contrast this condition was quite often characteristic of the hybrids between species. Muentzing (1932) has more recently called attention to the same tendency in hybrids. There seems to be little excuse for the errors of those who have worked on the cytology of ring formation in the case of Tradescantiae. In the species of Oenothera, however, and in the Onagraceae in general, the formation of pairs in connection with meiosis is very obscure and their separation can in general only be clearly made out at the actual metaphase. The rings and strings in species of Oenothera are also nothing more than persistent pachytenes which become distributed as such to the metaphase plate. It is obvious, if the statements made here are well founded, that the results obtained by Belling, Darlington and Sax in regard to ring formation are without sound foundation in fact.

E. C. JEFFREY

TWISTED TREES AND THE SPIRAL HABIT

THE behavior of organisms is determined by the physical and chemical nature of their protoplasm and by their environment. The relative importance of hereditary material and environment has long been, and probably ever will be, a controversial subject. This is true because both factors always play a part, sometimes one and sometimes the other having the predominant influence. There is also the very natural tendency of an investigator to attach more significance to the point of view represented by his field of work. A student of protoplasm or of genetics will see in heredity a greater influence, and the ecologist will lay emphasis on environment, though the former must be aware of the fact that protoplasm has come to be what it is primarily because of environmental influences working through the ages. The relationship between hereditary reactions and developmental expressions is presented fully and well by Stockard.[1]

It has occurred to me that a protoplasmic interpretation of the twisting of tree trunks might be a logical view of this interesting behavior concerning which there has been much discussion on the pages of SCIENCE.[2-6] Certain observers[2,4,5], see in the prevailing direction of the wind an explanation of the twisting of tree trunks. Persistent winds might well bring about a twisting of the trunk, in support of which is the fact that trees exposed to the wind often assume an oval shape. There is also the report that twisted trunks rarely occur in the heart of a forest.[4]

Several years ago this subject was again brought to my attention by my friend, Mr. Philip Sawyer, of New York, who told me of the twisted trunks of trees (conifers) along the trail up Mt. Audubon in Boulder County, Colorado. The degree of twist varied considerably, from a very gradual one to a complete twist within a distance equal to twice the diameter of the tree. The clockwise twist was the more usual. The reverse twist was infrequent and occurred among the others. This last remark of Mr. Sawyer's increased my belief that tree trunks twist because of an innate tendency to do so and not because of environmental factors. I was, therefore, very much interested in the recent report by Herrick[6] on twisted trees in the forests of Louisiana. He examined 1,527 trees, of which 364 (23 per cent.) were straight grained, 811 (53 per cent.) showed a right-hand twist, and 352 (24 per cent.) showed left-hand twisting. He observed further the condition of the roots of 57 trees that had been uprooted. Of these, 31 (5 per cent.) showed twisting to the right, 7 (12 per cent.) showed left-hand twisting and 19 (33 per cent.) were straight. He adds that if prevailing winds were the cause it would be expected that the limbs on the one side of a tree would twist in one direction and those on the opposite side would twist in the opposite direction. Actually, however, the limbs of any one tree always twist in the same direction. Herrick, therefore, concludes that as there is both right and left-hand twisting in tree trunks of the same locality, and as the twisting of limbs is in the same direction on all sides of the tree, and as roots also show twisting, winds can not be the cause. Mr. Laurence Moyer adds the old apple tree as another common example of tree trunk twisting.

It is the purpose of the present paper to suggest that the twisting of tree trunks is but one manifestation of a wide-spread tendency in organisms to grow and move spirally, a tendency due to a heritable protoplasmic quality and not to environmental factors.

The formation of spirals is not limited to living things. Crystals show both right-hand and left-hand growth. The precipitation of salts in gels, which goes by the name of the Liesegang phenomenon, is ordinarily rhythmic, resulting in the production of concentric rings, but occasionally a perfect spiral is produced, for which there is no adequate explanation. Organisms, from the lowest to the highest, give various indications of a spiral habit. Schaeffer[7] reports that Amoeba travels in a spiral when moving along a thin glass rod or within a fine capillary tube. The spiral may be to the right or to the left for varying lengths of time, and may alternate frequently, although a species is predominantly to the left or to the right. The shells of mollusks are striking examples of the spiral habit in organisms. Both Mr. Sawyer and my colleague Dr. Zirkle reminded me of this.

1 "The Physical Basis of Personality," 1931.
2 SCIENCE, February 13, 1931.
3 *Ibid.*, March 27, 1931.
4 *Ibid.*, May 22, 1931.
5 *Ibid.*, January 29, 1932.
6 *Ibid.*, November 4, 1932.
7 SCIENCE, July 10, 1931.

fact. The shells of Nautilus and Triton are examples; especially fine are the long, cornucopia-like spiral shells of *Terebra oculata*. Further inquiry brought from Dr. H. E. Crampton the interesting observation that sea snails in the South Pacific show both right- and left-hand twists, the latter being infrequent.

