experiments have been successfully repeated in a European laboratory, the following results which I obtained, will, no doubt, prove of interest.

(1) *The infinitesimal contraction recorder:* This apparatus, a marvel of ingenuity, records the cellular contraction in the interior of the plant under external stimulation. The principle of the instrument is extremely simple; the extreme delicacy of the apparatus bears testimony to the extraordinary skill of the Indian mechanicians trained at the Bose Institute. The stem or other organs of the plants are placed between a fixed and movable primary lever. The diametric contraction of the plant under stimulation is indicated by the movement of this primary lever, which is further magnified by optical means, the total magnification produced being a million times. The indication of the instrument is not affected by mechanical disturbances.

(2) *Sensitiveness of ordinary plants:* An extremely feeble electric shock was sent through me and the plant, both being places in the same electric circuit. It was a startling revelation that the plant should visibly respond by a contraction to a shock which was below the threshold of my perception. With stronger shock the cellular contraction was more intense; under excessively strong shocks the contractile spasm became very violent; after a short time the tissue ceased to respond, being effectively killed by the electric discharge. It is quite easy to show that the cortical cells in every section of the stem and of the leaf-joint are fully sensitive, proving a continuity of contractile cortex throughout the length of the plant. A wave of peristaltic contraction may thus sweep onward from the point of stimulation.

(3) *The movement of sap:* The following striking experiment affords conclusive proof that the movement of sap is essentially not a physical but a physiological process. A cut piece of stem of Antirrhinum with a pair of opposite leaves is suitably held at the cut end by a piece of sponge. Under excessive drought the leaves fall down, become crumpled up and appear to be wilted. A few drops of cardiac stimulant—dilute solution of camphor—applied on the sponge bring about a most striking transformation. The drooping leaves are quickly revived; they rear themselves up with great rapidity, and become fully erect in the course of two to three minutes.

(4) *Active cellular pulsation in propulsion of sap:* The pumping of sap by the propulsive layer is clearly demonstrated by the optical sphygmograph. The flow of sap along the stem is observed to consist of a series of pulsations. The pulsatory activity is greatly increased by drugs which enhance cardiac activity in the animal; it is enfeebled or arrested by depressing agents. Extracts from certain Indian plants are seen to have a potent influence in the propulsive activity of the plant and cardiac activity of the animal. This aspect of the investigation has roused considerable interest in the Medical Faculty of Vienna.

(5) *Movement of sap in sealed stems:* It has been thought that the movement of sap is essentially due to push from below by root-pressure and suction from above by transpiring leaves. The fact that there is an inherent activity in the stem itself, independent of those in terminal organs, is clearly demonstrated by experiments on an isolated stem covered with impermeable varnish. The sap can now be made to flow either upwards or downwards, according to differential stimulation. The law of directive movement of sap is that it moves from the stimulated to unstimulated or depressed regions. The cellular mechanism is highly sensitive, being automatically adjusted for subserving the well-being of the plant. A local depression or stimulation starts the alert machinery into action, making the sap rush towards the depressed or away from the overstimulated region. It is in this way that chemical substances stored in one region are conveyed to distant parts. By this hydraulic mechanism the plant as a whole becomes an organized unity.

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STOMATA WHICH SHOW FUNCTIONAL MOVEMENT FOR A CENTURY

The establishment of the fact that medullary cells of the tree cactus of Arizona live for more than a century and have a capacity for enlargement during the greater part of this period at the Desert Laboratory early in 1926 has been followed by the discovery of long-lived cells in the cortex of both Carnegiea and Ferocactus, in the medullary rays of the California redwood (Sequoia) and of both medullary and wood-cells in Parkinsonia. The living elements in question are in such relations to other tissues as to be well protected from sudden or intense action of environmental agencies and do not appear to be the seat of rapid metabolic activity.

