SELECTING TREES FOR COLD CLIMATES[1]

by Harold Pellett

Abstract. Lack of sufficient tolerance to low temperatures is often a limiting factor for successful use of many woody plant taxa in cold climates. Trees capable of acclimating to withstand the lowest midwinter temperatures may still perish if they do not acclimate early enough to withstand severe freezing temperatures in early winter. The University of Minnesota has introduced several tree cultivars selected for their winter hardiness. Merits of these introductions and other plants that have shown potential for use in Minnesota and other northern areas are described in this paper. The goals and activities of the Center for Development of Hardy Landscape Plants are also briefly discussed.

Various surveys indicate that trees planted in the adverse conditions of the urban environment often are relatively short lived. In northern climates, winter injury is often the major factor limiting plant survival. Severe cold may kill trees outright or predispose them to attack by insects or diseases, or by weakening them, limit their tolerance to other environmental stresses. For trees to successfully survive in climates that have considerable freezing weather, they must be able to acclimate sufficiently to withstand the lowest temperatures that occur in midwinter. They also must acclimate soon enough to tolerate early severe freezing temperatures. In addition they must be able to resist rapid deacclimation in late winter or early spring during unseasonable warm periods that might be followed by low temperatures. There are probably as many trees that are not sufficiently winter hardy because they do not acclimate soon enough as there are those that cannot harden sufficiently to withstand minimum midwinter temperatures. In the hardiest plants, cold acclimation is initiated by short photoperiods as daylength declines in late summer (11). As the days shorten, the critical daylength is reached, growth ceases, and the plants begin to harden. The critical daylength to initiate cold acclimation varies for different species, and even various cultivars of the same species if they originated from different latitudes within the native range. Data collected by Pauley and Perry (4) illustrate the extent that variation in latitude has on cessation of growth due to photoperiod. They collected seed of *Populus tricocarpa* from various parts of its native range and grew the seedlings at Westin, Massachusetts at 42° north latitude. Plants from 62° north latitude had quit growing and formed terminal buds on the 22nd of June, the longest day of the year, while plants from 33° north latitude were still growing when terminals were killed by frost in late October. Thus, one can see that the origin of plants can make a tremendous difference in time of growth cessation and initiation of cold acclimation.

To gain some insight into the inheritance of photoperiodic control of initiation of acclimation, Hummel, et. al. (2) used redosier dogwood as a test species. Plants from sources in Alaska and the Northwest Territory (62° north latitude) were crossed with plants native to Utah (42° north latitude). Parents and progeny were grown at the Minnesota Landscape Arboretum (45° north latitude). Beginning in late summer, stem sections were sampled periodically to determine levels of cold hardiness. Similar to the data of Pauley and Perry (4), plants from more northern sources began acclimation sooner. The hybrid progeny were intermediate in their time of hardening. In a followup experiment conducted in a growth chamber by starting with long days and gradually shortening the daylength, most of the F_2 generation were again intermediate in hardiness to that of the two original parents. However, a few plants exhibited transgressive inheritance as they had developed greater hardiness on a given sampling date than had the original parent from the Alaska or Northwest Territory source. Likewise, a few plants were slower to harden than the original

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parents from the more southern source. Thus there is potential to breed plants and select individuals that acclimate sooner than parental stock from the northern end of the natural range. In this way we can expand the potential useful range for landscape plants.

There also seems to be quite a difference in ability of different plants of a species to resist deacclimation. However, there has been even less research on this aspect of winter hardiness. Unfortunately, limited data are available regarding any aspect of cold hardiness for specific cultivars of different tree species. (3,5,9,10). In our laboratory we have started to gather more of this type of data for different groups of woody plants. We use our equipment to determine the hardiness levels of various cultivars at several dates throughout the winter. This was recently done with different cultivars of callery pear (6), and with some crabapple cultivars (8). We are continuing the effort with additional crabapple cultivars, and will tackle other tree species as time and resources permit.

