Observations on Hand Pollination and Blossom Maturation in *Magnolia fraseri*

R. Neal Peterson

I have just finished the autumn job of putting my hybrid seed to bed in the refrigerator for a long winter's sleep. Now seems a good time to reflect upon this project that began more than four years ago and that will continue for many years to come.

In some ways this project really began many, many years ago when I was a boy exploring the deep woods that lay beyond the civilization of the Kanawha Valley, West Virginia. I loved the woods and everything about the woods: the wildflowers, ferns, shrubs, mushrooms, salamanders, birds, and other wildlife. If the plant had a beautiful flower and a reasonable chance of surviving transplantation, I brought it home and planted it in the small woods behind my parents' house. Needless to say, not everything survived. But much has and the spring wildflower show there is a sight to behold.

I remember the day my explorations above Twistabout Creek in Clay County revealed to me my first mountain magnolia. "This is definitely a different tree the likes of which I have not seen before," thought I. And, I had to look it up in Strausbaugh & Core to identify it. *Magnolia fraseri*. Not a cultivated, foreign-to-these-parts magnolia, like the southern magnolias and saucer magnolias that grew in town, but a wild and native magnolia! This fact made the tree more exotic to me than if it had been from a faraway land across the wide sea. Over the years I fell in love with it, loved the way it grew, loved its large beautiful leaves, the way the leaves whirled around the tips of the branches in circles, and the purplish or sometimes copper-*y* color of the unfolding leaves. I loved especially the elegantly formed flowers, those fragrant chalices of pale cream that open with the unfolding spring leaves; loved the smooth, gray, beech-like bark; the stately size of the tree; the rosy crimson seed cones; the dark chocolate-*y* leaves of autumn marked with strange concentric circles of light and dark. And, I loved its reclusive nature and the cooler higher elevations it chose to inhabit. "What other tree in West Virginia could compare to it in elegant beauty?," I thought. Some are more flamboyant and more showy, dogwood and redbud, but this is a special tree.

So you see, I am a nut about *M. fraseri*. It is, in my opinion, the most overlooked, under appreciated, flowering tree in all of Appalachia. Keep in mind I am saying this about a region that boasts a bounty of native beauties—serviceberry, dogwood, redbud, silverbell, black locust, umbrella tree, sourwood, to name a few. We who live in the southern mountains are fortunate to have so much natural beauty at our back door. Yet while most of those trees I mentioned are cultivated widely, the mountain magnolia is not. Which is a shame, for although *M. fraseri* is not as showy as its Asian magnolia sisters that grace our urban and suburban parks and gardens, it is certainly showier and more fragrant than *M. tripetala,* which is frequently cultivated. And, it is one of the hardiest of magnolias, arguably as hardy as *M. acuminata* (zone 4). If only it wasn't so persnickety about soils and climate, insisting they resemble its mountain home (elevations 3,280 feet (1000m) or more) of cool, well-drained, acid soils and moderate summer temperatures! (For a fine article describing *M. fraseri* see "*Magnolia fraseri*" by Richard E. Weaver, Jr., pages 60-69, *Arnoldia,* March/April 1981.)

Well, being a nut about *M. fraseri,* when I learned from J. C. Raulston that Ron Lance of the North Carolina Arboretum was more passionate about this species than I am, I knew I had to meet him. So early in September 1996, the perfect time for collecting *M. fraseri* seed, I traveled to Asheville for a visit with Ron. We talked of many things, of collecting seed and germinating it, of natural variation and possible hybrids in wild magnolia populations and of other wild magnolias.

He took me to his favorite tree of *M. fraseri* to collect seed. It was a stately giant standing along a mountain road, loaded with crimson cones. Its trunk was over 24 inches (61cm) in diameter at breast height, its lowest limb eight feet (2.5m) over our heads, and it rose to a height of 75-80 feet (23–24.5m). I admired its size and vigor (see photo).

Standing by the trunk, with a rope and pole at the ready, I wondered how Ron intended to use the rope and pole to climb the tree. Tying an end of the rope to his belt and the other end to a hook on the end of the pole, he handed me the pole, and then proceeded to astonish. Wrapping his arms and legs around the wide column of wood, he shinnied up the eight naked feet of trunk to the first limb. Ascent by pure muscle power! He did it as easily as a walk in the woods. I was dumbfounded. At no time in my entire life could I do *that*!

Then, pulling the rope and pole up behind him, he ascended from limb to limb upwards into the green leafy heights of the tree, and disappeared from view. Suddenly, little bombs began plummeting to earth. BAM! BAM! they plopped all around me in the litter. Then I, condemned to an earthbound existence, scampered around like some half-crazed, seed-happy chipmunk, scooping up the crimson-pink seed cones. Not once was I hit on the head.

