Regions of Growth in Hypocotyls

Charles E. Brian and E. L. Stover

Eastern Illinois State Teachers College, Charleston, Illinois

This work was first begun in connection with a study by Mr. Stover of cell differentiation in hypocotyls, particularly that of the origin and development of the secondary thickenings of the walls of the xylem elements. In order to do this we first wanted to determine the region or regions of growth of which this paper is the result. Only one other study of the growth of hypocotyls could be found, and in this there were no recorded measurements of the growth regions.[1]

An extensive study has been made of the regions of growth in hypocotyls of lima bean (Phaseolus lunatus, L.), watermelon (Citrullus vulgaris, Schd.), and castor-bean (Ricinus communis, L.).

All seeds were germinated and grown between damp paper hand-towels in white porcelain pans placed in dark drawers. The seeds were disinfected by washing in a solution of 5% formaldehyde, and then rinsed in distilled water. Only distilled water was used in keeping the plants moist. The lima beans and watermelon seeds were grown at room temperature (22 C.); the castor-beans were kept in a warmer room of about 32 C. The castorbean seeds, when kept at room temperature, grew very slowly, and usually were soon destroyed by a brown endosperm rot.

The hypocotyls of the different seeds in their early growth were divided into four equal segments, the first segment being immediately below the cotyledons, and the second, third, and fourth in the order named toward the root.

The markings were made on the young hypocotyls in black carbon ink with fine glass capillary tubes which held a supply of ink. By using these tubes instead of pens, which were too large and blunt, or needles, which did not hold a supply of ink, a fine round stippling point was obtained. In the case of watermelon the segments were only one millimeter in length.

The location of the junction of hypocotyl and root in the very early stages of growth cannot always be determined with exactness. In the later growth the two can be distinguished by the smooth shiny surface of the hypocotyl and the dull white appearance of the root. When the plants were held up to a strong direct light, the hypocotyledonary plate, which is located at the junction of hypocotyl and root, showed up as a comparatively small dark region. If in the later measurements, it was found that the hypocotyl and hypocotyl markings did not coincide, that specimen was discarded.

Measurements were made every 24 hours with needle-like adjustable dividers, transferred to a millimeter scale, the length recorded, and the increase in length determined. Only the increase in length was used in making the charts and graphs.

Several sets of a large number of seeds of each type were germinated, and the hypocotyls measured for several days. The lima bean was studied through nine days, the watermelon ten days, and the castor bean only four.

[1] Halsted, Byron D., New Jersey Agricultural Experiment Station, Bulletin No. 245 (1912).

It was necessary to begin with approximately 60 seeds in each set in order to end the experiment with 15 to 25 seeds, so that an average could be taken. Some were lost because they failed to germinate, others were destroyed by various fungus growths (in spite of treatment), in others the hypocotyls and hypocotyl markings failed to coincide, and in some the root tips were broken in handling.

Lima Bean.—Twenty-five seeds were studied for nine days. The beginning segment lengths were 3.78 millimeters. The first four days the second segment increased in length the most but from the fifth day on, the first segment increased by far the greatest. The third and fourth segments increased very little, the fourth segment increasing the least. At the end of nine days, the first segment (which in the beginning was equal to the others) was 45.4% of the total length of the hypocotyl. The second was 31.5%, the third 13.5%, and the fourth only 9.6%.

Watermelon.—When the watermelon seeds were first germinating, a part of the seed coat was broken off in order to expose all the hypocotyl and to permit it to grow straighter, because the peculiar heel did not develop quite so prominently.

Fourteen seeds were studied for 10 days. The beginning segment lengths were 4.0 millimeters. The first segment grew the most throughout the 10 days, at the end of which it was 59.4% of the total length of the hypocotyl. The second was 22.5%, the third 12.9%, and the fourth 5.2%.

Castor-Bean.—Soon after the castor-beans were germinated, they were operated upon to expose the full length of the hypocotyl for measurement. A portion of the endosperm was simply cut away. A peculiar situation was met in the study of the castor-bean. At about the second day the endosperm began to split away from the cotyledons; on the third day it was far enough removed that the young plants starved. This shows clearly the necessity of close contact between cotyledons and endosperm to insure absorption of digested food from the endosperm. At the end of two days growth the first segment had increased 3.84 millimeters, the second segment 2.53 millimeters, the third segment .72 millimeters, and the fourth .30 millimeters.

SUMMARY

It was observed that the growth of the hypocotyls was decreased by daily exposure, handling, and changing of position.

It has been shown that the region of growth in the hypocotyls of these plants is not limited to any one segment, but by far the greatest growth occurs in that portion immediately below the cotyledons, the amount of elongation decreasing uniformly from the top of the hypocotyl to its base.