Vegetative Propagation of Oaks and Suggested Research Techniques

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Botanically, the oaks fall in the family *Fagaceae,* in which are also included both beech and chestnut, with their rather similar propagation problems. In a search of the literature through upwards of 300 propagation references to these plants, the walnuts, *Juglans,* have been included, in that difficulties have been experienced here too so that possible leads to our own problem might be discovered. Within the genus *Quercus* three major taxonomic subdivisions are currently recognized: Subgenus I (Cyclobalanopsis) with its few evergreen representatives is relatively unimportant from our standpoint; subgenus II (Erythrobalanus) comprises the large black oak group including Willow, Shingle, Water, Black-Jack, Scrub, Black, Scarlet, Pin, Red Oaks and several others; subgenus III (Lepidobalanus) includes the white oaks of which Turkey, Cork, Holm, Live, English, White, Post, Burr, Chestnut and Swamp White oaks are among the more familiar. These major divisions between black and white oaks should certainly be kept in mind in considering matters of propagation. Rehder's subdivisions of these major groups may at times have further significance especially in grafting and matters of stock-cion relationships.

From a cytological standpoint the oaks are fortunately simpler than many other plant genera. Present information, as summarized by Duffield (4) indicates that the basic somatic chromosome count for all species is 24 so that at least one cause for possible differences in behavior or response can be written off.

In matters of propagation, seedage is the simple and straightforward method, whenever it can be used. But our topic today is confined to vegetative methods and all of these become relatively difficult with many hardwood trees and with oaks and the oak relatives in particular. Let us review the kind of results that may be expected by employment of the usual techniques, noting where these techniques succeed or fail and where an occasional new avenue of approach may possibly lie.

Cuttings

Until the advent of chemical rooting substances the practical impossibility of propagating oaks by cuttings was so generally recognized that even mention of the method is almost wholly lacking in the older literature. Bailey's Cyclopedia is perhaps an exception in stating that "the evergreen species are occasionally increased by layers and sometimes by cuttings"—without further explanation.

With use of growth substances results have continued unpromising with cuttings from mature trees as especially evidenced by the work of Hutchings and Larsen (9) with white oaks and Flory and Brison (6) with the semi-evergreen Ness hybrids of *Q. virginiana* and *Q. lyrata*; the latter being almost a classic example of negative results. Of several thousand cuttings subjected to numerous variations in time of taking, type of wood, kind and concentration of growth substances, propagation media, etc., etc., a number developed callus growths and a few, set in February, produced roots but not one remained alive for longer than two months

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after the cuttings were taken. The parent trees from which cuttings were secured were 25 to 30 years old.

The last statement becomes important in relation to the juvenility problem discussed by Dr. O'Rourke before this Society last year. Using indoleacetic acid at 400 mg. per liter on February made cuttings, Thimann and Delisle (14) were able to secure 82 per cent rooting of red oak. Without auxin treatment the rooting was 22 per cent. The wood "more than a year old," was from four year old trees. Cuttings from old trees failed to root entirely. Using July cuttings and auxin treatment, Komissarov (10) secured 56 per cent rooting of English oak eight years old and 34 per cent from trees 20 years old. Untreated cuttings failed completely. Other examples could be cited pointing up the desirability of working with young stock plants in all attempts at cutting propagation. Unfortunately our printed references are seldom complete in telling of the success of these cuttings after rooting. Such should be investigated, as also any possibilities inherent in the use of sucker growths, induced by pruning, as a substitute for actual youth of the stock plant.

It would seem that the propagation of oaks by cuttings remains an undertaking for the experimentator rather than, to date, a method to be employed with any certainty of results.

Layering

While a limited amount of layering has occasionally been practiced with the evergreen oaks as with the rather similarly responsive beeches, for the deciduous oak species layering has proved almost wholly unsuccessful. This comment applies not only to conventional methods but also to the more modern system of air layering employing growth substance treatments and the use of polythene film. Of a number of air layers made by myself at the Morris Arboretum, on unusual species of beech and oak, in the spring of 1950, none were successful in producing any suspicion of roots, with or without growth substance treatments. Similar wholly negative results were reported by Wyman (16) regarding fifty-two air layers made in the spring of 1951 and involving *Quercus bebbiana, bicolor, dentata, falcata, marylandica, mongolica, robur, robur argenteo-marginata, rubrinata, stellata* and *variabilis*.