While collaborating in the preparation of one of the brief papers concerning this subject it appeared that the stomatal cells of the tree cactus (Carnegiea) also sustained a long period of functional activity, as mentioned by MacDougal and Brown.[1] This matter was held for continued observation. On a trunk of this massive cactus 10 meters in height the green epidermis persists to within a meter of its base, where it is displaced by bark or corky tissue. This is taken to mean that all the epidermis except

[1] D. T. MacDougal and J. G. Brown, "Living Cells Two and a Half Centuries Old, Science, lxvii, 447–448, 1928.

that formed during the first ten to twenty years of the life of the plant is alive.

The developmental period of stomata in *Carnegiea gigantea* is very short. Material two centimeters from the growing-point contains only well-developed stomata. The developmental stages of the guard cells are found within a few millimeters of the growing-point at the apex of the stem or branches. They reach full size within less than a month, and since plants of this species often live more than a century the life of the plant is more than twelve hundred times the duration of the stomatal growing-period.

A study of the movements of the guard-cells of a seedling seven months old showed them to be wide open at 5:30 A. M., soon after daybreak, gradually closing throughout the morning to a slit at noon. This slight opening remained until after the middle of the afternoon, and by nine o'clock at night they were completely closed. Epidermis from the base of a giant which contained representative guard-cells of great age showed the stomata open at daylight, closed to half the size by eight-thirty in the morning, either closed or with a slit opening at noon, and then completely closed until after ten at night, when they began to open again. This is a program largely in reverse of that shown by leaves of most plants, especially those living in moist regions in the tropics.

The guard-cells of the stomata are larger than the adjacent epidermal cells and open into a wax-lined sub-stomatal chamber which extends entirely through the hypodermal tissue, which may have as many as ten layers of cells in older parts of the stem. The changes coming with age which may affect the guard cells are easily observable. These elements are in direct contact with the turgid cells of the hypodermal layer for the first few years of their existence, and exchanges of water and other material may take place readily. The earlier contact with a thin-walled tissue containing chlorophyll facilitates the reception of material by the active guard-cells. Later the walls of the hypodermal cells thicken and the readiest communication is through the pits to the cortex. The best communication is perhaps with the neighboring epidermal cells. The external walls of the guard-cells also become heavily cutinized with age.

However, in spite of all these changes in the adjacent cells, these guard-cells retain the power of motion for perhaps a century. Then comes a time when some other changes take place which stop the functioning. The waxy cuticle disintegrates and masses of waxlike material clog the stoma and spread in uneven golden brown masses over the epidermis. This is the transition stage and occupies the region of green tissue nearest the base adjacent to the brown corky layers. The stomata disintegrate with the transformation of the outer layers into cortical tissues.

The developmental or growth period of the stomatal cells is not longer than a month; life and activity, including movements of the guard-cells, may continue for a century or more, or twelve hundred times as long as the formative period. The transformations of energy upon which daily action is based and the widely ranging conditions of temperature to which all epidermal elements are subject make the stomatal cells of Carnegiea one of the most remarkable cases of endurance of protoplasts yet recorded. The other epidermal cells which endure for a similar period are hardly less notable.

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PRESS SERVICE

WITHIN the past few years interest in science in the United States has so increased that several of the press associations and even a number of the larger newspapers have appointed science editors whose special duty it is to seek out and to present in popular phraseology information of current interest on scientific subjects.

In appointing science editors the general policy has been to select writers of unusual ability and of proved accuracy rather than to designate as science editors writers with previous scientific training.

This is a wise policy, for a writer must always maintain the closest possible contact with the public whom he serves, and must be able at all times to appraise the ever changing public interest in the varied lines of scientific work unbiased by personal preferences arising from that specialization which is inseparable from scientific training.

While this policy insures the necessary, and indeed essential, closeness of contact between the general public and the science editors, the contacts between the science editors and the great body of scientific workers who represent the source of their material are less intimate than is desirable.

In addition to the science editors there is an increasing number of feature writers who to a greater or lesser degree specialize in science and would do so to a much greater extent if it were possible for them to secure the necessary material.

Recognizing the desirability of bringing about a closer accord between research workers and the representatives of the press, the association at the New York meeting established the American Association Press Service.

The function of the press service is threefold. In the first place, material sent in at any time during the year will be made available to writers with the under-