Chilling in Germination of M. Virginiana

by Peter Del Tredici

(Adapted from an article in Arnoldia, *vol. 41 (2): 36-49)*

On October 13, 1980, a total of 938 sound seeds were collected from various plants of *Magnolia virginiana* growing in Ravenswood Park at Gloucester, Massachusetts. On this day, the fruit aggregates were just beginning to crack open, revealing the bright scarlet seeds inside. In processing the seeds, the first step was to clean them. Once the seeds were clean, I noticed that the hard bony layer on all was a creamy white. This is curious since all illustrations I could find show this layer to be black (Sargent, 1890; Schopmeyer, 1974; Wood, 1974). However, Professor J.C. McDaniel of the University of Illinois has told me that he has seen plants with white or mottled bony layers.

The seeds were then air dried overnight and placed in a moist stratification medium consisting of half peat moss and half sand. They were then put in a refrigerator kept at 2°C. Every two weeks, either fifty or one hundred seeds were removed and sown in medium grade vermiculite and placed in a greenhouse kept at constant 18°C with supplementary light from 4 p.m. to midnight. The purpose was to determine the exact minimum chilling requirement, the standard recommendation being broadly three to six months (Schopmeyer, 1974). The results of the experiment, summarized in the table, clearly indicate that sweet bay seeds, when properly stratified, can be stored as long as seven months with no loss of viability. From a commercial point of view, this translates into a recommendation to stratify fall collected seeds indoors until spring, so that they can be sown when the daylengths are favorable to seedling growth. It should be noted that although unchilled seeds did give 63 percent germination and seeds chilled for two weeks gave 54 percent germination, it took them five months to achieve these percentages. In contrast, when the chilling period

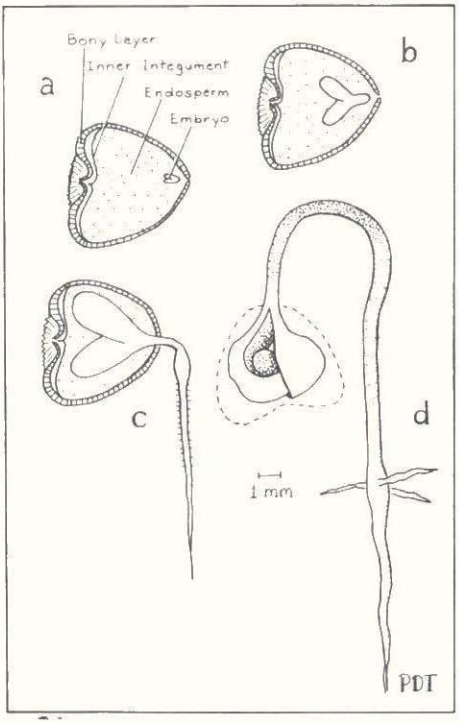

Figure 3. Seed germination sequence of Magnolia virginiana *after 90 days of cold stratification: (a) the day the seeds were sown: (b) 14 days after sowing; (c) 32 days after sowing; (d) 40 days after sowing, germination nearly complete.*

was four weeks or longer, full germination occurred within two months of sowing.

When the seeds of *M. virginiana* are shed (and indeed, in all magnolias that I have observed or read about), the embryo is minute, being less than 20 percent of the length of the seed itself. When the seeds are taken from stratification, whether for one or four months, the embryo shows little or no change in size. However, immediately upon sowing, the embryo starts to grow, so that after 14 days the embryo is about 50 percent as long as the seed, and after 30 days the cotyledons are almost as long as the seed and the radicle has broken through the seed coat. After 40 days, the germination is usually complete (see drawing). In contrast, the unchilled seed showed no uniformity. After 112 days, some embryos were still at the same developmental stage as when shed from the plant while others were fully germinated.

