Growth in length and thickness of the petiole of Richardia. By Katherine E. Golden.

The subjects of growth and tension have such a close inter-relation that it is difficult to separate them in order to determine how much of the expansion taking place in a plant organ is due to growth and how much to tension. It is well to understand first what is meant by growth and what by tension.

Growth is a permanent change that takes place in an organ, usually accompanied by a change in bulk, and is dependent on constructive and destructive metabolism, an adequate supply of moisture, and a temperature between certain definite degrees. Tension, on the other hand, is a state of turgidity of the cells, *i. e.*, the cells are capable of absorbing water in such quantities that it causes considerable stretching of the cell walls; this will cause a pressure from within on the cell-wall, and where a cell forms part of a tissue, there will also be a pressure from without from the surrounding cells, thus setting up tensions in the various tissues. These tensions will, of course, cause the dimensions of an organ to change.

From work done by Kraus* it has been determined that organs diminish in bulk (estimated on diameters) from morning until afternoon, and increase until towards dawn. This depends upon the quantity of water which the organ contains, and again on gain by absorption and loss by transpiration.

To determine the laws governing some of these changes I made a set of experiments upon the petiole of Richardia. The petiole is made up of thin-walled parenchyma, having large, regular, inter-cellular canals and small, fibro-vascular bundles scattered through it, and enclosed by somewhat smaller parenchyma cells containing chlorophyll, alternating with groups of collenchyma cells, the whole being surrounded by the epidermis which has very thick outer walls. It can be seen from its structure that it would necessarily contain much water and air, and respond very readily to tensions.

To show how much water the plant may contain a set of experiments made by Unger† who replaced the root pressure by a column of mercury in one case gave 26.5 grms. of water from 6 leaves in 11 days, and in another 36 grms. from 4 leaves in 10 days.

In my work I used self-recording auxanometers to make measurements,

*Kraus. Quoted in Vines Physiology of Plants, p. 405.
†Unger. Quoted in Physiology of Plants, Vines, p. 92.

the petiole being measured in diameter and length at the same time, so that there would be exactly the same conditions affecting the growth of the two dimensions. The plant was placed at a north window, and, while not receiving direct sunlight, had abundant light; the pot containing it was set in a saucer kept filled with water, thus providing a constant supply of moisture. The purpose was to keep the plant, as nearly as possible, under normal conditions while being measured.

The measurements of length show that a constant growth takes place, there being two periods in most cases during the 24 hours in which the growth was much greater than at other times, the maximum period of growth occuring from 12 o'clock midnight to 8:00 A. M., the lesser great period, where occurring, being in the evening. The growth in thickness was constant from day to day, as can be seen from the curves, but there were times during the 24 hours in which a contraction took place. The measurements, in every case, show that the diameter would increase gradually until a maximum point was reached, then diminish gradually, but not the entire amount that it had increased, thus proving that the increase in diameter was due to both growth and tension combined. The amount of growth is estimated for 24 hours by subtracting the sum of the increments of contraction from the total increase, thus leaving the sum of the increments of increase of the organ due to actual growth.

The measurements show that there were invariably two points of greater growth, the maximum occurring between 12 midnight and 9:00 A. M., this being the same time as the maximum period of growth in length occurs; the lesser great period occurring from 1:00 to 11:00 P. M.

These show a wider range in the occurrence of the greater and lesser points of growth than is found in woody stems, but is probably due to the nature of the structure of Richardia, which allows a ready response to variations in tension. This ready response was also shown by withholding water from the plant until the leaves become flaccid, then giving an abundant supply, when the leaves became turgid in about a half hour.

The curves show that the plant responds in expansion to an increase in temperature, though in two cases where the temperature went to 34° and 35° C. a contraction followed in one case, and a very slow growth in the other, seeming to indicate that a temperature of that extent was detrimental to the growth of the plant. This point would, of course, have to be worked out much more fully before anything positive could be deduced.

Theoretically growth in length and thickness should have their maximum at the same point, but the measurements of Richardia show that while the maximum for each dimension occurred between midnight and the middle of the morning, it did not occur at the same time, sometimes there being a difference of 4 or 5 hours between the maximum for length and that for thickness. The curve for length shows that considerable growth took place, but as this is the result of the growth for the entire petiole, which consists of the sum of the increments of growth of its zones, while the growth in thickness is but that of a single zone.

The curves are constructed having the abcissæ represent periods of one hour each, the ordinates representing growth. One division of the ordinates is used as a unit for the curve of length; 3 being used for the curve of thickness that the changes may be seen more readily as they are so minute. The measurements were taken in millimeters, and as the instrument recording growth in length multiplied 8 times, if the number of spaces traversed by the curve be divided by 8, the quotient will be the number of millimeters of actual growth. The instrument for thickness multiplied by 40, and as three spaces were used as a unit, the number of spaces traversed would have to be divided by 120 to give the growth in millimeters.

The effect of light on the germinating spores of marine algæ. By Melvin A. Brannon.

Notes on saprolegnia ferax. By Geo. L. Roberts.

As to the sporangial development in the Saprolegnieæ, two important theories have been presented—that of Strasburger and the more recent one of Rothert.

The former holds that the partition wall of the sporangium, in *Saprolegnia ferax*, forms at a thickened place in the protoplasm. This changes into a cell-plate of varying thickness. The cell-plate is formed from a strong light-refracting substance, yellowish in color, which is apparently the same substance that is distributed in small granules in the protoplasm of the thread. From this cell-plate, after a time, arises the limiting