

deep. Germination is usually high; it will vary according to the damage done by the weevils. Several kinds of rodents can be very destructive following seeding; hardware cloth over the seed beds provides the most effective control.

The only reported disease of small seedlings is collar rot, which kills seedlings in patches. The disease is soil-borne and can be controlled by treating the patches with 1½ fluid ounces of formaldehyde in two pints of water to each square foot of seed bed. This is an old remedy; some of the newer fungicides should also provide a control of this disease. Additional information can be found in the **WOODY PLANT SEED MANUAL**, Miscellaneous Publication No 654, U. S. Department of Agriculture.

MODERATOR ROLLER: Thank you, Roy.

We will go right along with our next topic, which is Vegetative Propagation of the Oaks by William Flemer, III, Princeton Nurseries, Princeton, New Jersey.

THE VEGETATIVE PROPAGATION OF OAKS

WILLIAM FLEMER III

Princeton Nursery

Princeton, New Jersey

The vegetative propagation of Oaks is one of the little traveled by-ways of plant propagation, infrequently employed and even then for only a very few horticultural varieties. The reason is that the oaks are difficult to propagate either by layering or cuttings and if grafted, which is the most successful method, are so badly stunted by the process that several years' culture are necessary before normal growth is resumed. It is a pity that there are not more successful methods known, for an inexpensive, reliable process would be very valuable for the nursery and forestry professions. Everybody who has grown large blocks of oaks for shade trees has observed the considerable variation which even young trees exhibit. Often standing side by side in the nursery row can be seen crooked, stunted specimens and ones which grow with exceptional speed, form a straight trunk and well furnished head without special attention, and are saleable long before the majority of the other trees in the same block. Similarly vastly superior forest types are to be found in the wild, ones which would be far more profitable as timber trees if they could be inexpensively reproduced. Seed selection from superior parents is always good practice, but since oaks are wind pollinated and highly heterozygous as well, this is of limited value. Another interesting phenomenon is the constant succession of natural hybrids which appear in large seedling populations. Many of these hybrids have real horticultural merit. Outstanding have been a *Q. palustris-coccinea* hybrid with superior fall color and a greatly improved branching habit over the Pin Oak, a *phellos x borealis* hybrid with leaves like the Willow Oak but somewhat larger and with brilliant scarlet fall color, and a number of *phellos x virginiana* hybrids of superior form,

almost as evergreen as the Live Oak and considerably hardier, grouped under the name "Darlington Oak." The best of these hybrids would merit naming and introduction to the trade if really satisfactory techniques of vegetative propagation could be developed.

Propagation Methods

Pot Grafting. The most reliable method for the vegetative increase of Oaks is the grafting of the desired variety upon potted seedlings of the same species. An economically acceptable percentage of "take" can be readily achieved. The method is somewhat costly but by no means prohibitive. However, as mentioned above the grafted tree which results is severely stunted for several years, and only gradually is normal growth resumed. This stunting results both from the temporarily limited flow of nutrients through the graft union and from the bonsai effect of confining the seedling to a pot for ease and economy in handling during the grafting process.

Small seedlings of the species desired should be potted up in the spring prior to the season when grafting is contemplated. More vigorous understocks are produced by directly sowing acorns in the pot through frequent liquid fertilizing to produce a seedling of sufficient caliper to be grafted. A three inch deep or "rose" pot should be used for establishing the understocks because it will better accommodate the rather long tap root of the normal oak seedling.

The potted seedlings are brought into the greenhouse in February and scions of the past summer's wood about 12 inches in length and up to pencil size, depending on the diameter of the understocks available, are cut and brought in. The scions are grafted onto the understocks using a veneer graft, tied with a budding rubber strip, and the top of the understock is cut back to a length a bit shorter than the scion. The callusing of the union and the eventual percentage of take are greatly improved by leaving on this large portion of the understock's stem. The grafts can be placed on beds of peat under double sash, but comparable stands and greatly reduced problems from fungus attacks can be obtained by setting the potted grafts upright on the open bench of a humid greenhouse and covering the unions with moist peat. Waxing the union does not seem to be of any marked advantage and since it involves still another operation, we have dispensed with it at Princeton. After the graft has callused and the scion has started into active growth (usually by mid-March), the pots are taken up, the understock is cut off at the graft with shears making a slanting cut, and the successful grafts are again set up in a humid greenhouse but without peat about the unions. After a week or so of high humidity, ventilation is gradually given until the new scion growth is well hardened off. Like *Fagus* grafts, the union is very weak for the first season's growth. Therefore, whether the grafts are bedded out or shifted into containers, much loss will be prevented by staking the grafts with a light 18 inch bamboo cane for the first season's culture. Similarly the rubber tie should not be cut until after the graft has been staked up. The dead scion can be removed from unsuccessful grafts and the potted understocks carried

