surements. The anaphases measured were divided into four classes according to the distance between the centromeres. Class I includes anaphases in which the centromeres of the daughter groups of chromosomes are 2 μ to 5 μ apart; Class II 5 μ to 8 μ apart; Class III 8 μ to 10 μ apart; Class IV over 10 μ apart. The average distance between the centromeres and the average distance from the generative centromeres to the wall was obtained for each class.

The distance traveled by each daughter group of chromosomes is the difference between its position at metaphase and its position at anaphase. At metaphase the generative centromeres are 3.9 μ from the wall; the vegetative centromeres are 5.0 μ from the wall (average of 50 measurements). In Class I the daughter groups of centromeres are 3.8 μ apart; the generative centromeres are 3.4 μ from the wall (average of 13 measurements). Thus when the daughter groups of chromosomes are 3.8 μ apart the generative chromosomes have traveled 3.9 μ less 3.4 μ or .5 μ. The distance traveled by the vegetative chromosomes is 7.2 μ less 5.0 μ or 2.2 μ. The ratio of distance traveled by the vegetative chromosomes to the distance traveled by the generative chromosomes is 4.4:1. The average distance traveled by each group of chromosomes at different anaphase stages and the ratio of vegetative chromosome to generative chromosome movement is shown for *Allium cernnum* in Table 1.

TABLE 1

	Metaphase	Anaphase Class I	II	III	IV
Average distance (μ):					
between centromeres ..	1.1	3.8	6.4	9.0	10.7
from gen. centromeres to wall	3.9	3.4	2.3	1.0	0.6
travelled by gen. chromosomes	..	0.5	1.6	2.9	3.3
travelled by veg. chromosomes	..	2.2	3.7	5.0	6.3
Number of measurements	50	13	33	40	53
Veg./Gen. ratio	..	4.4	2.3	1.8	1.9

It must be pointed out that the daughter groups do not merely travel different distances but travel at different rates; *i.e.,* it is not a case of the generative group being stopped by the wall while the vegetative group continues its movement. If this were so we would expect to find the distance traveled by each of the two groups to be the same until the generative group reaches the wall, then the daughter groups would be about 8.9 μ apart (twice the distance from the generative centromeres to the wall plus the thickness of the metaphase chromosome). As shown in the table, this is not the case. When the daughter groups are 6.4 μ apart the vegetative group has traveled 3.7 μ; the generative group only 1.6 μ, and it is still 2.3 μ from the wall.

Whether difference in rate of movement of the two groups of chromosomes results primarily from a stretching of the anaphase spindle, as suggested by Geitler (1935),[1] or from a difference in time of development of the two spindle poles will be discussed in a later report which is concerned with anaphase movement in *Allium cepa, Pancratium illyricum, Tradescantia* and *Vicia faba,* as well as *Allium cernuum.*

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MULTIPLE GROWTH LAYERS IN THE ANNUAL INCREMENTS OF CERTAIN TREES AT LUBBOCK, TEXAS[1]

A NOTABLE feature of the climate of Lubbock, on the High Plains of Texas, is the common occurrence of heavy frost after tree growth has begun for the season. These frosts are sufficiently intense to rupture the newly formed cells in the branches and leaders of many trees and to cause the formation of a partial or entire "frost ring" in the wood. Since the injuries must take place early in the spring, which is soon after growth begins, their presence marks the actual beginning of growth for the particular years. Definite frost injuries occurred in 1932, 1933, 1934, 1936 and 1938, slight and restricted injury in 1937, and no injury in 1935. These dates, established by examination of the wood, were verified by meteorological and vegetational records.

Once determined and dated, the frost injuries furnish a unique method of recognizing the true extent of wood formed during one year, because, with the injuries occurring as listed above, they register the beginning of each year's growth. This is commonly true for all years except 1935, in which temperatures did not sink sufficiently low to cause injury. Thus the method permits the determination of whether or not the trees studied form one or more "rings" per year.

All the trees reported upon here, except one, grew on the campus of Texas Technological College. Most of the work was done on the Arizona cypress and western yellow pine, but four other species were also examined. Many thin sections were made from different branches of the same tree, from different points along one branch axis, and, in two cases, from leaders.

Two anatomical observations are worthy of record at the present stage of the work: the number of growth layers in an annual increment, and the forms of the layers. In this connection the term "annual increment" refers to the total amount of wood formed during a complete growing season, and "growth layer" refers to a "ring" composed of early and late wood whose outer margin is sharply set off from the succeeding layer. An annual increment contains one or

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[1] L. Geitler, *Planta.,* 24: 361–386, 1935.

