chromosomes is of particular interest in connection with the statement that the spiral habit is a heritable one. Chromosomes are thus carriers of a trait which they themselves possess.

Right- or left-handedness may be a more fundamental character than the spiral tendency and possibly responsible for the latter habit. Mirror writing, in which some children are adept, is an extreme form of left-handedness. Perhaps right- and left-handedness and the spiral habit are both expressions of a common, deep-seated and heritable protoplasmic quality.

There has just appeared an article by Haskins and Moore[7] in which they report the spiral twisting of two young citrus plants grown from irradiated (x-rayed) seed. Both plants showed marked twisting in a counter-clockwise direction during early life. After six months, the habit was abandoned and subsequent growth was normal. The plants gave other evidence of x-ray injury when young. Haskins and Moore conclude that the experimental conditions indicate that twisting was the result of a physiological rather than an environmental condition—possibly x-ray induced abnormal mitoses.

Crampton adds a further note to that already given[1] on the spiral coil of marine snails, which is usually dextral. It appears that where the one or the other mode of coil predominates, dextrality is a Mendelian dominant with reference to sinistrality, although the case is complicated by the fact that the mode of coil in snails is one of maternal inheritance.

Again we come to the conclusion that the spiral habit among organisms is of wide-spread occurrence and protoplasmic in origin. This statement does not preclude the possibility of the characteristic being suppressed, accentuated or otherwise modified by environmental influences.

After the manuscript to the preceding account had left my hands there appeared in SCIENCE two articles on the spiral habit, one by M. Copisarow[8] and one by E. J. Kohl.[9] The latter author takes up in detail the suggestion made above that the spiral grain in trees is due to slippage between long, wedge-shaped cambium cells, a hypothesis first brought to my attention by I. W. Bailey. I wish merely to add here that there can be no question as to the possibility from the point of view of structural mechanics, that spiral grain in trees is due to the gliding growth of cambium cells with oblique transverse walls. Certainly this type of structure must be a contributing factor to spiral growth in trees. But the explanation does not take care of the experiments of Haskins and Moore cited above nor of the spiral twist in cacti, and of course not of the many other examples of spiral development and movement in numerous and varied forms of organisms. The purpose of my first account[1] was to look further than the one instance of twisted tree trunks, and to recognize that there is throughout nature a very marked tendency toward spiral form and motion. Slippage of wedge-shaped cambium cells may be a correct explanation of twisting in trees (it may also be only the means by which a tendency toward spiral growth is able to manifest itself), but it does not take care of the several other forms of spiral structure in plants, the coiled thickenings of the walls of xylem vessels, the twist in bast and cotton fibers, etc. Each may have its own ultimate cause, but the habit is too widespread to preclude the strong possibility of a general tendency toward spiral form and movement in plants and animals. It seems, therefore, that the spiral habit, whether in trees, snails or chromosomes, is a fundamental heritable protoplasmic quality.

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7 SCIENCE, March 7, 1933.
8 SCIENCE, June 16, 1933.
9 SCIENCE, July 21, 1933.

VEGETATION AND REPRODUCTION IN THE SOY-BEAN

GENERAL observations and considerable experimental work, recently summarized by Murneek,[1] point to the conclusion that the reproductive phase constitutes the most important limiting factor in the vegetative growth of plants. Where flowers are borne laterally (indeterminant type of growth) growth of the stem presumably continues until the developing fruits begin to monopolize the food supply. The data show an antagonism to exist between the vegetative and reproductive functions in fruit trees, tomatoes, cotton and some legumes. Maturity and death of some annual plants seem to be the direct results of heavy fruiting, since many of them will grow indefinitely and live for a number of years if fruiting is prevented. That this is not true for all plants has been proven by a series of experiments in our laboratories on soy-beans extending over a period of several years.

