RECENT HYBRIDIZATIONS WITH AMERICAN MAGNOLIAS

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Introduction

In the following paper, which is an updating of the talk I gave at the Cincinnati meeting of the International Plant Propagators' Society in 1962, I discuss my own crosses involving so far the two Sweet Bays, *M. virginiana* L. (synonym: *M. glauca*) and *M. australia* Ashe with other species; mention crosses which several other breeders have made with American Magnolia species; and outline some of the possibilities of further breeding to secure new hybrids worthy of propagation as evergreen or deciduous ornamentals. Though one prominent botanist told me that he thought any two magnolia species were fertile to each other's pollen, experience indicates the situation to be less simple. We may not in the foreseeable future cross between the two subgenera of Dandy's classification, but there are enough interspecific crosses and even intersectional and 3-sectional hybrids (within both subgenera) to indicate that much more may be done with breeding in this ancient genus. In the North American species of both subgenera, too, there remains much that can be done in selecting superior cultivars. Summer chip-budding, with a plastic wrap, appears to be an economical propagation method for all such cultivars as do not grow readily from cuttings.

Complexity of the Genus

The genus Magnolia has recently been given a systematic treatment by J. E. Dandy (1948, 1950) who differs somewhat with the classification given by Rehder (1927.) With three additions of tropical American species published since Dandy's work, we now count at least 89 species, subdivided by Dandy among two subgenera (Magnolia and Pleurochasma) and eleven sections. Their distribution is in Eastern Asia and the Americas, north of the Equator. In each of the subgenera (according to Dandy) there is a section with species from the more northern temperature parts of both North and eastern Asia.

In subgenus Magnolia there are some Asian evergreen Magnolias, but none is in the same botanical section as any of the American species, and none appears to be quite as hardy as our *M. grandiflora*. Of the total 27 recognized American species, seventeen are in the section Theorodon, which includes besides *M. grandiflora* some sixteen others, divided between the continental uplands and the high islands, southward to the slopes of Cerro Roraima in the Guiana highlands of Venezuela. That section, and the small section Magnoliastrum, limited by Dandy to the Sweet Bays, are strictly American. A more cosmospolitan section in subgenus Magnolia, however, is the deciduous Rytidiospermum, including five species from eastern U.S. and one from the mountains of southern Mexico allied to *M. tripetala* and *M. macrophylla,* plus three in Asia, the Japanese and Chinese *M. obovata, M. officinalis* and *M. rostrata.*

In subgenus Pleurochasma there are two important (in cultivation) but wholly Asian sections, and a third section, Tulipastrum, with a single Chinese species, *M. liliflora,* and two American ones, *M. acuminata* and its close relative, *M. cordata.*

Earlier Hybrids Mainly of Asian Species

Recognized hybrids of Magnolia date back in origin to at least 1808, when Mr. Thompson, a nurseryman at London, raised an intersectional hybrid between two North American species. *M. virginiana* (synonym *M. glauca*) and *M. tripetala,* this fragnant hybrid still in cultivation as *M. Thompsoniana.* It was introduced about 1820. From France in 1826, Chevalier Soulange-Bodin introduced *M. Soulangiana,* another intersectional hybrid but from the second subgenus, having the Chinese *M. denudata* and *M. liliflora* as parents. Soulangiana varieties, the original and others, have become the most widely grown deciduous Magnolia cultivars in both America and Europe. In this century, its two parents have entered into further breeding in England and the United States. In 1907, Mr. Peter C. M. Veitch obtained a cross of *M. denudata* X *M. Campbellii* from which three seedlings were germinated, and one of these which first flowered in 1917 was introduced as *M. Veitchii* (an intrasectional hybrid in the section Yulania of subgenus Pleurochasma.) Mr. D. Todd Gresham of Santa Cruz, California in very recent years has produced some outstanding hybrids in combining *M. Veitchii* with *M. liliflora* (intersectional), and is continuing cross breeding in this promising line, to combine the beauty of *M. Campbellii* with the hardiness and smaller plant of *M. liliflora.*

Other introduced hybrids in the subgenus Pleurochasma vary from probably intraspecific for *M. Loebnerii* (*M. Kobus* var. *stellata* X *M. Kobus* var. *Kobus* according to Professor Benjamin Blackburn), through the intrasectional *M. Proctoriana* (*M. salicifolia* X *M. Kobus* var. *stellata*) and *M. highdownensis* (*M. sinensis* X *M. Wilsonii*) to perhaps 3-sectional in the sterile Magnolia 'George Henry Kern', if we consider the latter to be *stellata* X *Soulangiana.* In subgenus Magnolia, the hybrid *M. Watonsii* is said by Dandy to be an intersectional hybrid (*M. obovata* X *M. Sieboldii.*)