[1] A paper read at the Alpine, Texas, meetings of the Southwestern Division of the American Association for the Advancement of Science, May, 1939.

more growth layers, depending upon how many times the tree ceased and then resumed growth during a season.

It was found that the annual increments in the various specimens of Arizona cypress contained from one to five growth layers. In a certain branch of a western yellow pine the years 1936–1937 contained five growth layers. No clue existed whereby the end of 1936 and the start of 1937 could be identified. The difficulty was overcome in a second branch, where frost injury indicated the beginning of 1937 growth. Thus, 1936 contained two and 1937 three growth layers. It must be added that the growth layers of one branch corresponded in relative thicknesses with those of the other.

In brief, the forms of the layers may be classified roughly as lens and non-lens. A layer forms a lens if its late wood merges with that of the layer next inside, that is if it fails to form a completely independent ring. Both types were observed to have sharp outer margins in some cases, diffuse in others, or partially sharp and partially diffuse. In addition, the lens type as a rule did not constitute an entire annual increment. It is obvious that sharp layers could be mistaken for annual increments in trees devoid of frost injuries.

The following conclusions may be tabulated: (1) When present, frost injuries in the trees on the campus of Texas Technological College give a unique method of determining with exactness the amount of xylem formed each year. (2) Within the annual increments for 1932 to 1938 multiple growth layers are by no means uncommon—layers indistinguishable from a single annual increment under any magnification up to 400×. (3) A single radius, or even an entire section, may not be a safe guide to the correct age of a tree. (4) Under any ecologic conditions, complex as they are known to be, it would seem to be scientifically unsound to reason theoretically concerning the unity or multiplicity of growth layers in the annual increments. Thorough investigation and experiment by means of well-known botanical techniques are necessary for each general environment in order to determine the behavior of the cambium and the resultant anatomy of the annual increment. In the work here briefly reported, frost injuries fortunately gave the necessary accuracy to dating and thus have been used as a substitute for other more thorough types of investigation. (5) No ecologic interpretations are attempted. Suffice it to say that those conditions which cause the cessation of cambial division *at the end* of the growing season can operate equally well to cause cessation with like results *within* the growing season not only once but several times.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE GRAVIMETRIC ALCOHOL CHECK FOR CALIBRATION OF METABOLISM APPARATUS

FOR alcohol checks of metabolism apparatus we have recently made two improvements on the standard procedures.[1] One improvement is the use of a small detachable lamp for weighing, which eliminates the use of a calibrated burette. The other is the elimination of the complicated water-cooled burner described by Barrett and Robertson.[2]

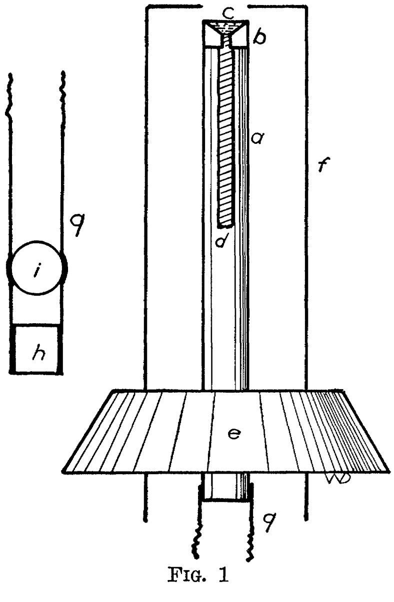

FIG. 1

As shown, the lamp consists of a pyrex glass tube (3/16″ by 5″), *a,* to which is fused a pyrex capillary tip, *b.* Asbestos fibers, *c,* prevent combustion of the wick, *d,* a piece of cotton binding cord. The large tube, *a,* by affording air insulation, eliminates boiling of the alcohol and the consequent loss due to sputtering. For weighing, a fine suspension wire (not shown) is attached to the No. 13 rubber stopper, *e.* Copper wires, *f,* for ignition connect to a spark coil. In Benedict-Roth machines the artificial circulation of air is perhaps most simply achieved by the method of Benedict.[1]

OPERATION

The thin-walled rubber tubing (3/16 inches by 6

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[1] F. G. Benedict, *Boston Med. and Surg. Jour.,* 193: 807, 1925.

[2] J. F. Barrett and J. D. Robertson, *Jour. Path. and Bact.,* 45: 555, 1937.