and rhizomes may participate in this reception (*1, 2*). Similarly, the reception of photoperiods which inhibit or retard flowering appears to occur principally in leaves. The absence of information concerning possible involvement of roots in such phenomena led the authors to perform an experiment on the effects of root illumination upon floral initiation and inflorescence growth.

Plants of *Amaranthus caudatus* L., a short-day species (*3*), were grown in greenhouse soil to the age of 6 weeks under long photoperiods to maintain them in vegetative condition and, after thorough root washing, were transplanted to especially constructed, trough-shaped boxes (Fig. 1) in such fashion that the root systems of the plants developed in a plane between the glass wall of the box and a sheet of finely woven glass fabric. Each trough was filled with a mixture of Vermiculite (two thirds) and peat moss (one third), and the mixture was watered daily throughout the experimental period with a complete three-salt nutrient solution with added micronutrients. The boxes were constructed in such fashion that opaque slides could be inserted against the glass sides; through manipulation of the slides it was possible to

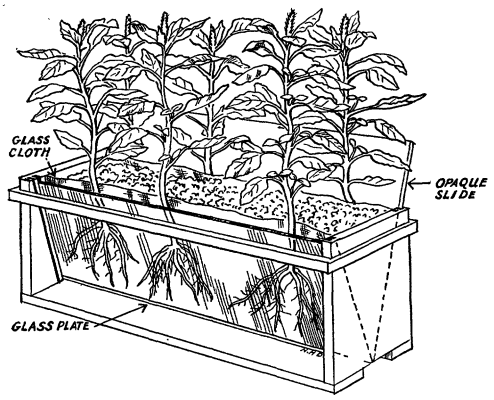

FIG. 1. Growth box for exposure of root systems to photoperiods.

expose root systems to differing photoperiods. Light-proof hoods, constructed to rest on the tops of the boxes, were used to control the photoperiods received by the tops. After transplanting, the plants in the culture boxes were exposed to long photoperiods for 6 days, a period sufficient to permit recovery from the transplanting procedure. The troughs were then divided into three experimental sets:

Set I—Tops exposed to daylight from 8: 30 A. M. until 4: 45 P. M.
—Roots exposed to daylight from 8: 30 A. M. until 4: 45 P. M.

Set II—Tops exposed to daylight from 8: 30 A. M. until 4: 45 P. M.
—Roots exposed to daylight from sunrise until sunset (from 13 to 14½ hours of daylight during the experiments), plus artificial light from 2 horizontal 47-in. fluorescent tubes (40 w) at a distance of 2 ft, from sunset until 11 P. M.

Set III—Tops exposed to daylight from 8: 30 A. M. until 4: 45 P. M.
—Roots received no light (i.e., opaque slides over glass sides not removed).

Observations were made during a period of 16 days upon inflorescence initiation and rate of inflorescence growth. The results with relation to inflorescence initiation are presented in Table 1.

TABLE 1

Days of exposure	Nos. of plants with inflorescences (inf) and without inflorescences (veg)		
	Set I	Set II	Set III
6	3 Inf, 9 Veg	1 Inf, 11 Veg	6 Inf, 6 Veg
8	9 " 3 "	5 " 7 "	12 " 0 "
10	12 " 0 "	9 " 3 "	12 " 0 "
12	12 " 0 "	12 " 0 "	12 " 0 "

Measurements made on the rate of inflorescence growth in the three sets are presented in Table 2.

The results of this experiment and of similar experiments indicate that exposure of roots to photoperiods retards both the initiation and growth rates of inflorescences of *A. caudatus* L., as compared with the initiation and growth rate of inflorescences of plants the roots of which receive no light. Since there were no apparent differences in the degree of development of roots and stems in the three sets of plants, it may be concluded that this effect of light is a direct effect upon the initiation of inflorescences and not an indirect effect in retarding growth of the plants. Both short and long illumination of roots results in delayed initiation of inflorescences and in their subsequent growth; the longer exposure of roots to light resulted in greater retardation of inflorescence formation and inflorescence growth, as compared with the effects of the shorter exposure of roots to light.

TABLE 2

Days of exposure	Av lengths of inflorescences (mm)		
	Set I	Set II	Set III
8	8.1	7.2	9.5
10	11.1	9.3	15.8
12	16.2	11.5	24.5
14	26.0	20.6	35.0
16	39.6	30.9	58.1

References

1. DOSTAL, R. *Věstník Králov. České Společnosti Nauk, Třída Mat.-přírod.*, **31**, 1 (1944); (*Biol. Abstr.* 12581 [1949]).
2. HARDER, R., and WESTPHAL, M. *Jahrb. wiss. Botan.* **91**, (1944); (cited by A. C. Leopold, *Quart. Rev. Biol.*, **26**, 247 [1951]).
3. FULLER, H. J. *Am. J. Botany*, **36**, 175 (1949).

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The Radioactivity of the Hot Springs at Tiberias[1]

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In a previous communication the results of an investigation based on the counting of alpha tracks and stars in nuclear emulsions exposed to water from the spa at Tiberias were reported (*1*). The investigation has been extended by making use of an alpha methane –flow proportional counter. This has facilitated the identification of the isotope responsible for the major portion of the activity, as well as a measurement of its concentration. Several methods of preparing samples were tried; the following procedure has been found most satisfactory. A glass bottle is washed thoroughly with spring water, filled completely and sealed with a ground-glass stopper while beneath the surface of the spring. Five ml water from the bottle is evaporated on a sample pan. No more than 20 min should elapse between opening the bottle and inserting the dry sample pan into the counter.

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