THE ROLE OF PLANT PROPAGATION IN THE PLANT BREEDING PROGRAMS OF THE U.S. NATIONAL ARBORETUM

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Plant propagation plays a vital role in every facet of the tree and shrub breeding programs at the U.S. National Arboretum (USNA). Although the Arboretum employs most commercial propagation methods, the way in which they are used and the plant materials involved make for a very unique propagation program.

The tree and shrub breeding projects of the USNA have been of particular interest to the members of the IPPS and other plant industry associations. The USNA has strived to introduce to the nursery trade plants with improved horticultural characteristics, which are most often meant to rectify deficiencies found in the list of available cultivated plants. The improved trait of a new plant may range from such functional characteristics as increased disease resistance to visual attributes such as novel flower color.

The main role of the shrub breeding project, led by Dr. Donald Egolf and described in previous papers (2, 3), has traditionally been the introduction of new cultivars. Mr. Gene Eisenbeiss has led the holly (*Ilex*) project. Its main emphasis have been on hybridization to improve the available germ plasm and on holly taxonomy. The tree breeding project, initiated by Dr. Frank S. Santamour, Jr. (recently joined by Dr. Alden Townsend) has been broader in scope; only recently has cultivar introduction become a priority. Previous papers describe the USNA's introduction program and research goals (1, 4, 5).

Vegetative propagation by cuttings is by far the most important propagation method used in selection programs. In turn, the process of selection, the simplest means of genetic improvement, is the most important technique used in the USNA programs. Selection is the technique whereby wild or cultivated, existing plants are screened for new and desirable horticultural characteristics. A selection may be an isolated plant or an individual in the midst of a large seedling population.

Once an individual with potential has been recognized, it must be thoroughly evaluated. Evaluation is the beginning of a long process, involving propagation at many steps along the way. The Arboretum must first propagate enough plant material to be sent out to cooperators for evaluation. Generally, the propagation must be in the form of cuttings, since grafted or budded plants could cause a mix-up (i.e. the living rootstock under a dead scion might

inadvertently be evaluated). A small number of rooted cuttings are all that are required at this stage. However, obtaining even a small number of a difficult-to-root plant can cause frustration and delay!

After a selection has undergone evaluation and the decision has been made to continue towards its release, another group of rooted cuttings must be sent to wholesale propagating cooperators. These cooperators may propagate the new plant by any feasible method which facilitates stock increase in anticipation of future sale. After an adequate supply of ramets has been propagated by the stock increase nurseries, the originator at the Arboretum assigns the plant a legitimate cultivar name and registers the name with the International Registration Authority for the particular genus. An official release notice is formulated through the Agricultural Research Service (ARS) of the U.S. Department of Agriculture. The wholesale cooperators are responsible for the release of the new cultivar to other wholesale and retail nurseries. The Arboretum will often supply additional propagations to other public or research (non-commercial) facilities.

Propagation by cuttings is also central to a more complex method of cultivar development—hybridization. This differs from the previous process only in how the potential new cultivar is created. Beginning with the evaluation by cooperators the steps are virtually the same until the plant's final release. Compared to simple selection, many more steps of propagation may be required in this type of breeding program.

A much-simplified example can be described as follows. Two parent plants are selected, each with a unique superior trait. The parents are selected with the intent that the combination of their characteristics would create a highly desirable plant. Through some means of controlled cross-pollination the two parent plants are hybridized. This process may be very complex, depending on many factors that include flower type, flowering time, and sexual compatibility. It is always prudent to propagate the parent plants (vegetatively) at the initiation of the project to insure against loss if the hybridization needs repeating in subsequent years; parent plants also serve as references for comparison with the progeny.

If all goes as planned, seeds will develop on the plant used as a female. These seeds provide the next generation of plants. Many times very few seeds develop, which makes this propagation step crucial; it must be done carefully to avoid losing any viable seed.

It should be noted that with interspecific crosses, it is necessary to determine whether the resulting seedlings are true hybrids. If morphological features are very distinct, hybridity may be assumed from morphological characteristics. Chemical methods and chromosome counts, when applicable, are more reliable characteristics upon which to base hybridity. As the progeny grow, several may be selected for continued evaluation.

These preliminary selections are propagated by cuttings and sent to cooperators for evaluation. It is easy to see that the process of selection is involved in any introduction of a new cultivar whether or not controlled pollination is employed. After cooperator evaluations, a final choice is made by the originator and the resulting cultivar is propagated in sufficient numbers to be sent out to wholesale cooperators for stock increase. Both the evaluation by selected cooperators and the propagation by wholesale cooperators are mediated by legal agreements, namely the "Standard Memorandum of Understanding for Evaluation of Potential New Cultivars of Ornamental Shrubs and Trees" and "Standard Memorandum of Understanding for Increasing the Planting Stock of Vegetatively Propagated Stock."

A good example of a hybridization program done at the USNA is the work that resulted in the release of two *Platanus* (planetree) cultivars in 1984 (6). 'Liberty' and 'Columbia' originated from crosses made in 1968 and 1970 respectively, between *P. orientalis* L. and *P. occidentalis* L.; the same species are the parents of the so-called "London" plane (*P.* ×*acerifolia* (Ait.) Willd. or *P.* ×*hispanica* Muenchh.). The goal of the project was to combine the disease resistance (sycamore anthracnose) of *P. orientalis* with the hardiness and growth form of *P. occidentalis*. Several hundred seedlings from the controlled pollination were planted out where natural infection by the anthracnose fungus (*Gnomonia platani* Kleb.) could occur. Four clones were selected for their resistance after 2 years of anthracnose infection. All four were also found to show strong compartmentalization of wounds (7) against decay organisms. These were propagated by cuttings and planted out again in field and roadside tests.