A germination process similar to that of *Magnolia virginiana*, where there is a chilling requirement to allow the embryo to complete its development, has been reported for *M. grandiflora* (Evans, 1933), and *M. acuminata* (Afanasiev, 1937), and my own observations have shown that it holds true for *M. tripetala* and *M. macrophylla* as well. It is also true for another member of the Magnoliaceae, the tulip tree (*Liriodendron tulipifera*) (Wean and Guard, 1940). In effect, what is happening is that the underdeveloped embryo requires a chilling period to remove the block that keeps it from developing. However, the embryo will not grow until it is moved to a warm environment. Thus, *Magnolia* seeds require a cold period (of about two months) followed by a warm period (of about one month) before they will germinate. What looks like an ordinary chilling requirement is, in reality, a special type of double dormancy. As far as I can tell, this dormancy type has never been recognized by seed dormancy specialists (Crocker and Barton, 1953; Stokes, 1965; Villiers, 1972; Mayer and Poljakoff-Mayber, 1975).

The situation in *Magnolia* contrasts with other dicotyledons that shed ripe seeds with underdeveloped embryos. In the case of *Panax ginseng* (Grushvitskij, 1956), and *Ilex opaca* (Ives, 1923), the tiny embryo grows to full size in warm temperatures but then will not germinate unless it receives a chilling period of 2 to 3 months. A variation of this type of dormancy is shown by *Viburnum acerifolium* (Giersbach, 1937) in which the radicle germinates during the warm period, but the epicotyl requires a chilling to grow. In the case of *Viburnum nudum*, on the other hand, both the radicle and the epicotyl grow to maturity and germinate without requiring any chilling. Finally, in the case of the herbaceous cow parsnip, *Heracleum sphondylium* (Stokes, 1952), the underdeveloped embryo actually grows to full size during the chilling process

Germination behavior of cleaned seeds of *Magnolia virginiana*. One hundred seeds per lot, except where noted.

Cold stratification period (in days)	Sow date	Number of days to germination *	Final germination %
0	21 Oct. - 1980	60	63%
14 **	4 Nov. - 1980	57	54%
27	17 Nov. - 1980	42	80%
42 **	2 Dec. - 1980	34	84%
58	18 Dec. - 1980	33	93%
71 **	1 Jan. - 1981	33	94%
89	19 Jan. - 1981	30	92%
103 **	2 Feb. - 1981	26	98%
111	10 Feb. - 1981	26	95%
133	4 Mar. - 1981	24	93%
162 **	2 Apr. - 1981	24	92%
193 **	3 Mar. - 1981	22	94%

* Germination is defined as the emergence of the hypocotyl above the soil surface.

** 50 seeds per lot.

and will even germinate in the refrigerator.

Thus, within the category of dicots which shed their seeds with underdeveloped embryos (which I shall arbitrarily define as having embryos less than 25 percent of the length of the mature seed), we have four basic germination behaviors: (1) plants which require only warm conditions; (2) plants which require a warm period and then a cold period; (3) plants which require only a cold period; and (4) plants which require a cold period followed by a warm period.

It should be kept in mind, of course, that the lack of a precise definition of germination complicates this otherwise neat situation. Villiers (1972) sums up the basic problem that one faces in discussing seeds with immature embryos: "It is difficult to decide whether this embryo development is part of the final stage of seed development or the initial stage of the germination process." In spite of this intrinsic difficulty, the type of dormancy shown by *Magnolia* and *Liriodendron* is distinct enough from those types already recognized to merit a classification of its own.

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. . . Short Takes

• Ronald Brightman, Edmonds, Washington, says we misidentified the photo on page 4 of the Spring-Summer 1980 issue as *M. sargentiana robusta* when it's really *M. campbellii*, as we photographed it at the University of Washington Arboretum at Seattle. Ron ought to know. He lives there. We probably knew them apart when we photographed them, but by the time our film was processed, our memory had fled.

• Domoto Nursery, mentioned in the Fall-Winter 1980 issue as the reported source of the *Magnolia denudata* 'Japanese clone,' is at Hayward, California, not in Japan, as written, which shows you can presume your way right out the window if you don't run down info that's incomplete.