However, to the best of my knowledge, potentialities in the cutting-like relationship of air layering to age of wood and age of parents has not yet been fully explored. More layers should certainly be tried out on very young trees. Furthermore in another difficult genus, the walnuts, very fair success has been obtained by Hatton (7) at the East Malling Experiment Station by use of their traditional stooling methods. The young growths produced by this technique seem much more capable of root formation than top-grown shoots. Adaptations of the stooling method might well be investigated in connection with oaks.

Layering then, like cuttings, must be classed as a field for further experimentation rather than a presently practical technique.

Budding

In budding we have a further propagation method which is excellent for so many other woody plants but which, with oaks, seems to be of indifferent value or wholly useless—and not, certainly, for want of testing. Flory and Brison (6) may again be quoted as furnishing a rather typical

example. Using T-buds from the Ness hybrids mentioned earlier, these workers used young seedlings of several species as understocks, including Burr, Chinese, Live, Overcup, Pin, Post, Spanish, Water, Willow Oaks, etc., and on different years inserted the buds variously in August, May and October. The stocks seemed to slip well and after as long as 4 or 5 weeks many of the buds were plump and green, but apparently there was no union. Soon after this the bark began curling and the buds dropped. Of 376 buds inserted only one united and produced a tree. From personal experience I could describe similar results as doubtless could most propagators of woody plants. While the difficulty cannot be explained without discovered facts to go on, it would seem, nevertheless, that it may possibly involve a somewhat excessive dormancy in the bud and one wonders whether earlier in the spring might not be the time to try budding with a plant of this sort.

In patch budding pecans in the Southern states there has developed a recognized practice of cutting previous years' cion wood while still dormant in February or March, storing the wood in moist sphagnum moss under cool conditions and then seasoning it (still in moist moss) at a warmer temperature to induce slipping of the patch buds at the time of outdoor budding in late April or May. Brison (2) found a temperature of 80 degrees F. for a 10 day period to be about ideal for the seasoning process. If the cambial changes which take place during the seasoning process in pecan and which permit a ready manipulation and subsequent union of the patch bud—would occur similarly in oak, a basis might possibly be found for the development of a more successful budding technique in this genus This, at least, might bear investigation.

Grafting

In contrast to the above less promising methods of vegetative propagation for oaks, grafting has long proved to be the means of increase next most successful to the use of seed. While the obvious disadvantage of grafting lies in the fact that the rootstock is necessarily of seedling origin, with uncontrolled physiological responses, it is possible that future investigation may produce a means of overcoming this sometimes objectionable feature.

Principal graft methods are of two types: indoor bench grafting as is principally practiced in this country, and outdoor grafting as has been used to a fair extent in Europe, but much less frequently in the United States.

Bench Grafting

Indoor grafting on potted seedling understocks follows the general pattern used for other woody plants. Dormant cions are usually of the previous season's wood and either top or side grafts may be employed. Closed cases are sometimes recommended (Sheat (13) for January-February grafts, the open bench for those done later in February-March. An experienced propagator, with proper selection of his understocks, should secure a reasonably good turn-off in bench grafting.

Outdoor Grafting

This method may merit greater attention than it seems to have currently acquired in this country. Actually it is an old system first apparently described by Nagel (12) in Germany in 1829, for the grafting of chestnuts onto oak understocks. In 1867 we find reference to it again, in a similar connection, by Weber (15) writing in the French Revue Horticole, while

in later years it has been used and described by Flory and Brison (6) and a few others in this country.

In essence this method of outdoor grafting of oaks employs the use of dormant 1 year old cions about ⅜ of an inch in diameter, gathered in February and stored under cool conditions until used. The stocks are outdoor grown seedlings varying usually from ½ inch to 1 inch in diameter and grafting takes place about two weeks after leafing has commenced. Various kinds of grafts may be used—whip grafts inserted slightly below ground level on the smaller stocks, or bark, inlay or cleft grafts placed a foot above ground on larger stocks. Flory and Brison found the whip grafts to be most successful with the Ness hybrid oaks. Grafts are tied with string and the cut surfaces usually protected with wax. Staking of the cion and desuckering of the stocks is necessary as growth proceeds. With proper selection of understocks, 100 per cent takes have been reported with this kind of graft.