Schaeffer[8] has carried his observations on spiral movement in organisms to man, whom he regards as a spirally twisted right organism. This is true not only of the movements of man but of body structure as well. The gall-duct is the most conspicuously spirally twisted unpaired organ in man, and it is a right spiral. There are numerous other examples of spirally-twisted organs in animals. As for movement, when man is blindfolded he walks in a right spiral. (In this connection there is the old saying that hunters when lost in the woods walk in circles to the right, the circle getting smaller and smaller, *i.e.*, man walks in a spiral. One wonders if the habit which dogs have of turning round and round before finally settling down for a nap, is another manifestation of the spiral tendency in organisms.) Spiral walking in man is also regarded as due simply to the fact that most people are right-legged, as they are right-handed, which results in walking in a curve. But the curve is most often to the right, while right-leggedness should, it would seem, produce a left spiral. However, right-leggedness is a possible cause of spiral walking in man, which, if true, eliminates but one of the many examples of the spiral habit in organisms.

The spiral structure of trees is duplicated in the most delicate of plant cellulose parts, namely, the cotton fiber. Titus and his coworkers[9] report such a structure for the cotton fiber. Denham[10] enumerates four distinct classes of spirals in cotton fibers. The structure does not always proceed in the same direction but suffers more or less regular reversals. Balls[11] has presented a number of papers dealing with the twisting of cotton fibers. He states that reversal from dexter (right) to sinister (left) spirals occur in the same fiber. Causation of the reversals is physiological (*i.e.*, protoplasmic). Ordinary environmental influences do not affect the statistical peculiarities of the reversals. The spiral habit in plants is further illustrated by the tight wrapping of tendrils and of vines. Two vines may twist around each other and give as perfect an example of spiral wrapping as exists in the artificial wound fibers of a rope. It appears, therefore, that the tendency toward spiral growth is as characteristic of the cellulose framework of plants as it is of the parts of animals. The spiral twisting of cotton fibers is convincing evidence that the twisting of tree trunks is an innate heritable property, and not an environmental effect.

The evidence presented here indicates that spiral development among organisms is the expression of a wide-spread tendency which is protoplasmic in origin.

WILLIAM SEIFRIZ
UNIVERSITY OF PENNSYLVANIA

[8] *Jour. Morph. and Physiol.*, p. 294, 1928.
[9] *Jour. Chem.*, 9: 114, 1932.
[10] *Jour. Textile Inst.*, 14: 86T, 1923.
[11] *Proc. Roy. Soc.*, London, 99: 130, 1926.

THE EXTINCT LAKE SAN AUGUSTIN, NEW MEXICO

A SEMI-ARID basin in western New Mexico, known as the San Augustin Plains, has been described by Bryan as an old lake basin.[1] To this extinct body of water he has given the name Lake San Augustin. Field work by the writer during the summer of 1932 not only supports Bryan's view, but has yielded detailed information on the extent and characteristics of this ancient lake.

The San Augustin basin lies in western Socorro and eastern Catron Counties, and is bordered on the north by the Bear, Gallinas and Datil Mountains; on the west by the Tularosa Mountains; and the south by a mountainous belt, including the O Bar O, Pelona and Tuera Mountains; and on the east by the Magdalena Mountains The basin is 60 miles long from northeast to southwest, and has a maximum width of about 20 miles. During the rainy season (July and August) ephemeral streams make their way from the mountains across broad alluvial slopes to two playas, the larger and westernmost of which is called locally the San Augustin Plains, and contains the lake basin herein described.

Lake San Augustin at its highest stage was about 32 miles long by 11 miles wide, with a surface at about 6,940 feet A. T. The lowest point in the basin is 6,776 feet A. T., and thus the greatest depth of the lake was about 164 feet. The shore lines of this and all the lower stages are strikingly marked by shingle beaches, spits and bay head bars, and by cliffs developed both on rocky mountainsides and on alluvial fans. These shore features form a descending series that indicates many lake stages, the details of which are yet to be worked out from a study of the field notes. At its highest stage Lake San Augustin was connected by a small channel with a basin farther east, as yet unstudied, that probably drained into Lake San Augustin. At all the lower stages Lake San Augustin had no possible outlet, and its waters must have been depleted by evaporation and underground seepage.

The highest beach has a constant altitude on all sides of the playa, and thus gives positive evidence that no differential earth movements have occurred

[1] Kirk Bryan, "Ground Water Reconnaissance in Socorro County, New Mexico," Seventh Biennial Report of the State Engineer, pp. 82–83, 1925–26.