

## *Budding and Grafting –if you think you know it all....think again!*

by Tim Brotzman

A quick search through the Proceedings reveals that at least 200 papers have been delivered on the subject of budding and grafting. Clearly this topic has remained a favorite of our members for the last 60 years. From my perspective, it stands as one of the most interesting and fundamental practices to the art of propagation where an assortment of mechanical skills must first be mastered. Once when I asked Mr. Harald Neubauer of Hidden Hollow Nursery in TN which technique he used to propagate *Cercis*, he replied "Every one that I have to." This response underscores a major tenet of the craft: the need to understand the many variables influencing both the understocks and scion material from year to year. In addition, the propagator must know, or be able to question, the choices of understock/scion combinations that will provide the desired results, whether they are long term compatibility, short term success to preserve a clone or a nurse graft to support a plant until it can make its own roots.

Harald Neubauer and his son, Alex, have become great allies when I need to save some new selection. Many years ago I sent them a form of *Magnolia virginiana* with extra petals that had been rescued from Paul Bosley's nursery. Harald put it on *M. kobus* and more than 10 years later it is still alive, although not very vigorous. Another time I received an unusual *M. tripetala* which Harald put on *M. virginiana*. So far the plants are still living and allowing us to prepare the proper understock to do them correctly. Both of these stand as examples where the goal was to keep the plants alive only for a few years....if longer, well, that is a bonus.

Although it was many years after becoming an IPPS member in 1976 that I made my first grafts, I have always been fascinated with this subject without even realizing how the before and aftercare of the graft was much more challenging and essential to success than the carpentry. I remember at the 1978 Eastern Region meeting when Mr. Brian Humphrey from England's famous Hillier's Nursery commented that birch understock had to be kept so dry that they would "rattle in the pots". (7) That seemed counter intuitive at the time, but years later I learned how important it is to manage the sap flow on this genus as well as *Acer* and *Cornus*. I have also learned that each year's conditions will be different and every propagator's facilities may respond uniquely. I have come to appreciate that a propagator should never take anything for granted and that knowing how to question may, in fact, be more valuable than thinking we already have the answers.

Many books on grafting have been published and an old favorite is R. J. Garner's 1947 *The Grafter's Handbook* (5). Most recently I have purchased a 7<sup>th</sup> edition copy of the classic *Hartman & Kester's Plant Propagation*, now co-authored by Fred Davies and Bob Geneve. (6) Both of these texts devote great detail to the many types of budding and grafting techniques, the how, when and why they are used. Anyone who has never referenced these books must make it a point to do so as they explore both the art and the science of the craft. As I have mentioned, within our own Proceedings there have been papers presented on just about every grafting question imaginable and now that they can be read on line we have an incredibly valuable reference at our fingertips. There are several of these which have been standby favorites of mine for years. In 1968, S.H. Nelson presented a paper titled "*Incompatibility Survey Among Horticultural Plants*, the format of which was to gather information about certain understocks and how any number of different scion

combinations would work on them.(9) So important was this information that the Society reprinted it in booklet form and sold it for many years. Another paper that I find very valuable is from Jack Alexander, *A summary of Graft Compatibility from the records of the Arnold Arboretum*, which provides an extensive list of successful graft unions. (1) Joerg Leiss' *Grafting on Roots* provided an update on the usefulness of root grafting, a presentation which always reminds me of the value of this little used technique. (8)

The intent of today's paper is not to make a serious review of the various types of grafts or the conditions needed to be a successful budder or grafter. Being my own boss has privileged me with the freedom to experiment and have a good time as well as try to be a productive and profitable propagator. Today I offer you some of the observations and opinions that have influenced my career, many of which I have gained by killing the plants I was trying to grow.

One winter about 30 years ago, I found a weeping crabapple. Lacking understock, I went to get some from John Ravestein, the highly respected propagator at Herman Losely & Son. John told me that he did not have any, so I left saying I would pot some up for the next year. A few days later one of John's assistants told me that he was disappointed I had given up so quickly. Supposedly he wondered how I could consider myself a propagator if I was not prepared to find another solution. I immediately returned to see John whereby he explained how to do root grafts. I went and dug up some roots from Snowdrift (cutting grown on its own roots) and made the grafts. I still have three of these trees to remind me of that polite, professional chastisement. At the 1995 Eastern Region Meeting, Joerge Leiss had observed that when grafted onto roots, many plants produce minimal or no suckers. (8) To this day, my three *Malus* from root grafts have NEVER produced even one sucker. Joerge also observed that when grafted onto the roots of the original clone, many plants, otherwise showing incompatibility, (i.e. Red Oak group species) grow without issues.