But that is an aside to the main story, and merely shows that both Ron and I happen to like mountain magnolias. As we talked that day, Ron mentioned that he knew of an unusual population of *M. fraseri* var. *pyramidata* growing in east Texas. This population is unusual because it grows in the xeric sand hills of Texas, a site totally different from the mesic ravines, and other mesic sites, that *M. pyramidata* occupies throughout the rest of its range. "Such a different environment from the soils and climate where *fraseri* grows," I said. "What if *pyramidata* were to be crossed with *fraseri*? Would their progeny exhibit a greater adaptability than either parent? Oftentimes hybrids exhibit greater adaptability. It should be easy to make the cross, as *pyramidata* is simply a subspecies of *fraseri*. It looks virtually the same as *fraseri* except for being smaller. If the hybrids were more adaptable, then Fraser magnolias could conceivably become available to those magnolia gardeners who live in the lower, hotter elevations of the East, South, and Midwest. And, if the hybrid were smaller than *M. fraseri*, that too would be a plus." Ron agreed. Thus, this visit begat our project.

A year and a half later, on April 18, 1998, I flew to Houston, Texas, rented a car, and drove to the sand hills east of Jasper. There I contacted Mark Karpel, the private land owner of the trees, and after some negotiations managed to obtain his permission to collect flowers from his property. The next two days I explored the population of *pyramidata* that extends over 40 or more acres (16 hectares), and though it was the end of the blooming season, many trees were still in bloom from which I was able to select the following four trees for superior floriferousness, flower form, and size:

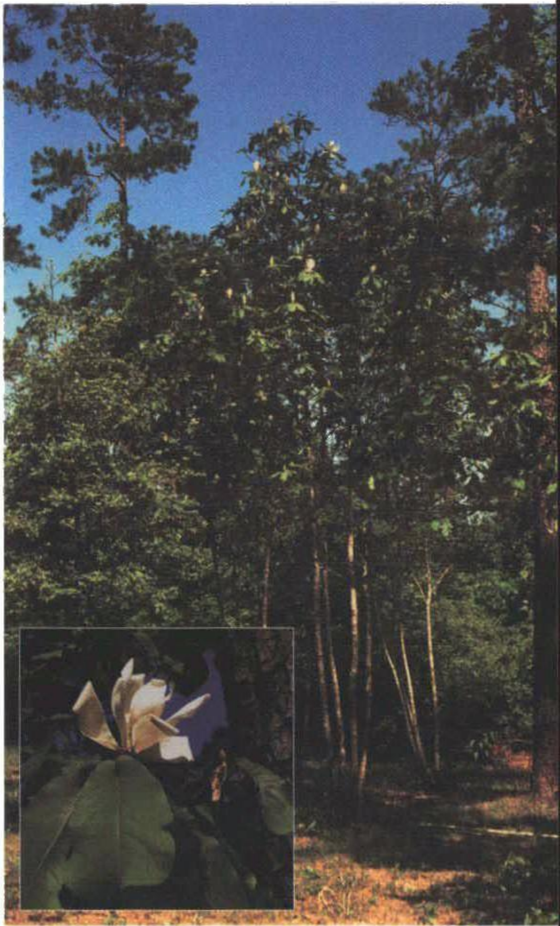
- Tree 1 Near the house. Made the best show of all the trees in that area. The stamen base is purplish red, a character not mentioned in Callaway (1994).
- Tree 2 North of Rt. 190. Was near the picnic table. Made a good show, better than other trees visible in the area, a radius of roughly 328 feet (100m). Stamen bases white.
- Tree 3 North of Rt. 190 and west of tree 2 (down a creek and up the other side). Near a ruined, fallen deer blind. Had largest and whitest flowers of all trees seen.
- Tree 4 North of 190 and south of tree 3. In a bend of the jeep trail. Flowers small with greenish outer tepals, but form excellent and tree floriferous. Good show.

M. fraseri on a slope in Haywood Co., NC. The flower is from a *M. fraseri* in Henderson, NC.

In the process of collecting, I learned that *pyramidata* pollen is shed much earlier than I had imagined. These assumptions were based on my limited experience with *M. grandiflora*. (I know now that I should have read the books more closely.) By the time the tepals have parted, not only has the pollen been shed but the anthers have fallen. To collect gynandrophores with undehisced anthers, I had to find flowers in the late candle stage. At this stage, the flower buds appear candle-like but show some separation at the tepal tips and edges to provide room for a small beetle to squeeze through.