In the soy-bean vegetative growth stops at about the same time that the fruits begin to enlarge and the plant dies when the seeds are ripe. To all appearances the curtailment of growth is just another case of correlation between the vegetative and reproductive functions. However, removal of the flowers does not affect the growth of the soy-bean as it does that of many other plants. Exflorated plants stop growing at the same time as the normal control plants and become no larger either in height, diameter of

1 A. E. Murneek, "Growth and Development as Influenced by Fruit and Seed Formation," *Plant Phys.*, 7: 79–90, 1932.

stems or size of leaves. The only visible difference is a darker green color and sometimes a slight wrinkling of the leaves. These exflorated plants remain green longer than the controls but do not grow and eventually drop their leaves and die.

Several changes accompany the development of fruits in the normal soy-bean plant. As the growth rate decreases, following the blooming stage, there is a very rapid increase in the percentage of dry weight, which means that the moisture content of the tissues diminishes. Accompanying this decrease in growth rate and loss of water is a very marked decrease in the percentages of potassium in all parts of the plant. Phosphorus also becomes less abundant in the stem tips than during the period of active growth. The percentages of nitrogen, however, show only slight decreases as the plant matures, although large amounts are used by the developing fruits.

Exflorated plants stop growing at the same time as the controls and the same changes occur in the chemical composition of the stems and leaves. This is a case of maturity which is not due to fruiting. The stems and leaves of exflorated and control plants are very similar in respect to moisture, nitrogen and mineral contents, although large quantities of nitrogen, phosphorus and potassium accumulate in the fruits. The only difference is that the exflorated plants show an abnormal storage of carbohydrates.

The soy-bean is a photoperiodic plant, and it is believed that the shortening of the day length not only initiates the reproductive phase but also curtails vegetative processes. It is significant that growth under normal seasonal conditions ceases simultaneously in exflorated and control plants and is accompanied in each case by decreases in the percentages of potassium and moisture. Also fruiting does not deplete the nitrogen or mineral reserves of the plant. Our comprehensive data show that old age and death in the soy-bean are due to circumstances which accompany the reproductive phase but are not the direct result of it.

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SOME SUGGESTIONS ON DEMONSTRATION

IN the April number of *School Management* appeared a very well-executed summary of Professor Beauchamp's monograph, "Instruction in Science." This should provoke a great deal of thought in the thinking teacher and administrator. Almost every one of the four conclusions provides material for discussion. From the many things mentioned I select the following:

> Teacher-pupil demonstration has replaced the individual experimentation to a marked degree in the Junior high school. A great increase in the use of demonstration is also desirable in the specialized science courses. . . . This shift in emphasis has been accelerated by the use of the demonstration method.

These questions occurred to me: Did the teacher use specially designed instruments, specially adapted for demonstration? Was the demonstration table carefully designed for intelligent demonstration? Was the seating arrangement of the pupils such as to make the demonstrations clearly visible? Was the illumination of the demonstration desk of the best? Were the teachers trained specially in demonstration methods? Did supervisors or other superiors demonstrate to the teacher suitable examples for demonstration?

In looking over the apparatus purchasable at the various firms one must realize that the greater proportion of the instruments to be had there are designed for individual student use and not for demonstration purposes. The dimensions of the purchasable materials are all so small that they can not be seen at a distance. The type of experiments suggested in our present text-books also lack visibility, and it might be profitable to adopt the classical examples given by Helmholtz.

Having given considerable thought to the above, I took up in a General Science Class the subject of "the electric bell," employing the usual and accepted procedure. With a second class I adopted the following method and compared results:

Before reading the text-book about this subject I showed one of the films (through the courtesy of the Bell Telephone Company) which portrayed very clearly in animated pictures the action of the electric bell, the flow of the current, the changes of electromagnetism and the production of sound waves. This I followed up with a demonstration, using, however, a model of an electric bell 3 feet by 4 feet in dimension, constructed by some of my pupils for this express purpose. All parts of the electric bell were shown, and because of their large size could be seen clearly by every member of the class. The results were highly gratifying, and this procedure had the additional advantage of requiring no outlay of money for inadequate equipment.

The same idea was carried out in a demonstration of the steam engine. A cardboard model, showing all the moving and stationary parts of a steam engine, was used, also of the dimensions of 3 feet by 4 feet, and therefore also visible to every member of the class.

If the economic pressure of the times necessitates demonstrations rather than individual experiments, the designing of apparatus for such demonstrations should receive a thorough investigation, in which the