The late Hans Hess, a great propagator and Eastern Region member, used to include with his shipments of young grafted plants, instructions to plant the union 1" below the surface of the soil, presumably to gain some stability and encourage the scion to produce its own roots. For this reason, I was always told to graft as low to the ground as possible. Because if not, and the union was planted too deeply, there would be a good chance that the understock would rot before the scion could root. High grafts can also result in an unsightly graft union located where it would be too easily noticed. I have never forgotten the stigma once placed in front of me that grafting high was the mark of a lazy grafter. Obviously this does not apply to top grafts/standards. The late Peter Girard Jr. taught me that grafting high was a good way to ensure success and build up a large, vigorous plant more quickly.

Peter Girard. grafted a lot of unusual material and I used to visit him every winter when I was just getting started. It was there that I saw him grafting *Syringa vulgaris* hybrids on *Ligustrum* roots. I had never heard of nurse root grafts so he explained that when planted deep with the lilac stem in the soil, the privet roots would nurture the lilac long enough to produce its own roots. While I assume Peter was grafting onto the top (proximal, closest to the trunk) end of the root, *Hartman and Kester's* states that the "rootstock piece will eventually die if it is grafted onto the scion in an inverted position", (onto the tip or distal end of the root) thus "reversing the polarity of the nurse-root understock."(6. pg 483) In this latter scenario the nurse root is certain to die from a lack of sufficient carbohydrates from the scion, thereby forcing the scion to produce its own roots or die as

well. I tried this in 2011-2012 with *Corylus avellana* 'Pendula' but the grafts failed, probably due to excessive temperature during the healing process.

Peter Girard had selected a hybrid of *Acer griseum* x *A. maximowiczianum* (*nikkoense*) which he grafted onto *A. saccharum*. When I questioned the long term compatibility, he showed me trees with absolutely perfect graft unions and gave me one to take home. Now, 40 years later, it is still very healthy with no compatibility issues, although my own grafts of this combination have produced some union failures. Supposedly, Peter decided on this combination because the buds appeared similar. Despite their very different leaf characteristics there must be some genetic similarities that allow this combination to work. I have plants which I believe are *A. triflorum* x *A. saccharum* and *A. griseum* x *A. pseudoplatanus*, and both of these have grafted successfully onto *A. saccharum* as well. I have also put *A. maximowiczianum* onto *A. saccharum* and I have healthy 40 year-old plants of *A. maximowiczianum* on *A. griseum* that were grafted by Mr. J. D. Vertrees.



Sometimes it is hard to grasp why certain combinations work, like the maples just discussed, and others do not. One reason the industry moved away from grafted/budded *Acer rubrum* and *A. x freemannii* production was the high degree of incompatibility when using *rubrum* rootstock. Although there was some speculation that the problem was related to the possibility that the rootstocks had some hybridity with *A. saccharinum* the failure seems surprising in light of the fact that so many unrelated species appear to work just fine on *A. saccharum*. Today,

most *A. rubrum* and *A. x fremannii* selections are on their own roots, either grown by cuttings or tissue culture.

Oaks are another frustrating genus. Within the White Oak group I have observed *Q. dentata*, *Q. pontica*, *Q. frainetto*, and the various hybrids between *Q. alba*, *Q. bicolor* and *Q. robur* all grafted on *Q. bicolor*. I have *Q. dentata* on *Q. macrocarpa*, and seen *Q. macrocarpa* and *Q. mongolica* on *Q. alba*. These combinations seem to be the current industry norm, but I have to wonder just what we may observe in the years to come?