on an additional season and grafted on the opposite side the following February. Equally successful grafting can be done in a humid greenhouse in late August, using current season's scion wood and cutting back the scion leaves to $\frac{1}{2}$ their former size. However since this operation occurs at an especially busy point in the soft wood propagation schedule, most propagators prefer the February-March timing.

Field Grafting. A number of Dutch and Belgian nurserymen practice open field grafting of Beech and Oaks. In this method the understocks are first lined out and established in field rows. Vigorous scion wood is gathered in early March, cut in 4 inch lengths and stored, heeled in boxes of peat in cold storage. Just as the buds of the understock begin to swell in April, the tops are cut off squarely, the stubs are split and wedge-grafted with scions cut to a long slender double-edged point. Understocks are normally larger than the scion, so special care is taken to match the cambium of scion and stock on at least one side of the graft union. The graft is tightly tied with string or raffia and the entire scion and graft union is coated with grafting wax. Since the seedling has an abundant established root system prior to grafting, splendid growth during the very first summer after grafting is achieved by this method. However, it is commercially practical only under the cool, moist spring conditions of the low countries or the British Isles and is decidedly not successful in the drying winds and sudden hot spells of our American spring. It is certainly worth a try in extreme coastal Oregon and British Columbia, but is out of the question for most other regions.

Dormant Budding. In an attempt to produce Scarlet Oaks with better root systems and to perpetuate superior clones of other species, a number of nurserymen, ourselves included, have made extensive experiments with dormant field budding of Oaks. In large measure they have been unsuccessful, and commercially practical stands have not been obtained. Both de-wooded and "flat" buds have been used, budded at two-week intervals from early July through to early September. The best stand we ever obtained was about 15% budding *Q. palustris* on *palustris*; and *phellos*, *coccinea* and *borealis* on *palustris* have averaged less than that, in order of descending success. The shields, especially of de-wooded buds, normally unite successfully, but the bud either dies and drops entirely off prior to the resumption of growth in the spring or else simply does not sprout at the appropriate time. I investigated several reports in England on budding oaks, in one case *Q. cocinea splendens* on *robur*, but even there a 25% stand was considered good and the *coccinea* on *robur* did not make a very prepossessing tree. Their somewhat better bud stands may again be a function of the mild, moist British winters and springs.

Understock — Scion Relationships. It has been a long accepted dictum that the two major divisions of the Oak family should only be grafted on members of their own section; ie. White Oaks on White Oaks and Black on Black. This is all very true and might be further refined to state that only members of a section should be grafted on their own section if a permanent tree is to result. Thus *Quercus*

pontica in England is successful on *Q. robur*, a member of the same section (Robur), but is not so on *Q. alba*, even though both are "White Oaks" in the looser sense. Similarly the evergreen oaks of the section *Ilex* are reasonably compatible. But even within a section cases of marked incompatibility occur. For example *Quercus borealis maxima* is decidedly stunted on *palustris* roots, while it is better on *coccinea*, and *coccinea* is fairly compatible on *palustris* roots. A specimen of *Quercus stellata* on *Q. alba* (both members of the section *Prinus*) grew satisfactorily for many years near Beltsville, Maryland, when it was snapped off clearly at the graft union one year during a violent thunder storm. All of this leads to the conclusion that oak grafting should be confined to putting the species on its own species understock or the hybrid oak on seedlings of one of the parent species, preferably on the parent species with the best and most fibrous root system, for ease in later transplanting.

Soft Wood Cutting Propagation. Some work was done at the Northeast Forestry Experiment Station in New Haven many years ago attempting to root Oaks from soft wood cuttings. The results were disappointing from a commercial point of view but at least it was demonstrated that there was variation in the rooting ability of different clones. *Quercus alba* was the principal species used. More recently Hans Hess of Hess' Nurseries, Wayne, New Jersey, has had some intriguing results rooting *Quercus robur fastigiata* from cuttings. Hans has kindly permitted the inclusion of his work in this paper. The cuttings were made from the current season's growth while it was still in a soft condition in early July. They were treated with 2% I.B.A. and stuck in an open mist bed with no shade. Rooting was about 50%, which while not startling is commercially valuable since cutting propagation is far cheaper than pot grafting with all the preparation and handling involved. The rooted cuttings were stored at about 38° F. and broke dormancy normally in March. The growth of the cuttings was vigorous, many of them making 10 to 12 inches by the first fall.

