in the old building, program reminiscent of history and service of the institute; December 7, Dr. Paul E. Sabine, director of acoustical research, Riverbank Laboratories, Geneva, Illinois, "Acoustics and Architecture"; December 14, S. W. Ferris, senior research chemist, The Atlantic Refining Company, Philadelphia, "Petroleum Refining by Means of Selective Solvents"; December 20, Dr. George S. Crampton, Graduate School of Medicine, University of Pennsylvania, "Ophthalmic Lenses with Special Reference to the Modern Type of Bifocals."

ON September 29, the new department of preventive medicine at the University of Bristol, England, was opened by the Minister of Health, Sir Hilton Young. The department is housed in Canynge Hall, and under an agreement between the university and the city the preventive medicine work of the city will be carried out by the department. The medical officer of health for the city, Dr. R. H. Parry, has been appointed honorary professor of preventive medicine in the university, and Dr. I. Walker Hall, formerly professor of pathology, is director of the new laboratory. Canynge Hall will also accommodate the department of pathology, with Dr. Hadfield as professor, and the departments of medicine, surgery and obstetrics.

THE office of the Iowa Geological Survey, of which Dr. George F. Kay is director, has been moved from the State Capitol at Des Moines to the geology building of the State University of Iowa at Iowa City, Iowa.

THE American College of Dentists has presented to Columbia University a fund of approximately $2,000 to provide secretarial assistance for Dr. William J. Gies, so that he may be enabled in 1933–34 to continue his work as editor of the *Journal of Dental Research* and as secretary of the International Association for Dental Research, and to cooperate with the American College of Dentists in the promotion of education and research in dentistry.

PROFESSOR C. H. BAXTER, of the Michigan College of Mining and Technology, Houghton, has been asked by the American Institute of Mining and Metallurgical Engineers to aid in providing the U. S. Geological Survey with nearly 400 topographical and civil engineers and geologists. The survey has been allotted funds by the administrator of the Federal Emergency Administration of Public Works to carry out activities in (1) topographic mapping, (2) stream gaging and construction engineering, (3) underground water survey and (4) conservation of natural resources by plugging or conditioning abandoned wells, protecting mine shafts and openings and suppressing coal fires. The personnel requirements for this work will be approximately: (1) Three hundred technical men competent to do topographic mapping, transit traverse and control and levelling. All these, however, will not be employed at once, since so many projects are in high mountainous areas where work can not be undertaken this late in the year because of early snows, and because many projects are in the northern part of the United States where it is difficult to work in the winter. The southern projects should be undertaken as soon as practicable and crews run all winter. (2) Sixty-seven engineers with construction experience and qualified to supervise and direct the building of structures. (3) Twenty geologists with experience on ground-water problems.

Museum News reports that the Newark Museum, New Jersey, is now planning a campaign to raise $20,000, needed in order to obtain a conditional grant of equal amount from the Carnegie Corporation of New York. On the success of this campaign depends the opening this year of the Educational Department of the museum, which it was decided to close on account of reduced city appropriations. This department has been supplying large quantities of material to the schools of the city. A year ago the city made cuts in its appropriations for all city-supported organizations, including the museum. The museum's original appropriation was $150,000. This was reduced last year to $100,000 and this year to $50,000. After the first allotment this year the city added $15,000 to the museum appropriation by taking it from the Public Library, so that the total museum appropriation is $65,000. If the museum can earn the grant by raising the added $20,000 it will be on about the same basis as it was last year.

DISCUSSION

MORE ABOUT THE SPIRAL HABIT

UNDER the title, "Twisted Trees and the Spiral Habit," I recently published[1] evidence of considerable variety indicating that spiral movement and development among organisms are expressions of a widespread tendency which is protoplasmic in origin. Barely had the manuscript left my hands than I realized that I had failed to carry that part of my discussion dealing with twisted trees to the individual wood cell rather than stopping at the cotton fiber. I had in mind at the time the work of Scarth.[2] Before taking this up, I should like to turn for a moment to other examples of the spiral habit which have been brought to my attention as a result of the first account.

[1] SCIENCE, January 13, 1933.

[2] *Trans. Roy. Soc. Can.*, Sec. V, 269, 1929.

In listing the articles which have appeared in SCIENCE on the twisting of tree trunks, I overlooked the one by Koehler,[3] in which he states with emphasis that twisted grain is not due to prevailing winds acting on asymmetrical crowns, because there is no evidence within the tree trunk that actual twisting took place after the wood was formed.

