The Development of the Seed of Liriodendron Tulipifera L.

A. T. Guard, Purdue University

Considering the great number of hazards which a young tree must overcome before it is established, it is important that a forest species produce a considerable number of viable seed. It is also highly desirable in reforesting that an abundance of good seed can be gathered with a minimum of time and labor. This is especially true where direct seeding is practiced.

The common tulip tree *Liriodendron tulipifera L.* is one of our most desirable eastern hard wood species both because of its size and the quality of the wood which it produces. This species characteristically produces many well-developed fruits. Very few of these fruits have well-developed seed in them.

The purpose of this, and previous studies on this problem has been to see what the cause or causes might be for the failure of many seeds to develop properly. With this in mind the course of the development of the seed has been followed from the time of flowering until maturity.

Shortly after pollination the development of the integuments and nucellus is very rapid. By the end of two weeks the seed is more than two-thirds the mature size, while the zygote has divided only once and there is only moderate development of the endosperm. The entire cavity within the integuments is filled with thin walled nucellar tissue.

According to Maneval (3) the mature female gametophyte of *Liriodendron tulipifera* has the seven cells typical of many of the Angiosperms.. The antipodals disintegrate early and shortly after the flower opens there is left only the egg cell and the endosperm nucleus with remnants of the two synergids.

The time of pollination of the flowers from which this study was made was between June second and fourth. Sections of ovules made one week later showed a very limited development of the endosperm, but no development of the embryo. The seed had about doubled in size during this week.

By June 18th, approximately two weeks after pollination, the seed had enlarged to about six times the length of the ovule and was almost twice as wide. Except for the portion of the seed now occupied by the endosperm the part inclosed by the integuments was filled with thin walled cells of the nucellus. The endosperm consisted of a narrow tissue four cells in diameter extending from the micropilar end of the ovule two-thirds of the way back through the nucellar tissue. The zygote had divided only once.

On July 1 (fig. 1) the endosperm filled almost the entire cavity with only a small portion of nucellar tissue left which had not been absorbed. The integuments were beginning to harden although they could still be cut in paraffin without special softening.

The embryo (fig. 2) at this time consisted of a short suspension and a group of cells with little or no differentiation evident.

The next observations made on August 12th showed the endosperm almost completely filled the seed cavity with only remnants of the nucellus. The embryo (fig. 3) had developed to about one-third mature size and the cotyledons were beginning to become evident. At this time there was some accumulation of stored food in the endosperm.

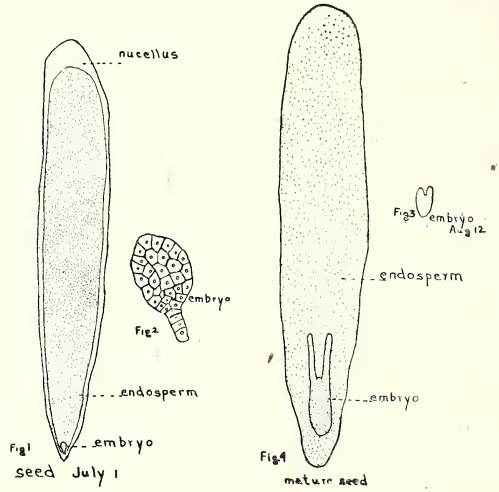

Figure 4 shows a median section of a mature seed at the time they were being dispersed naturally from the tree. The hypocotyl and cotyledons were well developed, but there was very little development of the epicotyl. Much stored food was present in the endosperm.

The seed must be stratified through the winter for spring germination but seed taken out of stratification in early March showed no evident morphological changes over the mature seed.

In a very large number of seed there is no evidence of embryo and endosperm development. This seems to indicate that failure of fertilization or early failure of the embryo to develop or both must be the case. In most of these seed there is, however, this same rapid development of the integuments and nucellar tissue as in seeds which develop embryo and endosperm.

Brink and Cooper (1) assigned the cause of failure of some seed to develop to the fact that there is severe competition between the new plant and surrounding tissue for food in the early stages of development. If this is true the very rapid development of integuments and nucellar tissue in the seed of the tulip tree may result in starvation of the zygote.

In alfalfa Brink and Cooper (1) found that cross fertilization resulted in a much reduced failure of seed to develop. Landes (2) also found that one of the principal causes of self-sterility in rye was failure of the embryo and endosperm to develop after self-fertilization.

There is also evidence that failure of seed in the tulip tree may be due to self-pollination. Of approximately 800 seed from cones, self-pollinated by hand, only 11.7 per cent showed filled seed. While the same number from the same tree, pollinated by hand, with pollen from a tree some twenty miles distant showed 38.9 per cent filled seeds.

Conclusions: The development of the seed of the tulip tree is slow. It reaches morphological maturity between August 12 and September 15; probably not before September 1.

It is doubtless better not to gather seed for planting until after the first week in September, although the fruits look mature by the middle of August.

Cross pollination, in the limited number of cases tried, did increase the per cent of good seed more than three times.

It may be better to mix seed from various sources when reforesting, causing a mixed population and possibly better natural reseeding.

References Cited

1. Brink, R. A., and Cooper, D. C. Double fertilization and development of the seed in angiosperms. Botan. Gaz., **26**, No. 1, 1940.

2. Landes, Margaret. The causes of self-sterility in rye. Am. J. Bot., **26**:576-571, 1939.

3. Maneval, Willis Edgar. The development of magnolia and Liriodendron including a discussion of the primitiveness of the Magnoliaceae. Botan. Gaz., **57**, No. 1, 1914.