Following the instructions for collecting pollen in Callaway's book, (pp. 188-189), but with a slight modification for travel, I impaled each gynoecium on a pin that I pierced through a polyethylene lid that fitted a tiny glass jar [1.5 x 2 inches (4 x 5cm)]. I then carefully snapped the lid, now holding the gynoecium, back in place on its jar. Thus packed, the gynoecium was protected from touching the sides of the jar. All the jars were then carefully packed inside a padded box that slipped neatly into my briefcase. One day later, I was safely back home in Washington. D.C., with my botanical treasures. The glass jars had maintained high humidity and the gynoecia appeared no worse for wear, time or travel; I observed no dehiscence. I removed the lids from the jars and inverting them, with their gynociea still impaled on the pins, set them on my desk to dry. One day later, the anthers had shed their pollen; whereupon I transferred the pollen into glassine envelopes which I placed in a sealed glass jar of desiccant.

This pollen became the source for three hybridization attempts. One lot of pollen was sent to Ron Lance; another to Charles Tubesing, who had agreed to help with the experiment; and the third I kept for myself. Charles pollinated a total of five flowers on two separate trees of *M. fraseri* var. *fraseri*, but no seed set. Ron pollinated a total of seven flowers on two separate trees of *M. fraseri* var. *fraseri*; 25 seed set on four cones on two trees. (I was unable to pollinate any that year because of work commitments and the distance from DC to West Virginia.) These results were very disappointing. I had hoped for enough progeny to distribute 20 or more seedlings to three sites for testing. As unlikely as it seemed that there should be barriers to cross-fertilization given the two subspecies' close relationship and their recent separation in geologic time, I was nonetheless forced to wonder if genetic incompatibilities existed between the populations. Or, had I collected and stored the pollen incorrectly?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M. pyramidata photographed in the sand hills east of Jasper, Texas.

By the spring of the following year, I was living in Franklin, WV, only a short drive from mountain ridges where *M. fraseri* grows abundantly. Still possessing the third lot of pollen, desiccated and stored in the freezer all this time, I decided to try my own hand at pollination, wondering, of course, if the pollen was still viable and, if so, how my attempts would compare to those of my colleagues. At 1 PM, May 28, I set off for the magnolia mountains, excited by the adventure but fearful that my late start had caused me to miss the best part of the day. At about 2 PM I pulled off the road on Middle Mountain at a stretch where many magnolias were in bloom. Unfortunately, these trees were *really* trees, most over 50 feet (15m) high, with few blossoms within reach Despite the size of the trees, there were still enough low hanging blossoms to work with.

I took great care to find flowers that were not opened and that showed no signs of insect damage or visitation. Although I was familiar with the flowering habits of *M. fraseri* var. *pyramidata* from having collected pollen the previous year, I was more familiar with the flowers at the male stage than the female stage.

As I searched for receptive female blossoms, I found that I must choose flowers that had not opened at all. (Once again, I should have read the books). This puzzled me, for I wondered what method pollinating beetles used to force entrance into the female stage flowers. It seemed clear that no insects had visited the flowers, as the flowers had not the slightest degree of opening, and I never saw any insect evidence inside. The stigmas on the gynoecium were short, feathery tongues of a pearly-white translucence. They looked receptive. By means of a tiny artist's brush I dusted the stigmas with the pollen from one of my vials, shut the flower back up, enclosed the entire bud in a little black sock made from pantyhose to prevent any insects from visiting the flower, and hung a small numbered tag from the peduncle. I searched for more flowers and more trees, and performed a couple more pollinations before moving on.

When I left Middle Mountain it was almost 4:00 in the afternoon. Time was moving fast and I had many miles to my next hunting grounds on Cheat Mountain. By the time I reached the top of Cheat it was almost 5:00 and I made slow progress. The road was rough and gravel, not suited to fast driving. And besides, I had to go pretty slow because I was looking at trees. It was stop, get out, examine flowers, pronounce them "not good enough," get back in the car, drive on. By the time I found the perfect tree with many unopened flowers in easy reach of the ground it was after 6:00. The sun was lowering in the sky. Working more efficiently now from having had practice, I performed three more pollinations. When checking the flowers to be sure they showed no signs of entrance or of insects having been inside, I couldn't help noticing the stigmas in these flowers were different. They were two, maybe three times longer and more feathery than those on trees I had pollinated earlier in the day. The difference was striking. By the time I performed the last pollination, the stigmas on that flower were the longest I had seen, and were exquisitely beautiful in a sinuous S-shape protruding from the gynoecium. "Miniature feather boas," I thought. It was like nothing I had ever seen on a magnolia before; certainly not *M. grandiflora*. (The photos of *M. fraseri* stigmas in Thien (1974) resemble the stigmas I saw in the afternoon, not evening the stigmas.) I finished bagging and tagging the flowers and left at twilight for the drive home.

In the last week of August, Ron Polgar and I collected the seed cones and later extracted the seeds. Success! Not only had the pollen been viable but there was a reasonable number of seeds. Interestingly, a pattern seemed evident in the data: pollination performed later in the day produced more seed (see table).

***M. fraseri* seed collection data**

Tree	Time	Pollen Source	No. of seeds produced
1	2:30 PM	#4	0
2	3:00 PM	#3	3
3	3:30 PM	#4	7
4	6:40 PM	#4	9
4	7:00 PM	#1	19
4	7:20 PM	#2	48

Of course, this was not a scientific experiment. Pollen from different sources were used on different trees at different times of day and the data were not subjected to statistical analyses. But even so, based on this small study and on my casual observations of the stigmas, I am persuaded to believe that *M. fraseri* is nocturnally pollinated.

Additional anecdotal evidence exists to support this belief in nocturnal pollination. I remember many years ago my friend Ron Polgar brought home an armful of mountain magnolia flowers to his wife, Suzi. He had collected a dozen or more branches from a large magnolia that a work crew had felled that day. Suzi tells me they made a lovely fragrant bouquet, but that in the middle of the night she got up from bed to throw them out of the house because the smell had become so overpowering.

According to Ron Lance, who has made close observations of the tepal movements of individual *M. fraseri* flowers over the course of several days, the timing of the tepal movements also support a hypothesis of nocturnal pollination. He reports (personal communication) the following:

- on day 1, the blossom remains unopened with tepals tightly appressed against one another
- at dusk on day 1, the tepal edges loosen slightly, but the tip remains closed; that the following morning the tepals close tightly again

- in the evening of day 2, the tepals open more widely and the following morning close somewhat, though not as tightly as before
- in the evening of day 3, the tepals reflex completely and remain open the following day

However, his report is contradicted by Thien (1974) and Dick Figlar (personal communication) who report that *M. fraseri* flowers close at night. It seems to me that the matter of *M. fraseri* tepal movement remains an open question requiring more observation. Scientists studying these matters must remember to note temperature and weather, as these can influence tepal movements.

A detailed study of the floral biology of *M. fraseri* would make an interesting and worthwhile research project. Tepal movements as related to time of day should be documented photographically, and so should the developmental sequence of stigma growth. Time-lapse photography could provide dramatic evidence of these changes. Collections of insects from the flowers at different times of day and night would be revealing. Very little is known definitively about the primary insect pollinators of this species (Thien, 1974: Piegler, 1988) perhaps for the very reason that insect collections in the past have been conducted during the day. Controlled hand pollination performed throughout the course of the day and night could also reveal times of maximum receptivity. Floral thermogenesis has recently been discovered in *M. tamaulipana* (Dieringer et al, 1999). It may be worthwhile to investigate the possibility of the same in *M. fraseri* as floral thermogenesis can be related to increased production of volatile attractants. (Thermogenesis is the production of heat within a flower. Skunk cabbage uses this process to push its flower through the snow.) Since I will probably not be performing any of these studies, having too many irons in the fire already, I can only hope that some of my readers will see fit to pursue these topics.

Notes:

There is a large variation in bloom dates and habits for *M. fraseri* across its range. I have observed that, in many years on Cheat and Middle Mountains, *fraseri* blooms coincide with the new unfolding foliage; whereas in North Carolina, bloom generally occurs after the foliage has expanded (Ron Lance, personal communication). Tom Dilatush's observations are that the variation in bloom time relative to leaf expansion is related to differences in temperature and day length (personal communication). Gardiner (1989) and Savage (1976) state that *M. fraseri* is the first American species to flower, with which I concur. Rockwell (1966) presented data on bloom dates for *M. fraseri, tripetala, virginiana and acuminata,* but did not control for altitude and latitude in his observations and therefore his data are severely flawed. The table of relative bloom periods in Callaway, Appendix C (1994) does not agree with my experience, as I have found that *M. fraseri* blooms *nearly* synchronously with *M. acuminata;* but Callaway may have used Rockwell.

Magnolia fraseri is frequently cited in tree guidebooks, and even in more scholarly works, as a small tree with heights of 30-50 feet. In the lower Appalachian elevations 600-1000 feet (182–305m) and at the highest elevations [over 6000 feet (1829m)] this is true, But, Lance and I find that it far surpasses those heights in its optimum habitat at elevations of 2000 to 4000 feet (610 to 1219m), where heights of 60 to 100 feet (18–30m) of mature canopy trees are commonplace. In forests managed for timber, *M. fraseri* is often culled as an undesirable species and so seldom attains a great age or size under those circumstances. The two champion specimens of *M. fraseri* , located in the Great Smoky National Park, are 107 and 110 feet (33 and 34m) high with circumferences of 116 and 113 inches (295 and 287cm) respectively, or roughly 3 feet (0.9m) in diameter (Bronaugh, 1994).

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