The Red Oak group is a completely different matter and it is difficult to have long term success putting *Q. palustris* or *Q. rubra* onto themselves. Faced with this problem, Klyn Nursery in Perry, Ohio is grafting *Q. palustris* 'Green Pillar' onto its own seedlings to reduce the potential for incompatibility. Although percentages of successful takes are up, they report incompatibility has not been eliminated. Frank S. Santamour Jr. has addressed this Society, explaining his theory of incompatibility in Oak and Maples based on differences in isoperoxidase enzymes between the stock and scion. (10, 11) For Red Oaks he proposed that developing clonal rootstocks of known enzyme types could then be used to successfully graft scions from selections with the same enzyme markers. We should also remember Joerge Leiss' suggestion of grafting onto roots taken from the original, mother tree. Obviously, this is not going to be practical or even possible in many instances

but it leads us to reflect on just how important it is to keep records of our understock/scion combinations, especially when not following commonly accepted industry norms or when those norms have not been proven over a long period of time. For this reason, I encourage all arboreta and those conducting tree research and clonal evaluations to include understock selection and compatibility as a matter of routine. My advice to growers, find out what understocks have been used on the plants you are producing and track the losses and growth characteristics. I recently purchased some *Pinus parviflora* cultivars and discovered that they were grafted on *P. sylvestris*. The rule of thumb as I know it is that five needle pine go on five needle understock, *P. strobus* being the most commonly used. These *P. parviflora* I bought are alive, but not growing very fast. I have no idea how long this combination will work or if it was done to dwarf the stature of the mature plant, or due to ignorance or indifference on the part of the propagator.

During the winter of 2011-2012, I got the notion that I should look for some good selections of *Tilia tomentosa* 'Petiolaris' (formerly *T. petiolaris*) to bud in 2012. For some reason, the Weeping Silver Linden is not commonly produced in the US but many beautiful large specimens can be found around the country and in Europe. As I sought out people's recommendations for a good form, Bill Barnes offered up his suggestions on a plant at the Scott Arboretum and then, much like John Ravestien had done so many years before, encouraged me to do it as root grafts. In February, 2012, even though William Flemer had reported that these species were compatible on each other, I put *T.* 'Petiolaris' on *T. tomentosa* roots, and *T. americana* 'Laciniata' on *T. americana* roots. (4) I also put *T. oliverii* and *T. henryana* on *T. mongolica* roots, *Malus tschonoskii* on *M. domestica* and *Ulmus carpinifolia* 'Variegata' on *U. carpinifolia* 'New Horizon' roots. In all cases I used a cleft or side graft, 4-6" long scions and 4-8" long root pieces. I dipped them completely in a 50/50 % mix of Trowbridges grafting wax and canning paraffin. Wrapped in moist burlap and plastic they were placed on 80 degree F heat pipes for about 2 weeks. Without taking off the wrapping, they were then put in a cool room (~40-50 degrees) for a few weeks until leaves were developing and new roots had formed. Roots were potted with the graft union below the soil line and placed in a greenhouse. In most cases the grafts appeared to be successful but shortly after potting, outside temperatures soared to 80-90 degrees and most all grafts failed. However, some did survive from all groups except for the Petiolaris. Almost all of the elms lived and by mid summer had reached a height of 3-4 feet. I certainly feel that this was a valuable process to use in getting these new selections established.

Speaking of Elms, over 20 years ago I had side veneer grafted *Ulmus x hollandica* 'Dampierei' on *U. parvifolia* understock. They have done fine and in some cases appear to have gone onto their own roots.

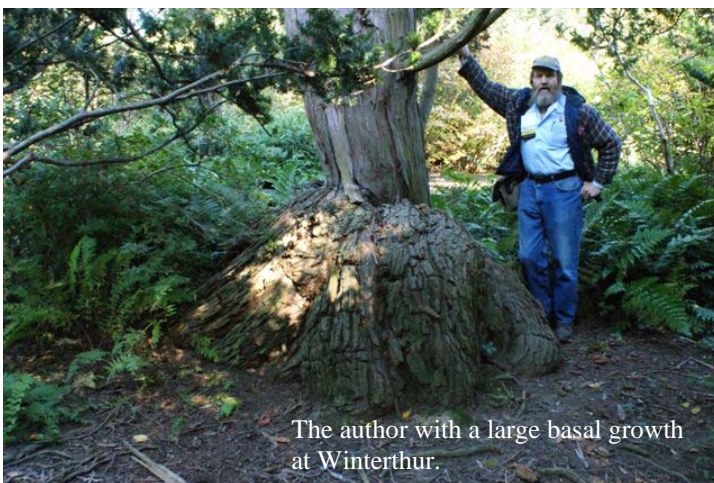
Early on in my grafting career my father, Charles Brotzman, asked me if it was possible to graft *Fagus sylvatica* clones onto *Fagus grandifolia* root stock. Before doing so we sought information from several local, older propagators and were told that there would be a long term incompatibility issue with this combination. Whenever the topic has come up in the years that followed, I was always told the same thing. When I do a search in the Proceedings I cannot find a specific reference to this question, except in Nelson's 1968 paper, a contribution from Peter and John Vermeullen, saying that they had made the combination (but without comments on failure or success).(9) Jack Alexander's 1998 report (confirmed via personal communication in 2012) indicated that in 1980 he put *Fagus sylvatica* 'Torulosa' on *F. grandifolia* and they are currently

very healthy, although he cannot tell if they have gone onto their own roots.(1) Conversely, and perhaps because there are so few clones of *Fagus grandifolia*, I have not found any literature that supports grafting *Fagus grandifolia* onto *F. sylvatica*. Mr. David Dannaher of Galena, Ohio, who discovered and released *Fagus g.* 'Cameron' (slow, horizontal weeping form), has used *F. sylvatica* for approximately 10 years with no negative results. His largest plants are approaching 6 feet in height and 1.75" diameter. About five years ago I put an ascending form of *F. grandifolia* on *F. sylvatica* and they are doing fine. As to other combinations, I have also been grafting *F. orientalis* on *F. sylvatica* for perhaps 20 years and usually can expect very clean, smooth unions to develop on vigorous growing trees.

There are many complex factors that can lead to graft failure besides incompatibility, including poor workmanship and disease. All of us will observe this at one time or another. When this failure is delayed for a long period of time, a bell shaped swelling or a ridge of rough bark may develop at the graft union. This should not be confused with overgrowths that can occur above the union as I have seen at Kew Gardens in an extraordinary *Fraxinus angustifolia* 'Pendula' or below the union, which is very common in conifers.



*Fraxinus* with swollen trunk above the graft union at Kew Gardens.



The author with a large basal growth at Winterthur.

The most extreme example of this that I have seen is right here at Winterthur Gardens on a *Chamaecyparis obtusa* (labeled Gracilis but Bill Barnes thinks might be Compacta). While the trunk is close to 24" in diameter, the understock is approaching 7 feet!! According to Hartman and Kester's, this "is more related to genetic tendency for growth than to incompatibility".(6, pg 440) However, I once found a dwarf, wide spreading plant of *Picea pungens* which had very swollen trunk and branch features, but

sparse, narrow roots. Every graft I made from this plant, using *Picea abies* understock, developed very heavy, oversized growth above the union, and very narrow stems below. None of them, including the mother plant lived more than 10 years before they died. Not only did it exhibit incompatibility but it was as if the plant was antagonistic to itself.

*Hamamelis* have been a major interest of mine for over 30 years and today we have over 130 clones in our collection. Due to difficulties in overwintering young plants that are on their own roots, grafting/budding on *H. virginiana* is the primary means of propagation. We learned many years ago that using *H. vernalis* was totally unacceptable due to the guarantee of uncontrollable suckering from the root system. Although usually not to the same extent and confined to an area closer to the



trunk, *H. virginiana* can also produce unacceptable amounts of suckering. Perhaps this is due to characteristics of certain provenances or possibly hybridization between *H. vernalis* and *H. virginiana* that may be occurring in nursery conditions where seed is being collected. We do have some *H. vernalis* x *virginiana* crosses and several clones of both species which flower at the same time. So it does seem possible that there might exist some hybrid *H. virginiana* understock that suckers more than normal. Many years ago I did graft some *H. x intermedia* hybrids onto roots of both species; but, I conducted the trial only until the plants were 5-7 feet tall before selling them. As I recall, there was some sucker production from both species, but there were other plants where it was absent. About 10 years ago, Carlton Nursery in Dayton, Oregon attempted to address the suckering problem by going completely to using *Parrotia persica* as their understock of choice. Many others have talked about this but the general lack of *Parrotia* seedlings may have held them back. Carlton is producing their understock from cuttings and using it for both low grafts and standards. In the near future I hope to repeat my nurse root trials and include *Parrotia* as well. For the time being, however, we plan on doing most of our *Hamamelis* production on *virginiana* by using a chip bud in August and September.

