snails in the spill-way were so numerous each rock and piece of drift wood was covered. Here were also egg clusters of snails and insects. Cadice worms of various species were on top sides or bottom of rocks. Simulidae were on algae-covered stones. Small limbs, water logged and lying on the bottom were covered with planaria and egg masses of different kinds. Deep pools contained fish. Crayfish were under bank walls, in vegetation, and protected sides of rock. Isopods were in vegetation and many animals were found in a screen wire held down stream while the stream bed was disturbed above. Sand contained clams and small clams were taken from vegetation.

The most unexpected animal perhaps was an earthworm. Earthworms are found in moist earth but not in water. Yet several were found and when identified were water forms of earthworms.

The abundance of life perhaps was due to two factors. First, this spring-fed pond does not change water level but little even in dry weather. Second the vegetation is varied and has a wide distribution. Other factors are the varied habitats, such as: deep holes, static water, sand bottoms, rocky bottoms, swampy areas, swift flowing water, and shelters provided by stones. The animal life appeared to have been left undisturbed for a long period of time.

If we learn the balance of nature and understand it we will know how to protect our natural life resources. We in Tennessee should be more conservation conscious since we have the beautiful dams and lakes of T.V.A.

GEOTROPISM

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From the time that a seed falls to the earth until the plant turns to dust, it is affected by many types of tropisms, the directional growth of plants in response to stimuli: phototropism, the effect of light on growth; thermotropism, the effect of heat on growth, and geotropism. Geotropism is the effect of gravity upon the growth of plants. When a tree grows out of the side of a hill, why does it turn to point its leaves toward the sky? When a plant is turned up-side-down, why does the stem turn upward, and the roots downward? These are just some of the effects of geotropism. The object of my experiment on geotropism was to see the effect gravity has on the roots, the stems, or both parts of plants, and to find out if this effect is proportional to the force of gravity. We must realize that the science of man in space is becoming the outstanding study of the era. However, before man can begin to find out how he will react to space travel, we must first see how plants and other

living organisms respond. It is for this reason that geotropism will become an important science.

It is known that centrifugal force and gravity produce the same effect upon many objects, and that centrifugal force can be made equal to, or greater than the force of gravity. I applied these facts to my experiment, and by rotation in a horizontal plane, produced a force equal to that of gravity.

My main purpose in doing this experiment was to see if the plant would grow along the resultant R where R is the resultant of two vector forces, Fg and Fc. Fc represents the centrifugal force at a distance r from the center of rotation O. Fg represents the force of gravity.

Fg=mg; g=32 ft/sec/sec; Fg=32 m.

So that I might find the radius that would be necessary to make the gravitational force equal to centrifugal force, I used the formula

$$F_c = \frac{mv^2}{r}$$

The letter r represents the distance of a rotating plant from the center of rotation, m stands for mass, while v is the velocity of the rotating plant in the circle. This formula is used to find the centrifugal force of any body moving in a given circle.

Seeing that

$$F_c = \frac{mv^2}{r}, \quad t = \frac{1}{\text{rev/sec}}$$

and

$$v = \frac{\text{distance trav. in 1 rev.}}{t} = \frac{2\pi r}{t},$$

we find that

$$v = 2\pi r \times \text{rev/sec.}$$

Therefore,

$$F_c = \frac{4m\pi^2r^2(\text{rev/sec})^2}{r},$$

or

$$F_c = 4\pi^2mr(\text{rev/sec})^2 .$$

Referring to a figure showing the resultant of two vector forces,

$$32m = 4\pi^2mr(\text{rev/sec})^2 .$$

Letting the rev/sec = 1, we find that

$$32 = 4 \times 9.85 \times r \times 1,$$

$$r = .81 \text{ feet.}$$

The plant rotating at one revolution per second, .81 feet from the center of rotation, will now have a centrifugal force acting upon it equal to the gravitational force.

When the two forces are equal, one should expect that a plant would follow the line of the resultant, and would grow at a forty-five degree angle toward the center of rotation.

Experimental Procedure

I first tried this experiment in 1952. It was carried out in a very unscientific manner, for I did not take into consideration such factors as light, heat, and non-uniform rotation. Therefore, the plants failed to follow the predicted angles.

My next series of trials was in 1954. Here the means of rotation was an old phonograph motor which I governed to one rev/sec. Later I designed and built a two-speed turntable for the rotation of my plants. To the rotating turntable I attached a box in which I grew the plants. The center of this box was placed over the center of the turntable. My rotating box was 3/8" thick, and had sides of glass for observation which were 7" high by 24" long. I also built an identical stationary box which served as my control. The soil in which these plants were grown was potter's earth, sifted and strained so that the pattern of the roots would not be disturbed by the rocks. These plants were grown in a totally dark room with controlled heating. I chose these conditions so that the plants would not be affected by thermotropism or phototropism. The plan used in this experiment was Golden Cross bantam corn, chosen for its strong stem and sturdy roots.

These corn seeds were planted two inches apart throughout the length of both boxes, and each seed received 10 cc's of tap water daily. Growth was first noticed in the control box four days after the experiment had begun, and in the rotating box after five days. The geotropic effect due to rotation was first observed on the seventh day.

Results

It was found that the rotating plants responded to geotropic stimuli, and followed the predicted angles. At .81 feet the corn was found to grow at a 45 degree angle. Plants nearer the center of the box grew in a direction making a smaller angle with the vertical axis, while plants farther from the center formed a larger angle. It was also noticed that the rotating plants were one day behind the control in their growth pattern.

This experiment was entirely original with me, and to my knowledge never before has been performed successfully.