DEVELOPING AND IDENTIFYING HARDY LANDSCAPE PLANTS

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This presentation will attempt to accomplish three things. The first is to review some background information that provides the basis of our approach to breeding and selection of cold hardy landscape plants. Secondly, I want to discuss a cooperative plant improvement effort that I am promoting. Third, I would like to mention our plant improvement research at the University of Minnesota Landscape Arboretum.

The primary goal in improvement of landscape plant materials is to combine desirable aesthetic and utilitarian qualities with ability to tolerate environmental stresses. The most limiting environmental factor for landscape plants in much of the United States is cold winter temperatures. To incorporate tolerance to such low temperature, an understanding of the physiology and genetics involved is essential. Research has shown that, in simplified terms, cold acclimation is a two-stage sequence, with photoperiod the initial stimulus triggering various metabolic events leading to cold acclimation (14). Cold temperature triggers the second stage of the process. In cases of plant species that are native over a wide geographic area, different geographic ecotypes have evolved with different critical photoperiods triggering growth cessation and initiation of cold acclimation (6,12,13). Research by Pauley and Perry (6) working with *Populus trichocarpa* illustrates the magnitude of these differences. They grew provenance collections from throughout the native range at Weston, Massachusetts, latitude 42° N, and recorded cessation of growth. Plants from a 60° N latitude source ceased growth on June 20 (the period of longest days), while plants from 35° N. latitude were still growing actively on October 28 when the growing shoot tips were killed by frost. Whether difference in winter survival ability of different geographic ecotypes within a species is primarily due to difference in timing of acclimation or whether there is also difference in maximum hardiness is unclear at present. Information on the relationship of provenance to maximum cold hardiness potential is quite limited. Sakai and Weiser (11) found large differences in hardiness between coastal and inland populations of *Pseudotsuga menziesii, Thuja plicata,* and *Tsuga heterophylla* collected in midwinter and hardened in the laboratory prior to hardiness determinations. However, there was no difference in midwinter hardiness levels of *Populus deltoides* and *Salix nigra* from southern and northern sources tested in the same manner. George, *et al.* (4) tested hardiness levels in January of latitudinal ecotypes of *Quercus rubra*, *Betula alleghaniensis*, *Juglans nigra*, and *Prunus serotina* from provenance collections growing in Michigan and Massachusetts. They evaluated hardiness by exotherm analysis of the freezing point of super-cooled water in stem sections. They found little difference in hardiness levels and no correlation due to latitude of the source in any of the four species. More research is needed to determine how much variation exists in midwinter hardiness capability among different geographic ecotypes of a given species. Research by Sakai (10) and Pellett, *et al* (7) indicate that many species of woody plants can harden to withstand midwinter temperatures lower than those of the zones for which they are recommended. This data might suggest that timing of acclimation is the critical factor. Through coordinated acquisition and breeding efforts, potential exists for development of genotypes capable of growing in colder climates than where they are currently used.

Information on inheritance of cold hardiness factors is quite limited. However, information that does exist indicates that hardiness is a quantitative character. Working with different species of woody plants, Pauley and Perry (6), Dormling, *et al.* (2), and Eriksson *et al.* (3) determined that F_1 plants are intermediate to the parents in time of growth cessation. Zagaja (15) crossed hardy Chinese peaches to commercial cultivars, screened the F_1 generation for winter hardiness, and either selfed or backcrossed F_2 selections to the commercial cultivars. Results indicated that backcross seedlings resembled the recurrent parent in hardiness levels, while individuals were found in the F_2 population that were as hardy as the Chinese ancestor. Clausen and Hiesey (1) crossed different altitudinal ecotypes of *Potentilla glandulosa* then planted F_2 populations at several sites differing in altitude and observed survival over a period of several years. The segregating F_2 population exhibited many recombinations of growth patterns and a widely increased range of adaptability of each general growth form. Some cases of transgressive segregation for adaptation were also noted. Hummel, *et al.* (5) crossed northern and southern latitudinal ecotypes of *Cornus sericea* and compared the F_1 and F_2 populations to the parent plants for initiation of cold acclimation in response to decreasing photoperiods. F_1 populations were intermediate to the parents in response while F_2 populations exhibited a wide segregation in rate of cold acclimation. A few individuals acclimated at the same rate or even slightly faster than the northern parent and others were equal to or slower than the southern parent.

Results of these studies suggest exciting opportunities for development of adapted landscape plant materials through well planned and coordinated germplasm improvement efforts. Ecotypes of a given species, or perhaps different compatible species, from different geographic areas could be acquired and hybridized. Growing open pollinated seeds of the F_1 population would enhance the germplasm through recombination and segregation from the broadened genetic base. Populations of this enhanced germplasm could then be evaluated at various locations in appropriate areas throughout the U.S. for selection of superior recombinant types combining desirable aesthetic qualities with adaptation to local or regional conditions. If transgressive segregation takes place, as suggested in research by Clausen and Hiesey (1) and Hummel, *et al.* (5), clones could be selected that are adaptable outside of the current use range of even the hardier more widely adapted parent. Selection of superior plants could result in new clones for direct landscape use or in superior parental material for utilization in additional breeding activities.

To achieve the potential suggested by the research just cited, a cooperative approach would be more economical and would yield greater returns for the cost than would projects conducted solely at any one location. For us in Minnesota, we have the limitation of our cold winters. Many species or clones that we might desire to use as parents for their superior aesthetic qualities cannot be easily maintained to flowering age. The F_1 generation also might not be sufficiently hardy. However, if we could get to the F_2 population the potential exists for combining sufficient hardiness with the desired aesthetic qualities in selected individual plants. Others would have the same problem when working for greater cold hardiness. If a cooperative approach could be developed, the initial hybridization could be done at a site with a milder climate, isolated F_2 populations could be grown out there, and open pollinated seed could be collected to produce the F_2 populations. The F_2 populations could then be distributed to several evaluation sites in various areas throughout North America where selections could be made of specific plants that combine adaptation to local environmental conditions with superior aesthetic qualities. Well adapted clones could then be selected for regional use. Thus, the most costly part of the breeding program (the maintenance of parental stock and the initial hybridization for F_2's) would not have to be funded by each state or institution involved.

The idea for this cooperative approach was described in a viewpoint article in the October, 1983, issue of HortScience (9). To give examples of what could be done by this cooperative approach, the genus *Acer* has excellent potential for germplasm enhancement in many different sections of the genus. In the Platanoidea, *A. platanoides* crosses readily with *A. truncatum*, and offers opportunity for development of small shade trees more tolerant to sun scald and other environmental stresses than are current cultivars of Norway maple. The transgressive segregation approach could be used with *A. saccharum* to increase drought and heat tolerance. If *A. saccharum* is compatible with the closely related *A. grandidentatum*, great gains could be made in fall coloration as well as drought and heat tolerance. In the Palmata section, excellent possibilities exists for developing hardier Japanese maple types. *A. pseudo-sieboldianum*, *A. sieboldianum*, and *A. japonicum* could be used to increase hardiness of *A. palmatum*. The section Trifoliata offers some excellent aesthetic qualities for possible use such as the very attractive defoliating bark of *A. griseum*. Excellent hardiness potential can be gained from using *A. mandshuricum*. *A. triflorum* also has much to offer in this group in both hardiness and aesthetic qualities. The transgressive segregation approach could also be useful with *A. rubrum* to incorporate greater drought tolerance and tolerance to higher soil pH.

I would like to give you a brief summary of our plant improvement research in Minnesota. For further information, our research was described in the August 15, 1983, issue of the American Nurseryman (8). Our primary goal is to develop and/or identify superior landscape plants adapted to our climate. We approach this through plant breeding activities and through testing of plant species and clones that we acquire from nurseries, other arboreta, and experiment stations worldwide. In this effort we are trying to acquire germplasm of species from areas of their native range most similar to our own. This past July, I had an opportunity to observe native plant materials in Northern China. We collected seed of a few species that were ripe at that time but, unfortunately, seed of most species was not. We are working on developing further cooperative efforts with our Chinese colleagues for exchange of seeds and with cold hardiness research.

Of our breeding activities, our most concentrated effort at present is development of cold-hardy deciduous azaleas. 'White Lights', 'Pink Lights', and 'Rosy Lights' have been introduced and will be available on the retail market this coming spring. 'Spicy Lights' will be officially introduced the following spring. We have to eventually introduce a number of additional clones to give a broad color range with reliable hardiness. We have a number of selections that we are currently evaluating in colors of yellow, various shades of orange, and bicolors. Our greatest need at present is true reds and we are making crosses to achieve that end.

Other current breeding activities and goals include:

1. Development of clones of *A. rubrum* and *Fraxinus americana* incorporating superior fall color and growth habit with reliable winter hardiness for Minnesota and areas of similar climate.

2. Crossing within the Lantana section of *Viburnum* to incorporate cold hardiness with superior aesthetic qualities of flower size,-color and fragrance, leaf quality and plant form.

3. *Lonicera* resistant to the honeysuckle aphid with superior aesthetic and utilitarian qualities.

4. *Cornus sericea* with brighter stem color, good fall color, and leaf spot resistance.

5. Intergeneric hybridization between *Sorbus* and *Aronia*, or other members of the Pomoideae subfamily, to incorporate fireblight resistance and recombine other aesthetic qualities.

6. Hybridization of *Spiraea* to combine the dwarf plant habit of daphne spiraea with golden spring and fall foliage color of goldflame spiraea and, secondly, to obtain dwarf types with brighter flower colors.

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PLANT NOMENCLATURE AND NAMING NEW CULTIVARS

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To review how plant names are formulated, what makes a name legitimate, and why and how to register a cultivar name, let us follow an example. You are on a fishing trip. A storm comes up, the boat sinks, but you make it safely to a deserted island where there is no evidence that man has ever set foot before. While awaiting rescue, you discover some small trees that look very similar to *Hibiscus syriacus*, but the flowers and growth habit are different from any hibiscus that you know. Some specimens of this plant bear yellow flowers; others have finished flowering and have set seed. You gather seeds and specimens and, when rescued, you take your plant specimens with you.

Once safely at home, you try to determine the identity of the mystery plant by using keys in books such as Rehder's *Manual of Cultivated Trees and Shrubs*, but your specimens just do not fit the keys or descriptions. Having exhausted your own resources to identify the plant, you send it to a taxonomist at a local university. Some time later he informs you that your plant is indeed a *Hibiscus*, but that it appears to be a new species. He states that he will publish this information.