In a recent conversation with Mr. Mark Holst (8) the writer learned that outdoor grafting of *Quercus robur* and *Q. sessiliflora* has been successfully practiced for some time by H. Barner of Stalsskovenes Planteavlsstation, Humbleback, in Denmark. In describing this particular system Mr. Holst places particular emphasis upon location of the basal cut of the cion in the bud scale region at the junction of the one and two year old wood, upon removal of the large-budded top section of the cion to secure growth from the lower, more dormant buds, and also upon the necessity for grafting only on quiet, cloudy days, the percentage take falling off rapidly under conditions of sun, wind, or rain. The Danish system also employs a low-placed side, rather than top graft and follows with stock restriction 6 to 8 weeks after grafting and continued as the cion develops. Average takes run 60-80 per cent with this method although under ideal conditions it may run as high as 90 or 100 per cent.

Bud Grafting

Of passing interest is the bud grafting of chestnut as described by Clausen (3) in France in 1881. Current season terminal buds were cut to a wedge-shaped base with small piece of wood attached and inserted into the cleft terminal bud of a ripening young shoot of the understock on the 24th of June. The bud was tied in place and shaded by the bunched-up terminal leaves. Takes were apparently good. Bud grafting of oaks might be worthy of at least a serious trial.

Stock-Cion Relations

The relationship of stock and cion is of very real importance in oaks. While considerable latitude sometimes seems to exist as to which species will unite successfully with which others, there is accumulating evidence that the factor of durability is not necessarily correlated with initial take. A century or more ago it was found in Europe that chestnut grafted very easily on *Quercus robur*. Apart, however, from one tree which attained the age of 50 or 60 years in the Botanic Garden of Dijon (and never bore mature fruits) apparently few others survived the stage at which the slower developing stock eventually throttled the fast growing chestnut cion.

Cases have been described by Armstrong and Brison (1) in which *Q. virginiana* apparently united well with *Q. stellata* as a top worked stock, made rapid growth for 16 years only to deteriorate quite suddenly at the point of union and die three years later. Causes for the eventually unsatisfactory union apparently lay in the slower rate of xylem or wood

tissue formation by the cion, resulting in a break which caused a girdling effect temporarily compensated for by increased growth of the cion.

In our American oaks there is ample evidence that in general, species of the black oak group both unite and succeed much better with species of the same group as understocks than with any of the white oaks and vice versa.

Perhaps cork oak *(Q. suber)* is as adaptable as any for it has been cited as a tree 100 years old in the Crimea, grafted upon *Q. pubescens* (Federov (5), has been reported by another Soviet worker to take 100 per cent upon stump sprouts of *Q. castanaefolia* and make 7 ft. growths the first year, while in California it does well upon the native *Q. chrysolepis* (Mirov (11) which conveniently comes into leaf so much earlier in the spring that storage of the cork oak cions is unnecessary.

By way of a brief summary we can therefore classify grafting as the most successful present method for the vegetative propagation of oak, whether indoor or outdoor procedures be used. Cuttings are very poor indeed, but merit further trial with emphasis upon the use of wood from quite young plants or sucker shoots from more mature specimens. Layering, generally unsuccessful to the present, also merits experimentation in the use of juvenile plant parts.

The oaks are perhaps outstanding in their ability to demonstrate the pathetic limitations of our knowledge of the basic scientific principles underlying vegetative plant propagation.

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. . . Dr. Skinner presented his paper, making the following interpolation on page 7 of the paper:

No. 1: I didn't mean to imply in the question I asked following that excellent paper of Mr. Hoogendoorn that I am against grafting. Rather, as Mr. Seibenthaler asked this morning, are we getting the end results we want? Having been involved in arboretum work for quite a number of years, I have rather developed the habit of looking at plants not on a 1 to 4 year basis but in terms of the 20 or 50 year results that we can expect with those plants. That has tended to make me a little bit critical of grafting in some groups, particularly in the bush types of plants—things like azaleas and Japanese quinces and lilacs and even *Viburnum Carlesi*—where you have a bush which under arboretum procedure and the procedures of the average home grower needs to be renovated periodically, to be pruned to get good flowers. Even an azalea, we like to cut off occasionally at the bottom. You know what happens. You kill the plant; if you don't kill the plant you get a beautiful lot of understock suckers. It is a picture which has to be faced. I think very often we haven't thought enough about that angle in grafting—the results after a long-time period.

