growth on the stock plant. We use two to four sets of buds on the stick.

The scionwood is mature if it is firm or stiff and has a slight streaking on the bark. The procedure from this point is the same as the *Fagus* stick budding process, except for our spring pruning.

Usually in March we begin to see bud swelling on those stick buds with a successful union. We cut the understock back to one foot above the stick bud and will cut it back to about two in. above the stick bud after the initial growth occurs, usually three to four weeks later.

Stick budding of both *Fagus sylvatica* and *Acer palmatum* cultivars has proven to be a very useful method for open field production.

STRANGE GRAFTS I HAVE KNOWN

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Because grafting involves living organisms, it is not too surprising that there are as many exceptions regarding compatible stock/scion combinations as there are rules. For instance, in most cases a cultivar of a particular species will flourish when grafted onto a seedling of the same species, but there are examples, such as *Acer rubrum* cultivars and *Quercus palustris* 'Sovereign', where grafting onto the species can result in eventual failure of the union resulting from delayed incompatibility. There are many documented cases of graft compatibility between species in the same genus, and a smaller number of successful grafts recorded between members of different genera within the same family. The success of these less closely related combinations offers sufficient encouragement for propagators to continue trying to use more common, readily available species as rootstocks when confronted with unfamiliar species or cultivars to be propagated. In my career, I have encountered several unusual interesting grafts, some of which I will discuss and evaluate in this paper.

The rose family has provided both examples of compatibility between different genera, and incompatibility within a single genus. The medlar, *Mespilus germanica,* is a pome fruit, and when grafted on *Pyrus ussuriensis* will unite and grow, but displays the symptoms of localized delayed incompatibility, (2). Bark is not con-

tinuous across the union, but is separated by profuse callus tissue. The general appearance of the union suggests that the scion is perched on the stock rather than joined to it.

A similar situation occurred a few years ago, when dormant scions of *Cotoneaster affinis* were received and were chip-budded onto seedlings of *Pyrus pyrifolia* [syn. *P. serotina*] in one gallon containers. Union was successful and growth from the scions was vigorous. Shoots 3 to 4 ft in length were sectioned into cuttings, which were successfully rooted. In this case also there was extensive callus production and discontinuous bark, and when moderate pressure was applied to the scion growth, it broke off cleanly at the union.

A different response was observed when scions of *Sorbus granulosa,* a simple leaved species, were chip-budded onto seedlings of *S. caloneura*. The union appeared normal, but the growth from the scion was spurlike, very short and containing several buds. Similar results occurred when, faced with no pear rootstocks at hand, I grafted unexpected scions of *Pyrus calleryana* 'Capital' onto *Crataegus laevigata* [syn. *C. oxyacantha*]. Some grafts united and, although the scions produced only stubby growths, these provided bud chips for grafting onto *Pyrus calleryana* rootstocks later that season.

The Japanese flowering cherries are frequently top-worked at 5 to 6 ft onto seedling or clonally propagated *Prunus avium* (mazzard). This combination is compatible but, as the plant matures, the stout trunk of the mazzard, and the swelling at the graft union, contributes to an unnatural, almost bizarre, appearance. The resultant tree will look much better if the stock is budded or grafted low, so that the trunk is developed from the scion. A very ornamental alternative for flowering cherry production is practiced at Weston Nurseries in Hopkinton, Massachusetts. There the scions are top grafted onto stems of *Prunus serrula,* which has exquisite, glossy red bark. This practice yields specimens which have great appeal even when out of flower.

Magnolia is a genus which displays little, if any, true graft incompatibility among different species. It is advisable, however, to consider the vigor and ultimate size of the scion cultivar when choosing a suitable rootstock. When the vigorous, large-growing Asian species, *Magnolia campbellii, M. dawsoniana, M. sargentiana, M. sprengeri,* and their hybrids are grafted on *Magnolia kobus* or *M.* × *soulangiana,* they will succeed, but an unsightly overgrowth develops at the union. This "goiter" would be less conspicuous if it were close to the ground, but frequently the grafts are placed 10 to 12 in. up the stock. Because it is the hardiest of the large Asian magnolias, and seed was available locally, I tried seedlings of *Magnolia sprengeri* 'Diva' as rootstocks for this group, and am very satisfied with them. With *Magnolia sprengeri* rootstocks, growth of

the scion is vigorous, and within a few years it becomes difficult to locate the graft union, so similar are the stock and scion in growth rate.