University of Minnesota Introductions

The University of Minnesota, Department of Horticultural Science has an active research program devoted to breeding, evaluation, and selection of woody landscape plants. Over the past 10 years several new cultivars of trees have been introduced for landscape use in northern areas. We have made two introductions of red maple. These are 'Northwood' and 'Autumn Spire'. 'Northwood', our first introduction, was selected from seedlings of populations native near the town of Floodwood in northern Minnesota. It has a typical broad oval crown with very symmetrical branching. Fall color is an orange red. 'Autumn Spire', a recent introduction, originated from seed collected near Grand Rapids, Minnesota. Its primary features are a narrow crown and outstanding bright red fall color.

'Autumn Splendor' buckeye was introduced because of its outstanding foliage characteristics. Its glossy, dark green foliage remains free of leaf scorch throughout the season and develops an excellent maroon red fall color.

Prunus nigra 'Princess Kay', a double flowered selection of the Canada Plum, was found growing in the wild in northern Minnesota by Catherine and Bob Nylund. It blooms in early spring and is very fragrant. Fortunately, it usually sets few fruit since they are very susceptible to plum pockets which mummifies the fruit.

Kentucky coffeetree, *Gymnocladus dioica*, is a native tree that, in my estimation, should receive more landscape use (Fig. 1). The individual leaflets of the bipinnately compound leaves are fine textured and the tree provides an open shade. The ridged gray bark is quite attractive. Female trees have large 1.5 by 5 in. dark seed pods which persist all winter and drop in the spring. Although some people dislike the pods, I feel they add a lot of interest to the winter landscape and are worth the minimal effort needed to rake them up. We have selected an unnamed male plant of Kentucky coffeetree for future introduction. It has an excellent narrow crowned form.

Another unnamed new introduction is a male selection of corktree (Fig. 2). It originated from seed produced by *Phellodendron sachalinense*, but may be of hybrid origin. It is a vigorous grower

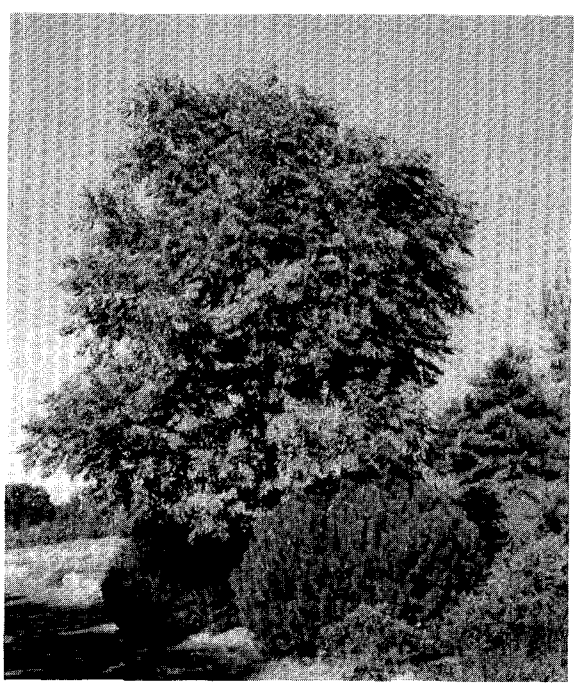

Figure 1. Minnesota selection of Kentucky coffeetree.

Figure 2. Minnesota corktree selection.

and is somewhat higher headed than most Amur corktrees.

Promising Tree Species

Based upon our evaluation efforts in Minnesota, we feel there are a number of woody plant species that have potential for use in Minnesota and other northern areas that currently are not widely known. Many of these have not been extensively evaluated. These plants deserve to be planted and evaluated more thoroughly for their adaptability and landscape potential.

Several Asiatic maples that are not widely used in landscape plantings in North America have excellent potential. *Acer griseum*, paperbark maple, with its extremely showy exfoliating bark is fairly widely known but still not widely used because it grows slowly and is difficult to propagate. Also, it is only hardy to USDA zone 5. *Acer triflorum*, three-flowered maple, is a closely related species(Fig. 3). It also has attractive exfoliating bark although not quite as colorful as that of *Acer griseum*. However, *A. triflorum* is much hardier than *A. griseum* surviving in zone 4 and perhaps even in zone 3 if grown from the right seed source. Three-flowered maple develops an outstanding orange fall color.

The Shantung or purple blow maple, *Acer truncatum,* is another very promising small maple that is native over a wide range of China. It is closely related to Norway maple and crosses quite readily with it. *Acer truncatum* is more drought tolerant than Norway maple (7) and, from the right seed source, should also acclimate sooner and be more cold tolerant.