Well, we are not confronted with a bush type in oak. We are thinking of a large growing tree with a single trunk which should normally make a perfectly good plant as a graft but there are none-the-less after effects which we have to watch out for. I want to come to those just a little bit later on in relation to these graft-scion understock relations.

. . . .Dr. Skinner finished reading his paper . . .

PRESIDENT WELLS: Has anyone any questions?

MR. HOOGENDOORN: Dr. Skinner, what are you going to say is the best oak to use in understock for grafting?

DR. SKINNER: That is a problem which depends entirely upon the oak which you intend to graft. In general, I would say by all means graft within the groups I mentioned. If you are grafting oak of the white oak type such as swamp white, use a white oak understock—it may be white oak itself or swamp white or any one of the white oaks. If black oak, use a black oak stock. There may be cases when grafting is successful between these groups. This is an example of the many understock-scion problems which we know so little about. We just do not know which are the best

understocks for our main groups of plants, on a basis of long term performance. I am afraid, frankly that stock selection is largely a matter of trial and error. If you find one that works it will be good to use in the absence of better recommendations.

MR. HOOGENDOORN: What I had in mind was "fastigiata." We used that several years ago on *Quereus robur*, which is the English oak.

DR. SKINNER: I would say by all means put the fastigiata on English oak if you can get English oak seedlings. That is the closest relationship you can find.

MR. HOOGENDOORN: They have very good stands on them.

DR. SKINNER: I think that is certainly the one to use.

MR. HOOGENDOORN: Then I heard you mention about outdoor grafting and you cut the top off the understock after it has leafed out. Is that what you said?

DR. SKINNER: Yes, it is done both ways. One is a top graft with the stock cut off at the time of grafting. In other words, it is the top-working of a small understock, while the other is done much as in greenhouse bench grafting, a restriction of the stock after union of the scion. The latter is the Danish system. In the restriction system it may be 8 or 10 weeks or longer before the stock is completely removed.

MR. HOOGENDOORN: Yes, but I heard you mention that you performed that operation after your own stock is leafed out. Is that what you said?

DR. SKINNER: Just after leafing starts was what I meant to imply, not after they are fully leafed out—after the buds are broken.

MR. HOOGENDOORN: That is right.

DR. SKINNER: It is much the same as in top-working fruit trees where your stock is definitely on the move.

PRESIDENT WELLS: Roy Nordine has a question.

MR. NORDINE: A comment in regard to understock. The primary consideration in all understock, of course, is the ability of the plant to transplant in later years. In work that we have done in the white oak group we find that the English oak *(Q. robur)* as a stock for the entire white group has a good root system which is transplanted very easily and very well. I would never consider using any of our native white oak as an understock. Anybody who has ever transplanted a white oak or burr oak knows what I mean, but the English oak and the English oak group will graft in a case very easily and very well. 80 per cent or 90 per cent should be a reasonable catch and they will grow out easily and well.

In the red oak group, we use only eastern pin oak, which is *Quercus palustris*. It transplants very easily, very well. It makes a fine root system and so this is the only one we ever consider using. In neither case would we substitute any other oak. I would rather forget the grafting if I had to substitute the understock. The entire red oak group is very difficult to graft. The stand is poor. They stand still for years to come and they have to be kept tied for at least two years, possibly three years,

because they will not unite. They will pull away from the union. I have seen them pull away from the union as much as four years after they had been grafted, indicating a difficulty in the red oak group. I have never found any case of the two types intermingling one on the other and there are also no reported hybrids between the red oak and white oak group, indicating there is apparently no compatibility either in the flower or the plant itself.

DR. SKINNER: I am sure Ed Scanlon will congratulate you on having found a use for pin oak.

MR. FLEMER (Princeton): We found the best way to get good understock grafting is to sow the acorns directly in three-inch flower pots so they don't go dormant and become woody. You know the way they behave if you dig up seedlings and try to cut back that long tap root and establish them in a pot!

DR. SKINNER: I think that is an excellent suggestion. Grafting is a pretty slow process in some of the oaks as Mr. Nordine has said. With all the digging and moving you can do to seed bed raised stock you may not get a root system worth a nickel.

MR. JOHN B. ROLLER (Scottsville, Texas): We are at the present time doing hybrid work for Dr. Flory and Brison.

DR. SKINNER: Do you have any information on it?