The only indication of incompatibility in magnolias that I have seen occurred when I chip-budded *M. acuminata* var. *cordata* 'Miss Honeybee' onto a seedling of *M. dawsoniana*. The union knit cleanly, but the scion growth was stunted. It grew to only 15 inches over two seasons, and remained much smaller in caliper than the stock. Although the union did not fail, growth was far from satisfactory.

Stunting was also the result when *Betula chinensis* was chip-budded onto *B. pendula*. *Betula chinensis* is a large shrub or small tree. After it was grafted on *B. pendula,* the scion elongated rapidly to about 5 ft in height, and then stopped. Branches which were produced bent down toward the ground. The diameter of the scion growth was one-third that of the stock. The following year, no more extension of the leader occurred. All growth went into the drooping branches.

Robinia pseudoacacia was the rootstock for two interesting grafts I have seen. One year in early June, in Bellingham, Washington, my attention was alerted by a tropical-looking small tree with large, rose-pink clusters of flowers. On closer inspection, I saw that it was a *Robinia* (later identified as *R.* × *ambigua* 'Idahoensis'). It had been grafted on black locust at about two feet, and with the stock being twice the diameter of the scion growth, it had the appearance of a tree growing out of a stump. Here too, grafting as low as possible would do much to improve the appearance of the specimen.

In Seattle, Washington, a few years ago, I noticed some rather unthrifty wisteria standards. Their crowns were thin and contained some dead branches. The wisterias were grafted about 1½ ft up on stems of black locust. The grafts had obviously lived and grown for a few years, and the leaves were still expanding when I saw them, so it is not possible to comment on the appearance of the plants in flower or full leaf.

Girard Nurseries of Geneva, Ohio, for several years have propagated and sold a maple listed as *Acer griseum* 'Girard's Selection' (1). This cultivar appears to be a hybrid between *Acer griseum* and *A. maximowiczianum* [syn. *A. nikoense*]. Its bark differs from that of *A. griseum* in that it exfoliates in small shreds, but it is still very attractive. Peter Girard, Jr. states that in nursery production the hybrid is superior to *A. griseum,* being faster growing and more inclined to form a leader. Girard propagates this cultivar by bench grafting onto *Acer saccharum* rootstock. I inspected several grafted trees as old as ten years, and observed both unions which appeared compatible, with continuous bark and uniform diameter of stem above and below the union, and unions which looked to be headed

for failure, with swelling and a continuous groove around the stem at the point of union. Some of the unions which showed symptoms of delayed incompatibility were tested mechanically and proved quite strong. All of the older trees were grafted 8 in. or more above the ground, but Girard reports that he is now grafting as close to the root collar as possible, which seems to limit swelling at the union.

By this point, it must be obvious that I have a bias toward placement of grafts low on the rootstock. Although oddities such as I have described are of interest, I believe that it should be the goal of every propagator to produce graft unions that are as nearly invisible as possible. It is one manifestation of the art of our profession.

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DEVELOPMENT OF DOUGLAS-FIR CLONES FOR CHRISTMAS TREES

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Coastal Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) var. *menziesii* is the major Christmas tree species in the Pacific Northwest. An estimated 3.7 million trees were harvested in Oregon in 1987, most of which were genetically unimproved planting stock. As a result, there is considerable variation in such important characteristics as vigor, form, needle color, and budbreak, which profoundly affects tree quality, length of rotation, and culture. Genetic improvement of seed parents has been explored by Oregon State University and the Northwest Christmas Tree Association. Because of the long commitment required for seed orchard development, however, this approach has seen only limited application.

Asexual propagation of selected, superior trees is being studied as a more rapid method to realize genetic and economic gains. Development of superior Douglas-fir clones for the Christmas tree industry has been underway in the Department of Horticulture at Oregon State University for about 15 years. We have identified promising clones, developed selection criteria for new clones,