'Columbia' and 'Liberty' were selected for their superior growth and appearance. Two plants were named since each may respond differently to other pests and diseases and to various planting sites (6). The introduction process, from pollination to release to wholesale propagators, took 14 to 16 years, a time interval quite common in such a breeding program.

In addition to propagation by cuttings, seed propagation may play a major role in a USNA breeding program. As mentioned previously, seed resulting from controlled pollinations must be harvested, stored, and germinated for progeny testing. Also, potential germplasm for future breeding work is sometimes found on seed lists through the Index Seminum (a world-wide cooperative seed distribution program among arboreta and botanic gardens). Plant exploration trips often bring seed to be evaluated for future use. The seed are typically from uncommon plants and must be handled with utmost care.

In general, the National Arboretum does very little large-scale propagation. However, most propagation projects are crucial in the

outcome of Arboretum breeding programs. Each step along the path to the release of a new cultivar requires some type of propagation and successful propagation is essential to the final goal.

The following list represents the most recent compilation of cultivar releases from the U.S. National Arboretum breeding programs:

Buxus microphylla var. *japonica* (Muell.-Arg.) Rehd. & Wils. 'Morris Dwarf', 'Morris Midget', 'National'

Camellia 'Ack-Scent', 'Ack-Scent Pink', 'Ack-Scent Red', 'Ack-Scent Sno', 'Ack-Scent Spice', 'Ack-Scent Star', 'Ack-Scent White', 'Cinnamon Cindy', 'Fragrant Joy', 'Fragrant Pink', 'Fragrant Pink Improved', 'Frost Prince', 'Frost Princess', 'Sunwor-shiper', 'Two Marthas'

Camellia japonica L. 'Frost Queen'

Clematis viticella L. 'Betty Corning'

× *Cupressocyparis leylandii* (A.B. Jacks & Dallim.) Dallim & A.B. Jacks. 'Silver Dust'

Eurya japonica Thunb. 'Winter Wine'

Hibiscus rosa-sinensis L. 'Vulcan'

Hibiscus syriacus L. 'Diana', 'Helene'

Ilex 'Accent', 'Apollo', 'Clusterberry', 'Elegance', 'John T. 'Morris', 'Lydia Morris', 'Oriole', 'September Gem', 'Sparkleberry', 'Tanager'

Ilex × *attenuata* Ashe 'Sunny Foster'

Ilex crenata Thunb. 'Highlight', 'Twiggy'

Ilex × *koehneana* Loes. 'Jade', 'Ruby'

Iris kaempferi Siebold ex Lem. 'Blue Zebra', 'Capitol Dandy', 'Enduring Pink Frost', 'Grape Fizz', 'Lasting Pleasure', 'Lavender Krinkle', 'Pink Bunny', 'Royal Fire-works', 'Sky and Mist', 'Violet Vase', 'White Profusion', 'Wine Ruffles'

Kalmia latifolia L. 'Bettina'

Lagerstroemia × 'Muskogee', 'Natchez', 'Tuscarora', 'Acoma', 'Hopi', 'Pecos', 'Zuñi', 'Tuskegee'

Lagerstroemia *indica* L. 'Catawba', 'Cherokee', 'Conestoga', 'Potomac', 'Powhatan', 'Seminole'

Magnolia × 'Ann', 'Betty', 'Freeman', 'Galaxy', 'Jane', 'Judy', 'Maryland', 'Nimbus', 'Pinkie', 'Randy', 'Ricki', 'Spectrum', 'Susan'

Malus sieboldii (Regel) Rehd. 'Fuji'

Metasequoia glyptostroboides H. H. Hu & Cheng 'National'

Platanus × 'Columbia', 'Liberty'

Pyracantha × 'Mohave', 'Navaho', 'Shawnee', 'Teton'

Pyrus calleryana Decne. 'Capital', 'Whitehouse'

Rhododendron × 'Bowie', 'Pryored'

Rhododendron austrinum (Small) Rehd. 'Yellow River'

Rhododendron bakeri (W. P. Lemm. & McKay) H. Hume 'Camp's Red'

Rhododendron prunifolium (Small) Millais 'Hohman'

Ulmus × 'Homestead', 'Pioneer'

Ulmus *parvifolia* Jacq. 'Dynasty'

Viburnum × 'Chesapeake', 'Eskimo', 'Oneida'

Viburnum × *burkwoodii* Burk. & Skip. 'Mohawk'

Viburnum × *carlcephalum* Burk. ex Pike 'Cayuga'
Viburnum dilatatum Thunb. 'Catskill', 'Erie', 'Iroquois'
Viburnum lantana L. 'Mohican'
Viburnum plicatum Thunb. forma *tomentosum* (Thunb.) Rehd. 'Shasta', 'Shoshoni'
Viburnum rhytidophylloides Suringar 'Alleghany'
Viburnum sargentii Koehne 'Onondaga', 'Susquehanna'
Viburnum sieboldii Miq. 'Seneca'

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