The twisting of vines and tendrils around their supports is common knowledge to all, but possibly it is not generally known that both may change their direction of twist several times between the base and the tip. The tropical liane Bauhinia may change its direction of twist six times within four feet, or within nine complete revolutions.

Mr. L. F. Brady, of Mesa, Arizona, has been kind enough to send me photographs showing twisting in the stems of the cactus, *Chamaecereus sylvestrii*. Out of twelve stems on a single plant, four show a clockwise twist, six a counter-clockwise twist and two are straight. In general, Brady says, the twist is to the right. *Echinocereus* also shows twisting of the stem. The spines of *Neomammillaria* are arranged in perfect spirals.

It is reasonable to see in the wedge shape of long cambium cells an explanation of the twisting of tree trunks. The slippage or sliding growth of cambium cells would bring about a spiral twist. But such development can not serve as an explanation of the twisting of individual cotton fibers or of the walls of a single bast cell. Also, as the spiral habit is equally characteristic of animals from the lowest to the highest, the ultimate cause, if there is a universal one, must be protoplasmic in character.

A brief reference[1] was made to the spiral nature of certain body organs (the gall duct) in man. My attention has since been called to the work of F. T. Lewis,[4] who, in an article on symmetry in plants and animals, presents evidence of a pronounced tendency among body organs in mammals to show a marked right or left twist. The cardiac loop in man rotates dextrally. Human viscera do likewise. (The primary loop of intestines may rotate sinistrally, but rarely so.) The coiled colon of the pig is dextrally wound through three or four complete revolutions. The trachea and esophagus show dextral rotation. There is a dextral spiral trend of muscle fibers throughout the digestive tube.

Returning now to the spiral character of wood elements, there is the work of Scarth,[2] already referred to and illustrated in Fig. 1. The figure is of a portion of a single wood cell showing part of the wall. The wall is built up of concentric layers (20 in number and about 0.5 μ thick). Each comprises a parallel

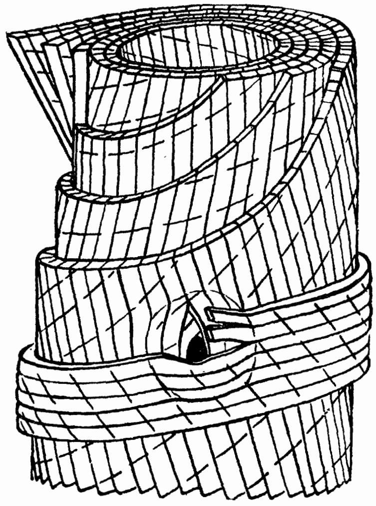

FIG. 1

series of fibers, the orientation of which varies from layer to layer. In the outer layers the fibrils are inclined at nearly 90° to the long axis of the fiber, in others at 0°–30°. (Fig. 1 is by Dr. Scarth.)

Herzog,[5] in a very interesting article on the structure of cellulose, gives evidence of the spiral wrapping of bast fibers. I had hoped to find in this article of Herzog's some suggestion of a molecular interpretation of the spiral orientation of structural units in natural cellulose, but no such suggestion is given. There is only a very cautious reference to crystals, which, from a solution that is slightly polluted, crystallize with a spiral structure. While we can not yet find in the molecule an ultimate explanation of the spiral structure of animate and inanimate things, we have at least some indication that molecules are, at times, also subjects of the same habit. There are molecules which show spiral (axial) symmetry (in the same way as do crystals), and molecules in which the atoms are arranged on a helical curve. The cellulose chain has a spiral axis of symmetry in that along the chain the rings are alternately right- and left-handed. The cellulose molecule, as ordinarily pictured, is linear. However, spirally wound molecules have been proposed for cellulose as fitting in well with some of their chemical characteristics, although this has been offered only as a speculation. The same can be said of the spiral molecule suggested for rubber.

Returning to less speculative and grosser, though still microscopic examples of the spiral habit, we have the newly discovered spiral structure of plant chromosomes. A spiral twist appears to be universally characteristic of plant chromosomes. It was first well established by Kaufmann.[6] Such a structure of plant

[3] SCIENCE, May 1, 1931.
[4] *American Naturalist*, 57, 1923.
[5] *Koll. Zeitschr.*, 61: 280, 1932.
[6] *Amer. Jour. Bot.*, 13: 59, 1926.

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 wide-spread 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.