MR. ROLLER: In a small way. At the time, it fell to my lot to do grafting of these oaks and we used—

DR. SKINNER (Interrupting): Wouldn't you like to come to the microphone? This is first-hand information on grafting of oaks. The main purpose of this paper was to promote discussion and secure information from you as to how oaks are best propagated.

MR. ROLLER: Dr. Brison and Dr. Flory when they started their work with this Ness oak they came up to us and wanted us to work with them, to help them. So my boss—he is a good egg—consented. Naturally, he came up to me and handed me a bunch of scions and said, "Graft these." I knew nothing about it. I wasn't in on the deal, so to speak. All I did was graft them. I was a young kid, about 18 or 20, something like that, but we had a good stand on live oak understock, *Q. ilicifolia*. They grew well. But we got one of our Texas quick freezes. They were beautiful prizes and the next morning the bark was split from top to bottom. We more or less lost interest in it. Of course, I made notes for Dr. Brison on what happened to them. I was just doing the work. Mr. Ravenhaven was making the report. At the same time, you know how young fellows are. I think I had a date that night. I had a little handful of scions left over and I stuck them in the ground out there. I planted a few seed off those trees this fall. They are growing. When I see Dr. Brison I am going to tell him about it.

DR. SKINNER: You mean the scions grew as cuttings?

MR. ROLLER: They had been kept dormant, been stored in cold storage, in fact, they were stored with rose budwood to keep them cold and dormant. As I recall, they were just the current season's growth. They weren't extremely hard and they worked out very well. I am going to report that to Dr. Brison the next time I see him.

DR. SKINNER: Good.

MR. FILLMORE: I would like to ask what species those were.

MR. ROLLER: They were Ness hybrid oak.

DR. SKINNER: It is getting into the group perhaps the easiest to root from cuttings of most of the oaks. Any other comments or suggestions?

MR. J. V. STENSSON (Sheridan Nurseries): The shingle oak is a very handsome oak but, unfortunately, it is almost impossible to get seed. Would it be feasible to graft it on the pin oak?

DR. SKINNER: Mr. Nordine, have you had any experience with that? Would it be feasible to graft shingle on pin?

MR. NORDINE: Yes, but the entire red oak group, in my experience, is not at all satisfactory. It is not satisfactory at the present time for a commercial man to graft red oak because, as I said, they are too slow to grow, too slow to make a tree and unfavorable in their graft union. It would take too long. I would certainly attempt to get seed in that particular case of shingle oak. I would attempt to get the seed by all means.

DR. SKINNER: I would say, incidentally, by all means get on the ball right away. This is one of the best oak seed years and also one of the best beech seed years we have had for some time. Perhaps you can find shingle oak seeds this year when you couldn't previously.

PRESIDENT WELLS: Thank you very much, Henry. (Applause.)

Would you like to have a break before we go into the holly roundtable?

. . . Brief recess . . .

Gentlemen, will you please take your seats again?

We are now about to consider the propagation of holly. I think this is something which is of great interest to everyone of us.

I was out at Paul Bosley's nursery the other day. I came out here a day earlier and if any of you are interested in seeing some beautiful holly, just go out and take a look at some of the trees he has growing in his nursery. I think they were beautifully grown, stiff, dark green leaves, masses of berries. It looked more like Oregon holly. Incidentally, I was out in Oregon a couple of weeks ago and I turned green with envy.

It is not my purpose to talk about holly; we have some experts here to do that. The leader of this roundtable is Mr. H. Gleason Mattoon. I suppose all of us are nuts about some plant or other. Mr. Mattoon is nuts about holly, and he certainly grows some fine stuff. I have been down to his place at Narberth. He astonished me one day by coming to our nursery, and buying a block of Ilex opaca seedlings. I wondered what he was going to do with them. He grafted them. I would think he ought to have saturated the market by now. There is no doubt he knows holly. He is intimately connected with the American Holly Society, I understand, and I am sure he can give us some good information. Mr. Gleason Mattoon!

MR. H. GLEASON MATTOON: Thank you, Mr. Wells. Yes, I am sort of a nut on holly.

From what I say here you may gather that I am also posing as an authority on propagation but actually I realize that I know far less now about propagation and growing holly than I did when I started 7 or 8 years ago.

. . . Mr. Mattoon read his paper, making the following interpolations as indicated: