

Electric Control of Polar Growth in Roots of *Allium cepa*.

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Numerous experiments have been performed to determine the effects of continuous electric currents passed through growing roots immersed in various aqueous media. In practically all, the electric field was oriented at right angles to the long axis of the root. Under such conditions a minimum of two diverse

stimuli, *viz.*, gravity and applied E.M.F., operate at right angles to one another, thus causing a complicated type of variable growth response.^{1,2}

¹ Elfving, F., *Bot. Z.*, 1882, **40**, 258.

² Navez, A. E., *J. Gen. Physiol.*, 1927, **10**, 551.

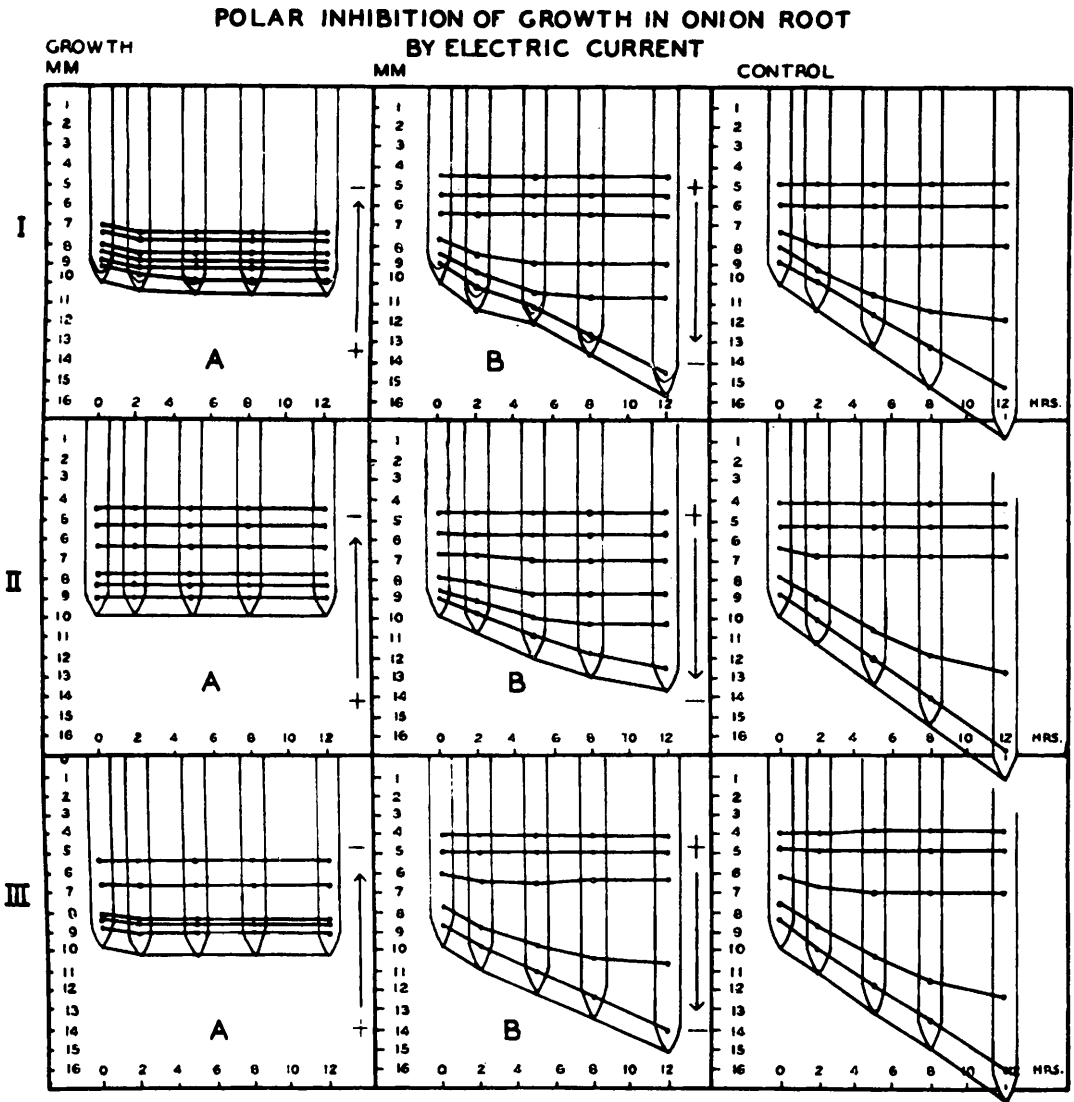


FIG. 1.

To provide simpler experimental conditions, an electric current having parallel isopotential lines and appropriate current density must be passed up or down the polar axis of the root and must coincide with the orientation of the general axis of the inherent electric field of the root as well as that of gravity.

An apparatus was designed to comply with this requirement and to maintain the roots under normal conditions of growth except for the applied current. Three sets of roots were used in each experiment: (1) control roots, (2) roots through which an electric current was passed upward, and (3) roots in which the same current was passed downward. Since individual roots vary slightly with respect to the threshold of current density for reversible inhibition of growth and also in their rates of elongation, each experiment involved 3 or more duplicate sets of roots. Preliminary experiments led to a choice of a current giving an IR drop of 40 mV/mm, with the root immersed in tap water as the growing medium and the current passed upward through 25 mm of the apical end of the growing root. This gives complete inhibition of growth. The same current passed downward gives a very slight inhibition of growth, Fig. 1, or none at all. At 37.8 mV/mm, complete but reversible growth inhibition is obtained

with ascending currents.

Most experiments were divided into 3 periods: normal growth rate, current passing, and current off. The growth of each root was recorded under the microscope throughout the experiment.

Regions of the Growing Root Affected by the Electric Current. To determine what region of the growing root apex is involved in the growth response and inhibited by the current, a set of roots was marked in the usual way by means of particles of India ink. The results of one experiment are drawn to scale in Fig. 1. Ordinates are mm length, abscissa hours. I, II, and III are triplicate sets. A current of 40 mV/mm was passed up roots A, down roots B, and the right-hand group were controls. It is evident from the measurements that the growth process under these conditions was prevented by an ascending current in both the region of active cell division and the region of cell elongation.

The inherent E.M.F.'s generated by the root are so oriented that the ascending current, which causes inhibition, opposes them. An applied current (field) of like intensity, but oriented with, rather than against the inherent one, has little or no effect. A detailed report of all experiments will be presented elsewhere.

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Effect of Induced Pain on Pain Threshold.*

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Relief of pain by counterirritation is common experience and frequently was utilized therapeutically by the older physicians. The number of experimental studies reported in the literature is too small to permit conclusions to be drawn regarding mechanisms involved in the phenomenon which thus remains but poorly understood. Therefore re-investigations on a larger group of subjects appeared desirable.

Methods. Pain threshold determinations

were performed in a group of 14 normal human subjects, men and women, ranging in age between 19 and 45 years. The algometric method employed has been described in detail elsewhere.¹ It consisted of applying an

* This work was aided in part by a grant from Whitehall Pharmaceutical Company.

¹ Goetzl, F. R., Burrill, D. Y., and Ivy, A. C., *Quart. Bull. Northwestern Univ. Med. School*, 1943, **17**, 280.