determines the period and wave form of the oscillations.

This investigation is being continued.

CARL H. ECKART,
K. T. COMPTON

PRINCETON UNIVERSITY

ON WALDEN-INVERSION

IN connection with the problem of Walden-Inversion, it is important to know whether the change in the polarity of a group attached to the asymmetric carbon atom is accompanied with a change of direction of optical rotation when the change of polarity is accomplished without resorting to substitution. It is realized that the result may depend on the polarity of the other elements attached to the asymmetric carbon atom. A systematic study in this direction is possible on substances of two groups; first on derivatives of secondary carbinols of the type R_1CHOHR_2 and second, on the derivatives of the primary alcohols of the type $\begin{matrix} R_1 \\ R_2 \end{matrix}\!\!\diagdown\!\!\diagup\!\!\begin{matrix} H \\ \end{matrix}\!\!C\text{—}CH_2OH$. In both groups of substances the radicles R_1 and R_2 may be varied infinitely and in both of them, the polarity of one group may be changed without substitution. Both these groups of substances are now under investigation in our laboratory. Results have already been obtained on a derivative of the first group of substances.

Laevo-methylhexylcarbinol was converted by substitution into dextro bromide; this, in its turn, again by substitution into laevo-mercaptan and the latter by oxidation (without substitution) into dextro-sulfonic acid.

$$\underset{\text{laevo}}{C_6H_{13}CHOHCH_3} \rightarrow \underset{\text{dextro}}{C_6H_{13}CHBrCH_3}$$
$$\rightarrow \underset{\text{laevo}}{C_6H_{13}CHSHCH_3} \rightarrow \underset{\text{dextro}}{C_6H_{13}CHSO_3HCH_3}.$$

Thus, in this group of substances, the change in polarity, brought about with or without substitution on the asymmetric carbon atom, leads to a change in the direction of rotation.

P. A. LEVENE,
L. A. MIKESKA

THE RELATION OF CLIMATIC CONDITIONS TO THE SALT-PROPORTION REQUIREMENTS OF PLANTS IN SOLUTION CULTURES

ALTHOUGH it has been known for more than sixty years that many forms of higher green plants may be grown to maturity with their roots in an aqueous solution of a few inorganic salts, it is only in the last decade that attention has been seriously directed to the study of the relations that prevail between the nature of the solution thus used (kinds of salts, salt proportions and total salt concentration) and the amount and kind of growth exhibited by the plants. Since the publication of the earlier work in this field by Schreiner and Skinner, Tottingham, and Shive, many experimental studies have been made, by different investigators, with the aim of throwing light on this complex relation. Great difficulty has thus far been encountered, however, in obtaining satisfactory agreement or consistency, even by the same experimenter, between the results of two or more experiments planned and executed so as to be as nearly alike as possible with respect to the plants and solutions used. Similar difficulty is frequently encountered in many other lines of biological experimentation, whether with plants or animals.

In experimentation dealing with the influence of external conditions on the growth of any kind of plant, it is of course essential that all the individual plants of the same experiment should be as nearly alike as possible (in variety, race and physiological condition) at the outset of the experiment, and also that this same degree of similarity should obtain among all the plants of several experiments that are planned to give comparable results. But we can not be at all sure that variability among the plants with which the experiments are set up is satisfactorily cared for by employing seeds of a pure line, selecting them for uniformity of weight, germinating all seeds in the same way, and selecting the seedlings for likeness in size, robustness, and so forth. Even after taking all feasible precautions in this respect, internal variability is generally found to be far from negligible. The difficulty can of course be largely overcome by employing a great number of duplicates in every test. The number of duplicates needed naturally depends on the degree of precision required in the results and on the degree of internal variability that persists in the plants after care has been exercised in selection, and other experimental details. By using a sufficient number of duplicates, all cultures in a comparable series, whether in the same or in several experiments, may be made to represent the same quality and range of internal variability in the plants. It may be added that the plants at the beginning of an experiment should be adequately described. This is necessary in order that it may be known for just what sets of original internal conditions the experimental results may be considered as applicable, in order that the experiment may be repeated later, and in order that subsequent experimentation in general may be carried out so as to be comparable with earlier tests. Statistical methods are requisite for finding and stating what kinds and ranges of variability persist in the original plants. Also, statistical treatment of the experimental results