An additional excellent maple prospect is Miyabe maple, *Acer miyabei*, a medium sized tree with excellent foliage quality(Fig. 4). It develops a clear yellow fall color with a pinkish blush. The Morton Arboretum recently introduced the cultivar 'State

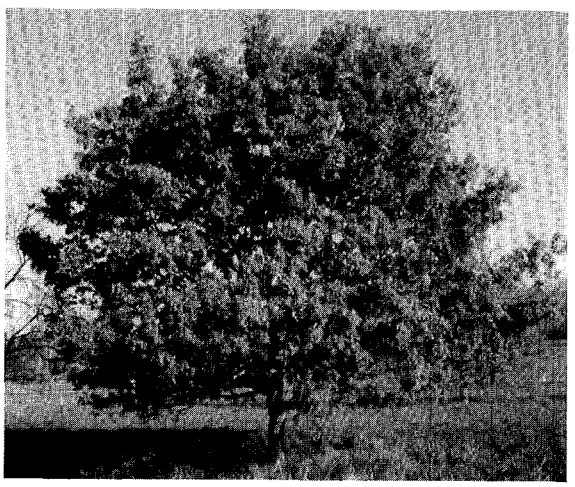

Figure 3. Mature tree of Acer triflorum growing at the Holden Arboretum.

Figure 4. Foliage of Acer miyabei

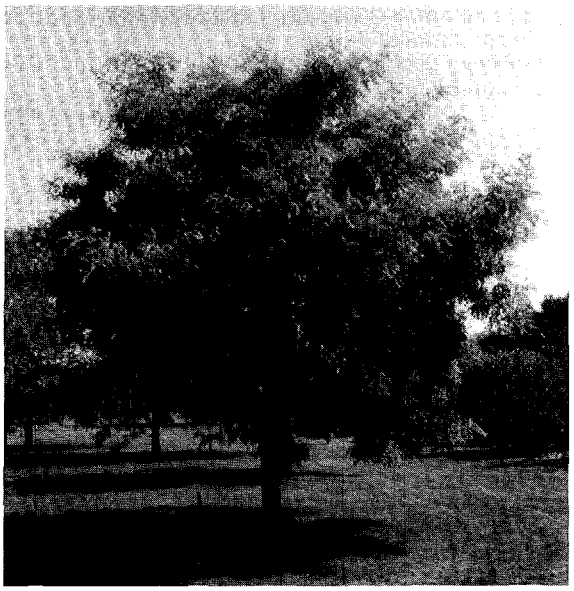

Figure 5. Amur Maackia tree in the University of Wisconsin Arboretum.

Street' through the Chicagoland Grows program.

Amur maackia, *Maackia amurensis*, a member of the legume family, native in Manchuria, is another very hardy small tree with excellent potential(Figs. 5,6). Batzli, et al. (1) have determined that it fixes nitrogen and therefore has potential for use in areas with low fertility. Amur maackia flowers in late July or early August in Minnesota with racemes of creamy white flowers and adds landscape diversity in a season when few woody plants exhibit any special seasonal features. The smooth bark has a patchy green coloration which adds variety to the winter landscape.

Native to the eastern part of the USA, *Betula lenta*, sweet birch has potential for more landscape use. Its very clean, somewhat glossy foliage develops a clear golden-yellow fall color. Young trees have a fairly strong central leader and develop an oval crown. They widen considerably with age. Like most birch, sweet birch is probably not particularly drought tolerant. The biggest obstacle to increased use may be its name for being a birch, many people immediately think of white bark. Sweet birch has a smooth, almost black bark with prominent white lenticels resembling cherry bark. Perhaps we need to give it another name such as

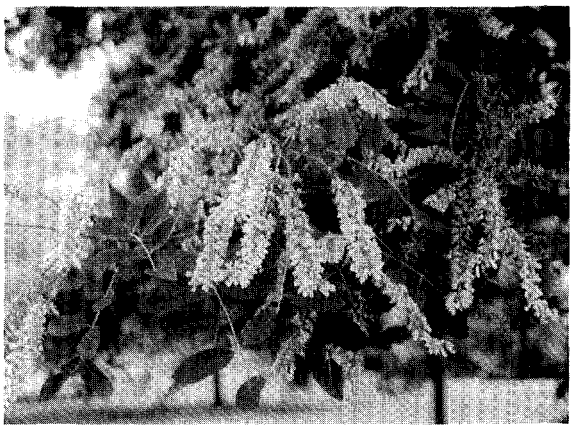

Figure 6. Flowers of Maackia amurensis.

wintergreen tree to help increase its acceptance.

Center for Development of Hardy Landscape Plants

Although a number of promising trees have not been widely used, there is a definite need for more effort to develop and select trees that are more tolerant to the biological and environmental stresses that we often expect them to tolerate. The Center for Development of Hardy Landscape Plants is a relatively new organization that was established in 1990 to develop landscape plants that are more stress tolerant. The Center is a cooperative effort organized as a non-profit corporation. It has research participants located at nearly seventy different institutions across North America and in the Scandinavian and Baltic countries.

Through funds generated by contributions of supporting members, the Center has initiated breeding programs. The initial effort, started in 1991, is breeding of small landscape trees of *Pyrus*. We have used the pear species collections growing at the USDA clonal repository in Corvallis, Oregon, to do most of the crossing. Interspecies crosses have been made between several different species that have the potential to contribute desirable characteristics. In general the pears are fairly tolerant to heavy soils and thus survive in many landscape sites where other trees do not do well.

The only pear species that has received much landscape use in North America is the callery

pear, *P. calleryana*. They are hardy only to zone 4b and thus are not reliable for use in Minnesota. The most cold hardy species is the Ussurian pear, *P. ussuriensis*, which unfortunately grows fairly large and has a larger fruit than is desired for landscape use. *P. fauriei* is a large shrub or small tree that is also quite hardy (zone 4) and develops an excellent fall color and small black fruit. *P. salicifolia* has attractive silvery foliage, while several of the species such as *P. nivalis* and *P. eleagrifolia* have good potential for drought tolerance. Another species with considerable merit, *P. betulifolia*, has small fruit and attractive foliage. The leaves are bright green on the upper surface and silvery green beneath reminiscent of the quaking aspen.

We now have many different hybrid populations of different combinations of these species. The first generation hybrids (F_1's) are being grown at the Washington State University Experiment Station in Puyallup, Washington. When they reach flowering age, we will produce F_2 populations and distribute them to sites in many different geographic regions for evaluation to select superior plants that are well adapted to the climatic conditions of the region in which they are selected. In this way we can efficiently breed and select plants for use in many different regions. We have started a second project to breed small maples and, as resources become available, we will expand this approach to breed many different groups of landscape plants.

Through the Center we hope to develop more stress-tolerant trees and other landscape plants adapted to many different regions of the world. For us to continue the research that we've started as well as initiate new projects, we need to expand our support base. To become a supporting member, contact me or other members or participants of the Center. The Center publishes a quarterly newsletter that describes the activities underway and reports the research results.

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Professor, University of Minnesota
Department of Horticultural Science
Minnesota Landscape Arboretum
P.O. Box 39, Chanhassen, MN 55317.

Résumé. Les arbres capables de s'acclimater aux plus froides températures du milieu de l'hiver pourraient ne pas y survivre s'ils ne s'acclimatent pas suffisamment rapidement pour supporter des températures sévères de gel tôt en hiver. L'Université du Minnesota a introduit plusieurs cultivars d'arbres sélectionnés pour leur résistance à l'hiver. Les mérites de ces introductions, ainsi que d'autres végétaux qui ont démontré un potentiel intéressant pour être utilisés au Minnesota et ailleurs dans d'autres régions du Nord, sont décrits dans cet article.

Zusammenfassung. Bäume mit der Fähigkeit, sich an källeste Temperaturen mitten im Winter zu akklimatisieren, können dennoch nicht überleben, wenn sie sich nicht rechtzeitig an schwere Fröste zu Beginn des Winters akklimatisieren. Die Universität von Minnesota hat einige Baumkultivare eingefuhrt, die für ihre Winterhärte ausgewählt wurden. Die Vorzüge dieser Eingeführungen und anderer Pflanzen lassen schließen auf die mögliche Nutzung in Minnesota und anderen nördilchen Regionen, die in dieser Studie beschrieben wurden.