Recent Hybrids from American Species

Interest in hybridizing American Magnolia species revived in 1930, when Oliver M. Freeman, then of the U.S. National Arboretum at Washington, made the first recorded crosses of *M. virginiana* X *M. grandiflora.* From his numerous seedlings, the 'Freeman' cultivar was selected and named by the Arboretum in 1961. See Freeman (1937) and Kosar (1962.) Meanwhile, at least three others, including myself, had repeated Freeman's intersectional hybridization, and I had used pollen of the

'Freeman' clone to make back crosses on *M. virginiana* in 1961, with interesting results to be discussed below.

In 1960 and later, I have also intentionally repeated and confirmed the accidental 1808 cross of Thompson, and have several hybrids of the combination *M. virginiana* X *M. tripetala*, two clones of which were uninjured when exposed as top grafts to -14° temperatures in the 1962-63 winter at Urbana, Illinois. (The original *M. Thompsoniana* from England is reputedly less hardy than either parent.) I am increasing one hardy and vigorous clone of my *M. virginiana* X *M. tripetala* cross by cuttings, and if its flowers prove equal to those of the original *M. Thompsoniana* it will be introduced as a hardier cultivar.

While still at the U.S. National Arboretum, where Mr. William F. Kosar now is in charge of Magnolia work, O. M. Freeman in 1944 had crossed *M. acuminata* X *M. cordata* (sometimes regarded as *M. acuminata* var. *cordata*.) Clones of this intrasectional hybrid are being evaluated, according to Mr. Kosar (1962.)

At the Royal Botanical Gardens, Kew, England, what was probably the first intercontinental (though intrasectional) hybrid was produced, I am told, by crossing between *M. tripetala* and *M. obovata*. This hybrid seemed in England to offer no advantage over its Japanese parent, and was not introduced. It might merit repetition in America, where I have observed that the more decorative *M. obovata* is less hardy than *M. tripetala*, which is being grown as far north as St. Paul, Minnesota. The second, and more exciting intercontinental hybrid (also intrasectional) was mentioned at our 1962 Cincinnati meeting by its breeder, Doris M. Stone of the Brooklyn Botanic Garden staff (1962 Proceedings, p. 114.) She has secured some quite promising crosses using *M. acuminata* as the female parent. One of her *M. acuminata* X *M. liliflora* hybrid seedlings, nine feet tall in 1962, had flowers described as a sort of "dusty pink" color, and was quite hardy in a cold part of Westchester County, 50 miles north of Brooklyn. We may look for some introductions of hybrids from Mrs. Stone's work before many years.

Reasons for Some Newer Crosses and Back-Crosses Involving Magnolia grandiflora

Magnolia grandiflora is the principal "evergreen magnolia" planted in warm temperate areas around the world, and is justly regarded as one of the most beautiful in tree form and foliage among the world's ornamental trees, whether evergreen or deciduous. Sometimes regarded less strictly as a "flowering tree" than some of the deciduous Magnolias, it is probably more often included in modern American plantings for its foliage and form than for its fragrant large white flowers. Yet there are some clones in the southeastern states and up to southern Illinois in which the usual six weeks flowering season of the species may be stretched from mid-May to October or even November. Experience of growers scattered from Connecticut to Kansas shows that it is not so strictly southern in its adaptation as the common name "Southern Magnolia" would denote. Yet it is admittedly more southern than the deciduous Sweet Bay Magnolia, *M. virginiana,* which has one natural outpost in an Essex County, Massachusetts swamp area north of Boston. And as it grows to 100 feet in its native habitat, *M. grandiflora,* in climates and soils best suited to its growth, can become an embarrassingly large tree for a small home property, if not pruned back, or selected and propagated as a smaller than average cultivar. To Freeman, therefore, and to some of us working with it more recently, it seemed desirable to try hybridizing *M. grandiflora* with the naturally smaller *M. virginiana,* in an attempt to secure trees that might have wider usefulness because of greater hardiness, smaller stature, and perhaps finer texture. There was also the lure of seeing what unexpected new recombinations might be obtained from a hybrid not known to occur in nature.

Others who are known to have made crosses with *M. grandiflora* and Sweet Bay Magnolias between 1930 and 1960 are Dr. Yoneo Sagawa, a cytologist at the University of Florida, Gainesville, and Dr. Fred C. Galle of the Ida Cason Galloway Gardens at Pine Mountain, Georgia. Both probably had the Southern Sweet Bay, *M. australis* Ashe (or *M. virginiana* var. *australis* Sargent), the pubescent, taller, more nearly evergreen one which I think W. W. Ashe was correct in calling a separate species. It is the usual Sweet Bay in their areas, and probably the only one occurring naturally west of Georgia, in the range from Alabama and west Tennessee, through Mississippi, southern Arkansas and Louisiana to the edge of Texas. Dr. Sagawa used *M. grandiflora* as the female parent, and obtained hybrid seedlings but these failed to survive. Most of Dr. Galle's seedlings, which showed mainly *M. grandiflora* leaf characteristics, like Freeman's hybrids and my first crosses of similar parentage, accidentally were mixed with a lot of *M. grandiflora* in a landscape planting, but may be rediscovered when they reach flowering age. Dr. Galle also is culturing a few seedlings of *M. grandiflora* X *M. Thompsoniana,* which so far look like *M. grandiflora.* I have some seedlings also now from a 1962 cross of *M. australis* X *M. grandiflora* made on the one *M. australis* so far flowered in Urbana. As with my seedlings of the combinations previously mentioned, some are weak or have already died at early stages, but several are growing satisfactorily.

Variations Observed in Crosses and Back-Crosses

The cross of *M. virginiana* X *M. grandiflora,* like the early one of *M. denudata* X *M. liliflora* (and some more recent ones involving Asian Magnolias) unites species with different chromosome numbers. *M. grandiflora* has 114 chromosomes and is the only hexaploid among species native to the United States. *M. virginiana* is a diploid with 38 chromosomes. (Presumably *M. australis* also is diploid and *M. Thompsoniana* likewise.) In nearly all these first crosses of a diploid with the hexaploid *M.*

grandiflora, the latter has proved quite dominant for evergreen character (though the leaves may be relatively thinner) and in suppressing the expression of the glaucous underside leaf color common to the several American diploid Magnolia species parents. In the 'Freeman' hybrid, the flowers are of intermediate size between the two parents, but look more like a smaller *grandiflora* rather than a larger *virginiana.*

Mr. J. E. Dandy suggested that if *M. grandiflora* produces hybrids with another temperate-zone American species, the hybrids should be expected to show some degree of stipular scars on their petioles, which *M. grandiflora* does not, at least beyond the first few leaves above the colyledons in young seedlings. I find this to be true with some leaves on all the known *M. grandiflora* hybrids I have examined recently. By Dandy's criterion, and by other indications, an evergreen, generally *grandiflora*-like tree used as a pollen source in my 1961 crosses on *M. virginiana* and 1963 crosses on *M. australis,* may itself be of at least remotely hybrid origin. This is the somewhat mysterious specimen, probably more than 100 years old and of unknown original source, now owned by Mr. and Mrs. Charles E. Dickens in Franklin County, Tennessee. Its broad, glossy, flexible leaves and its large, highly red-pigmented seed cones at maturity are its chief readily visible distinctions from the ordinary *M. grandiflora* seedling. But as a pollen parent in my crosses with *M. virginiana* it gave rather similar seedlings to those obtained with the hybrid "Freeman" pollen, and a root-tip cytological examination of one of its open-pollinated seedlings (made by Dr. Frank S. Santamour, Jr. of the Northeastern Forest Experiment Station early in 1962) indicate it to be a 76-chromosome tetraploid. (Another open-pollinated seedling from the Dickens tree, examined by Dr. Hale M. Smith at the Botany Department, University of Illinois in 1963 appeared to be approximately hexaploid.)

The 'Freeman' and other such first crosses of *M. virginiana* X *M. grandiflora* should have received 57 chromosomes from *M. grandiflora* and only 19 from the diploid parent, so it is not surprising that the hexaploid parent should show so high a degree of dominance.

But cross such a hybrid back to *M. virginiana* and the resulting back-cross hybrids should be approximately triploids, in the neighborhood of 57 chromosomes, and with nearly equal numbers of chromosomes (give or take a few) coming from each of the original parental species. The back-cross seedlings I obtained with 'Freeman' pollen, and also the hybrids between *M. virginiana* and pollen of the Dickens tree are altogether more "hybrid" in appearance than are the first crosses, being more nearly intermediate in appearance between *M. grandiflora* and *M. virginiana.* Nearly all these 'Freeman' back-cross and Dickens hybrids show to a considerable degree the glaucous leaf undersides derived from *M. virginiana,* and their leaves are thinner and apparently will be narrower and shorter on mature plants than are those of 'Freeman.' The range of leaf variation is somewhat greater in the Dickens hybrids than in those from 'Freeman' pollen so far obtained.

Vigor of growth, as mentioned previously, shows considerable variation within nearly all my hybrid seedling populations, and I expect that it may be possible to get some rather shrubby evergreens at maturity, in addition to tall tree forms. All my 'Freeman' back-cross seedlings and all hybrids (and open-pollinated seedlings) from the Dickens tree so far seen appear to be evergreen, the climate permitting. They are gradually being tested for hardiness.

I should mention that Don Shadow at Winchester, Tennessee has started grafting clonal material of the Dickens tree, and it should be on the market as a cultivar some few years hence. Several nurserymen in that area have been growing open-pollinated seedlings of it, which in general reproduce its leaf type. Though they apparently show somewhat too much variation to properly qualify as a seed-reproduced cultivar, it is without doubt an elite seed source. In 1962, Mrs. Jewel Templeton used the Dickens tree as a seed parent and with *M. australis* pollen I furnished to her, had seeds develop which have apparently given apomictic reproduction of the seed parent. This subject of apomixis in Magnolias will be mentioned further below, and seems to need more investigation as a possible method of commercial propagation in certain cases. It remains to be seen whether the Dickens seedlings which now appear to entirely resemble the seed parent will actually be like it in spectacular fruit display when they mature.

Possibilities for Further Inter-Sectional Hybrids

In the subgenus Magnolia, the fertile hybrids already obtained suggest further possibilities for recombinations. At least one inter-sectional hybrid now is known, involving respectively the sections (1) Theorodon X Magnoliastrum, (2) Theorodon X (Magnoliastrum X Rytidiospermum), (3) Magnoliastrum X Rytidiospermum and (4) Rytidiospermum X Oyama. The sections Rytidiospermum and Oyama each have an intrasectional hybrid species. In Magnoliastrum, several trees have been seen which perhaps combine *M. virginiana* and *M. australis*, while *M. grandiflora* (section Theorodon) is so variable as to suggest probable descent from at least two other species (extant or extinct) within its section.

I am attempting hybridization of *M. virginiana* X *M. macrophylla*, and harvested two cones from this cross in 1963. If successful, this cross should give a reduced leaf size compared to *M. macrophylla*, while giving larger flowers than *M. virginiana*.

Section Oyama, with the species *M. Sieboldii, M. globosa, M. sinensis, M. Wilsonii* and the hybrid *M. highdownensis* (*M. snensis* X *M. Wilsonii*) is entirely Asian, but it has hybridized once with a species in the partly American section Rytidiospermum to give the beautiful *M. Watsonii* (*M. obovata* X *M. Sieboldii.*) Since *M. tripetala* is hardier than anything in section Oyama, either it or one of its hybrids should be tried in further crosses with the Oyama magnolias, to make their beauty available for more parts of America.

In the subgenus Pleurochasma, I understand that Mrs. Stone's recent hybrid of *M. acuminata* X *M. liliflora* has already been crossed with some pollen from one of D. Todd Gresham's hybrids, *M. liliflora* X (*M. denudata* X *M. Campbellii*), which should give quite interesting four-species, two section, two-continental hybrids. Further combinations of *M. acuminata* or its hybrids with anything in this large subgenus should be rewarding in introducing greater hardiness, as *M. acuminata* may probably be the hardiest of all Magnolia species. Some of the more fertile Soulangiana derivatives, such as 'Grace McDade' and 'Rustica' might well be tried, for breeding with the *acuminata* derivatives.

Apparent Barriers to Some Magnolia Hybridizations

There will no doubt be further combinations and recombinations of Magnolia species by controlled or chance crosses. I am now attempting with some success to line up a few pollen sources south of the U.S. for some of the relatives of *M. grandiflora*, to use on it and on *M. virginiana, M. australis* and their hybrids. None of these so-called tropical American Magnolias appears yet to be in cultivation in the continental U.S., even in southern Florida, according to recent correspondence I have had with E. A. Menninger, "The Flowering Tree Man" at Stuart, and Dr. John Popenoe of the Fairchild Tropical Garden at Miami. Menninger suggests that some of these may not actually be tropical in their adaptation, since they occur at elevations up to 8000 feet for the Costa Rican *M. poasana* and 7000 feet for two in Venezuela.) Dr. A. J. Sharp of the University of Tennessee thinks that at least the two he has examined in Mexican highlands may actually fall within the limits of the wide variation shown by *M. grandiflora* within the U.S. The Mexican *M. Schiedeana* is a hexaploid like *M. grandiflora.* But Janaki-Ammal (1952) found one of the two Dominican Republic species, *M. Hamori,* to be a diploid.

It has been shown that hybridization can occur between Magnolias with widely different chromosome numbers, and that some of the hybrids at least are fertile enough for further crossing. Hybrids are also known which cross the lines between two and even three of the botanical sections of the genus, and between Asian and American species within a section. No one, so far, has successfully crossed between the two subgenera, represented in both continents.

Mrs. Stone in 1962 has mentioned the occurrence of apomixis as an obstruction in the path of hybridization, particularly with *M. virginiana* as the seed parent. Though this is by no means universal in that species, as evidenced by Freeman's hybrids and those I have obtained with several different seed trees of *M. vrginiana* in Illinois, I too have encountered at least one tree where in 1960-61 several cross-pollinations resulted only in seedlings that looked like duplicates of it. With this particular shrubby and narrow-leafed clone growing in Champaign, Illinois, I obtained a few true hybrids with a long-flowering *M. grandiflora* selection in 1962, though the majority of its seedlings from my presumably well-controlled crosses continue to turn out non-hybrid. Wide crosses (pollen other than *M. grandiflora*) appear to give apomictic seedlings from the Dickens Magnolia tree in Tennessee.

In addition to crossing failures attributable to too little relationship between parents, some crosses, in the section Tulipastrum at least, may fail because there is too close a similarity. This section, including *M. acuminata* and *M. cordata* of North America and *M. liliflora* of China, seems to parallel the related genus *Liriodendron* in having many trees highly sterile to their own pollen. This sterility may extend to a considerable degree to crosses between trees having similar sterility factors, as reported for *Liriodendron* by Carpenter and Guard (1950) and Boyce and Kaeiser (1961.) Most of the other species of American Magnolias that I have studied show indications of being compatible with their own pollen. In another paper I discuss an exceptionally self-fertile *M. acuminata tree.*

Dichogamy seems to be universal in Magnolia flowers. In all but one reported species it takes the form of protogyny, where the pistils are receptive a little before and after a flower first opens, but became unreceptive before the same flower sheds its pollen a day or so later. The expection is reported by Johnstone in England for the Chinese evergreen species *M. delavayi* where the flowers are protandrous, shedding pollen before their own pistils become receptive. In no case should dichogamy, as such, be a barrier to cross-pollination, if proper pollen (or even "improper" but compatible pollen) is applied to the pistils during their receptive period. Since most magnolia trees have at least a several-day spread in time of flower opening, most should be fruitful within the clone, if suitable insects are present to carry pollen from an older to a newer blossom. A few of the hybrids seem strictly sterile, as 'George Henry Kern' and *M. Soulangiana* 'Verbanica'. Perhaps dichogamy has accounted for many failures of attempted magnolia crossing, where breeders applied the pollen too late. With the American species, at least, the late bud stage seems to me to be the most favorable pollination time.

Weather conditions can be a barrier to successful crossing (or selfing) of Magnolias in parts of the U.S. for species that usually flower there, for two or more reasons. In the lower Southeastern States there seems to be rarely any seed production on early flowering Asian species and their hybrids. Mr. D. Todd Gresham at Santa Cruz, California tells me that *M. grandiflora* (usually quite fruitful in the Southeast) seldom holds fruits after flowering along the fog belt of the California coast. Weather, or perhaps self-sterility, may account for the infrequent production of seed on a *M. denudata* specimen at Urbana, Illinois.

Besides actual freeze injury to the flower parts, weather too cool, or too hot, at flowering time may possibly interfere with pollen germination or fertilization. Unfavorable weather could result in spoilage of pollen, or interfere with its natural distribution by insects, though we do not need or want insects in our parent flowers for controlled crosses. Dr. Charles E. Heiser, Jr. of Indiana University has studied the relationship of insects to natural fertilization in American Magnolias.

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MODERATOR MCDANIEL: Our next paper will be given by Jim Wells, James Wells Nursery, Inc., Red Bank, New Jersey.

THE USE OF CAPTAN IN THE ROOTING OF RHODODENDRONS

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I would like to take one of the three minutes allotted to me. if I may, to mention briefly an aspect of our work which I think has not always been recognized, and that is the "quality" of the rooting obtained from any given treatment. I believe that sometimes we are inclined to be mesmerized by percentages, and it is very easy to present a misleading picture from figures which do not reflect the quality of the rooting obtained. We all know how much the successful re-establishment and ultimate survival of a young plant depends upon the quality of the root system produced in the propagation bench. Where material is propagated in fall or winter, the percentage of survival the following spring, no matter how carefully the storage conditions may be controlled, is in direct ratio to the number and the quality of roots on the cutting when they are first moved. I must own that I was quite disturbed to hear at last year's meeting, a num-