LETTERS TO THE EDITOR.

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The "Stomatograph."

THE recent controversy regarding the causes which had depreciated the yield of Egypt's cotton crop, terminating in the Egyptian Government's Cotton Commission of 1910, showed very clearly how little accurate knowledge of the physiology of the cotton plant was available, more especially in regard to field conditions. This ignorance was most striking in respect to the water relationships, which—Egypt being dependent on the Nile for its water—are very largely within human control.

One point of interest in this respect is the action of the stomata, especially since I showed that growth is completely arrested by direct sun, from the first emergence of the seedling until late in the summer, the heavy water loss involved by the high sun temperature (160° C. in May to August) and the low day humidity being the limiting factor.

Investigation of plant physiology in the field, however, usually requires special and automatic apparatus, and no suitable appliances were available for investigation of the stomata. After several trials I succeeded in constructing a self-recording form of Mr. Francis Darwin's "porometer," which will work without appreciable errors under any variation of wind, sun, temperature, or barometric pressure, in rain or in dust-storms.

Briefly described, the apparatus consists of an electrical air-pump expelling 3 c.c. of air at each stroke under a constant pressure of 1 millimetre of mercury. The out-flow tube is closed by a definite area of leaf, so that the air in escaping has to pass through the leaf tissues. The resistance to this escape depends almost entirely on the aperture of the stomata, of which there are some seventy on the upper leaf surface and two hundred on the lower in adult leaves of Egyptian cotton. The rate of escape is a direct measure of the porosity of the leaf, as in the "porometer." A relay circuit is operated when one stroke of the pump has been completed, and this telegraphs the signal to an electromagnet carrying a pen on its armature; this pen writes on a spiral drum which revolves once every hour.

The complete appliance is very convenient in use, being composed of a box like a microscope case, which is placed on the ground under the plant to be examined; from this box issues the air-tube leading to the leaf and the telegraph wire to the recorder. The number of adjustments which have to be made in the field is thus reduced to a minimum, which is no unimportant consideration under the field conditions obtaining during an Egyptian summer.

The trace of five consecutive days recorded from the same leaf without adjustment shows the stomata slowly closing as the hottest part of the day approaches, then closing when the sun goes behind the trees at 1.40 p.m., and remaining closed all night, opening slowly after sunrise, more rapidly when the direct sun strikes the leaf about 7 a.m., attaining a maximum at 9 a.m., and thenceforward closing steadily, in spite of the brilliant illumination, since the soil around the roots is being dried up by the heavy transpiration.

A side-issue from such records as this, which promises to give further unexpected results, deals with the effect of such stomatal closure on assimilation of CO_2 . I have already mentioned that the stem of an Egyptian cotton plant does not grow in sunshine, and it appears that the growth of the root is also checked; it now seems not unlikely that photosynthesis may also be arrested or reduced after a certain hour of the day through stomatal closure, this closure being dependent on the development of the root system and on the water content of the soil.

The beneficial effects of Egyptian sunshine seem to be rather indirect.

W. LAWRENCE BALLS.

Ghezireh House, Cairo, July 10.

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Photograph of Multiple Lightning Flash.

I BEG to enclose a copy of a remarkable flash of lightning which I took some years ago in Uruguay, South America, and which, so far as I know, has never been published—with my knowledge or permission, at any rate.

This copy is an enlargement from a small negative about $1\frac{1}{2}$ inches square, and shows the curious curl-like form in some of the streaks. One noteworthy point about this photograph is that I "snapshotted" it. I had wasted many plates in the usual way, and obtained nothing of any value, but noticed that before every big flash there was a slight flicker in the clouds where the flash came from; I waited for this, let the shutter go just as I saw the flicker, and obtained the enclosed result.

Uruguay is noted for its severe thunderstorms, and animals, fences, trees, and houses are constantly struck. Some years before this photo was taken a powder-house was blown up by lightning not far from where this flash occurred, and in the sand a few miles off

I found a fulgurite—a glass tube about $2\frac{1}{2}$ inches in diameter made by the lightning striking and fusing the sand. These fulgurites are mentioned by Darwin in "The Cruise of the Beagle"; he found some near Monte Video, also in Uruguay.

A. E. WALBY.

67 Lansdowne Street, Hove, Brighton, July 27.

The Rearing of Sea Urchins.

I HAVE read with much interest in NATURE of July 27 a short letter from Prof. Stanley Gardiner in which he communicates the fact that a hybrid of the species *Echinus esculentus* and *E. miliaris* was successfully reared from the egg through all the larval period until after the completion of metamorphosis in the zoological laboratory at Cambridge. It may interest your readers to learn that by means of salt-water aquaria established last year in the zoological laboratory of the Imperial College of Science in