I enjoy working with *Aesculus*—there are a lot of interesting species, hybrids and cultivars to choose from and they are usually easy to graft. *A. hippocastanum* seems to be the industry's standard understock for most types and I have used it for *A. hippocastanum*, *x. carnea*, *pavia*, *turbinata*, *arguta*, *glabra*, *x arnoldiana*, *x mutabilis*, *x neglectus* and *x woerlitzensis*. At the 2000 Eastern Region meeting I presented a poster on how the type of graft can influence healing, as determined by the amount of advantageous buds that would form along the graft union. (3) Although they are easy to clean off, I usually prefer a whip and tongue or splice graft rather than a cleft or side veneer graft to minimize adventitious buds as much as possible. Three years ago I thought that I would try switching to *Aesculus flava* (*octandra*), since that specie produces larger, stockier seedlings with more fibrous root systems than *A. hippocastanum*. I have successfully used *A. flava* for *hippocastanum*, *x arnoldiana* and *x neglectus* selections. However, when grafting the variegated cultivar, *A. turbinata* 'Marble Chip' the new growth was small, weak and often expressed as ribbon-like distortions and the plants finally died after four-six months. I plan on trying a normal, green-leaf *A. turbinata* selection in the future to see if the same results occur. I initially thought the problem might be viral in nature, but Marble Chip grafts easily onto *A. turbinata* and *A. hippocastanum*. I assume this must be an expression of incompatibility but in my entire career this is the only instance where I have seen such malformed growth develop on the scion before failing.

In 2012 I noticed an especially dark red flowering *Aesculus pavia* which also remained in flower longer than most and I immediately thought about getting a few grafts started. Years before I had discussed modified nurse seed grafting onto the epicotyl of germinating seedlings with Mr. Chris Lane (IPPS GB&I) and in 2001 Jack Alexander had prepared a poster on this subject.(2) We had recently potted up some one-year old *A. pavia* seedlings and the new growth was just about as soft as celery. On June 1<sup>st</sup>, using small scions of similar size and condition, I attached them using a whip and tongue, saddle or side veneer graft. Tied with a rubber band and then wrapped with Parafilm tape, I tied a plastic bag over each one to keep the humidity high, and then placed them in semi shade, venting the bag after approximately one week. Of 25 attempted, 23 took, thus gaining me a year in trialing this selection. On a number of the whip and tongue grafts, a large growth of tissue

formed at the bottom of the union. I suspect that the cut on the scion was longer than that on the understock, thus the healing occurred without being able to attach itself at this point.



*Calicanthus floridus*  
graft union.

In August, 2012, I was able to visit the Blandy (Palhiero) Gardens on the Portuguese island of Madeira. Growing there, I found a 10' x 10' *Calicanthus floridus*, single trunk, formed with two fused stems totaling almost 10" diameter. The Director of the Gardens, Ms. Christina Blandy, told me it was already a large plant 40 years ago and had been severely pruned twice in the last 27 years. Most curious to me, however, was the fact that it had a swollen base that gave every appearance of having been grafted!! There was absolutely no evidence of the suckering nature so typical of this shrub and I remain puzzled why it would have been grafted and at a loss for what the understock would be (*Chimonanthus* is in the same family and this may be a possibility??)

About 8 years ago I decided we needed an alternative plan to the winter grafting I had been doing. Summer budding has now allowed me to work more economically and produce better *Hamamelis* and *Cornus* liners. I have been able to chip bud various *Larix decidua* and *L. kaempferi* (*leptolepsis*) onto *L. kaempferi* and also put *Pseudolarix amabilis* selections onto itself with good success. At the same time we added new crops like *Chionanthus virginicus*, *C. retusus*, *Liriodendron*, *Taxodium* and this year included *Carpinus*, *Quercus* and *Tilia*. We even trialed budding *Prunus* x 'First Lady' onto rooted cuttings of itself to see how this differed from just cutting the stock back to train up a whip. Our work is done primarily by chip budding from August to September. Where failures occur I am hopeful we will have the time in the spring to field graft with dormant scions as the understock begins to grow. We look forward to having multiple techniques on hand to back up our propagation goals.

I never had the privilege of training with a master propagator, and I often wish I had. Too many of us, myself included, have been conditioned to regurgitate the facts we are taught, and not how to think for ourselves or leave a comfortable groove. I do consider myself lucky to have been a member of the IPPS during a time of this Society's history when so many pioneer propagators could be found together and allow a youngster to listen in. Now that the Proceedings are online, their invaluable contributions and insights are accessible for all of us to use. Unfortunately, our editors were not able to capture the often times multi-accented, emotional dialogue in which these exchanges were made. One thing I am sure the "old timers" would not argue about is that none of them knew everything about grafting or budding.

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