

Brassica nigra, *Sisymbrium officinale*, *Agrimonia parviflora*, *Rubus villosus*, *R. allegheniensis*, *Trifolium pratense*, *T. incarnatum*, *T. repens*, *Melilotus alba*, *Medicago sativa*, *M. lupulina*, *Oxalis Acetosella*, *Euphorbia maculata*, *E. marginata*, *E. humistrata*, *Acalpha virginica*, *Acer saccharinum*, *Vitis cordifolia*, *Sida spinosa*, *Malva rotundifolia*, *Viola pedata*, *Oenothera biennis*, *Erigenia bulbosa*, *Pastinaca sativa*, *Daucus Carota*, *Vinca minor*, *Apocynum cannabinum*, *Aselepias syriaca*, *Gonolobus laevis*, *Convolvulus sepium*, *Ipomoea Batatas*, *I. purpurea*, *Prunella vulgaris*, *Solanum nigrum*, *Lycium halmifolium*, *Datura Stramonium*, *Physalis subglabrata*, *Verbascum Blattaria*, *Linaria vulgaris*, *Conobia multifida*, *Verbascum Thapsus*, *Veronica officinalis*, *Plantago major*, *P. lanceolata*, *Galium Aparine*, *Sambucus canadensis*, *Cucurbita Pepo*, *Lobelia siphilitica*, *L. spicata*, *Vernonia altissima*, *Solidago canadensis*, *Aster Shortii*, *A. ericoides*, *Erigeron annuus*, *Xanthium canadense*, *Rudbeckia hirta*, *Helianthus annuus*, *Bidens frondosus*, *Achillea Millifolium*, *Anthemis Cotula*, *Chrysanthemum Leucanthemum*, *Articum Lappa*, *Cirsium lanceolatum*, *Taraxacum officinale*, *Sonchus oleraceus* *Lactuca canadensis*.

MIDSUMMER GROWTH.

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In the year 1893 the writer's father transplanted a two year old specimen of *Liriodendron tulipiferu*. This tree was cut down on account of some street work the present year (1923). It had attained a height of 21 meters and a diameter of 33 cm., one decm. above the ground, in the 30 years. When standing it presented a beautiful spectacle with its towering slender shaft-like trunk and admirably balanced top.

Within the recollection of the writer it has been defoliated on three occasions, twice in one year, and once during a later year. When it was felled the writer started an investigation to ascertain how distinctly the above mentioned defoliations had impressed their results in the formation of the annual rings. Accordingly a disc 2.5 cm. in length was cut from the trunk of the tree one decm. above the ground and exactly at right angles to the trunk by means of a guide which the writer has invented. The accuracy of this simple arrangement may be judged by the performance, since with a one-man cross-cut saw a variation of only a few mm. was shown in the above mentioned diameter cut of 33 cm. We have therefore in such cases, where proper care is used, a very commendable approach in a large scale, comparatively speaking, to the accuracy of an ordinary mitre box.

The disc cut as above described was next passed over a "jointer" which decidedly helped the visibility of the annual rings. The distinctness of the rings was further enhanced by sand-papering one side of the disc with a sanding block which was adjustable by means of a pintle. This last operation brought out the annual rings with much greater distinctness. The treatment above outlined made it possible to study the annual rings minutely. The section showed distinctly the

32 annual rings for the total number of years of the tree's age, and these stood out with unusual clearness. In addition, however, during the two years of defoliation above referred to, three other rings were observable although somewhat less clearly. A reference to the Weather Report records gave the explanation of these narrower annual rings. When the tree was 15 years old there occurred after the leaves were formed frosts on two successive nights which were so severe as to cause defoliation. After this leaves were again formed but later in the same year were destroyed by insects, a thing which rarely occurs with *Liriodendron tulipifera*. These two defoliations caused the formation of two rings or midsummer growths in the tree in its fifteenth year, which were not so distinct as the usual annual rings. The formation of two rings in one season is exceptional, but it shows, as stated by Jost, that a relation exists between defoliation and annual ring formation. When the tree was 23 years old it was again defoliated early in the season by frost which caused an extra ring to form. This was less distinct than the annual rings. These same midsummer growth formations were visible in some maple trees that were in the same locality, but they were less distinct than those mentioned for *Liriodendron*.

Various and numerous theories have been advanced concerning annual ring formation but as yet the real causes are unknown. Mechanical explanations have failed but the teleological viewpoint deserves study. While some facts are known concerning annual ring formation in temperate zones extremely little is known concerning annual ring formation in tropical trees. The first case of growth rings on record in a monocot has recently been reported by Chamberlain¹ for *Agave ferox* which grows in South Africa. In view therefore of the production of the midsummer growths as recorded in this paper, controlled experiments, although they would be costly to perform, should be carried out in order to determine the physiological facts involved in this important question.

STUDIES ON POLLEN—IV.

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Since my third contribution to this subject I have investigated the germinal behavior of more than a score of different pollens not heretofore considered in this series of studies. The more one progresses in this line of investigation, as in many others, the more one finds to be done in the various interesting and important phases of the subject. It is also clear that in many respects corrections of previous work needs attention and re-investigation from different angles. Improvements in the methods of research in this subject are constantly required as the work has progressed. The petri dish method has practically supplanted the procedures usually employed. A temperature arrangement has been devised which has definitely advanced this field of investigation. Too little attention has been paid heretofore to conditions controlling pollen

¹ Chamberlain, C. J. Growth Rings in a Monocotyl. Bot. Gaz., 72, 293-304, 1921.