Further experiments with soft wood cutting propagation seem desirable, using especially desirable clones for cutting wood. Since it is evident that there is variation in the ability of various clones to root from cuttings, it is always possible to stumble upon really superior species or hybrid clones which will also root with commercially feasible percentages of success.

MODERATOR ROLLER: Thank you, Bill.

Now at this time we are going to have time for your questions.

MR. DON HILLENMEYER: This I address to Roy Nordine. How long do you treat your seeds in the 120 degree water?

MR. NORDINE: Thirty minutes at the 120 degree temperature. This is an old practice that has been handed down from mouth to mouth. As far as I can remember and find out, it is not recorded in the literature. It was an old treatment used for treating bulbs for nematodes and things like that. That is the standard

treatment and can be used on any of the seeds for treatment whenever we have common insect injury.

MR. McDANIEL: I have a comment on one of the so called hybrids mentioned as the Darlington Oak. I believe the latest opinion is that it actually isn't a hybrid, at least in the phellos and Virginiana. Apparently, it is a select type of the southern evergreen oak. I don't know of any actual hybrid between live oak and members of the red oak or black oak to which it belongs.

On the weevil treatment, that is one of the standard procedures with chestnut seedlings in areas where the chestnut weevil occurs.

MR. INGELS: I would like a little more explanation on treating the acorns when you plant them. For instance, were they treated with arsenate of lead? Would that have any effect on keeping the rodents away? I did that this last year and I don't know.

MR. FLEMER: I would be a little afraid to soak the acorns in arsenate of lead, but we have found it a very effective treatment to control squirrels and field mice. We wet the acorns first and then put them in a box and shake them in regular lead arsenate spray powder until they get covered with the white spray powder. We had a flight of squirrels and the woods are littered with dead squirrels around our seed. They have to chew through the lead arsenate before they can get into the acorns. It is highly effective.

DR. CHARLES HESS: Bill, do the grafts of oak during the period of adjustment you mentioned, go on their own roots?

MR. FLEMER: It depends upon how compatible the graft is. For instance, it is possible to graft *Quercus robur* and *Quercus alba* and if you plant it deep, the scion will go on its own roots. Then you have a perfectly happy combination, but in our cases of *Quercus phellos* on *palustris* or some of those rather compatible combination or *Quercus coccinea* on *coccinea* seedlings, they do not go on their own roots and it takes some time until you get the graft union mature enough to permit rapid diffusion of nutrients. They are quite stunted but only temporarily.

MR. RALPH SHUGERT: You mentioned chestnut leaf oak listed in Rehder for Zone VII. It will be growing in the southern range of Zone V. I was wondering, Roy, aren't chestnut leaf oaks at your Arboretum? It seems like I saw some.

MR. NORDINE: What do you refer to?

MR. SHUGERT: *Castaneaefolia*.

MR. NORDINE: No, we do not have this plant.

MR. FORSTER: I believe you can't give the name chestnut leaf oak to a group which do have foliage similar to the chestnut. There are more than several of them, apparently.

MR. FLEMER: I would like to recommend, speaking of unusual oaks, to the southern members of the Plant Propagators Society that they try growing the Japanese live oak, *Quercus myrsinaefolia*. This is, to my mind, one of the handsomest of all evergreen oaks, with long polished green leaves. The seed is available for the writing by the bushel from the Plant Introduction Station just outside of Savannah, Georgia. The people down there are quite kind about making

it available. It forms a large majestic rounded tree at maturity and has this thick, heavy polished foliage, one of the most beautiful ever-green trees I have seen.

MR. HILL: In what zone will it grow?

MR. FLEMER: There is a lot at Greenbrier. They have quite a patch at Norfolk. That is Zone VII or VIII. I don't think it will take it to the National Arboretum. Do you know, Ray?

MR. RAY BRUSH: I would like to make a remark about this. Capitol University got hold of it somehow from the South about eight or ten years ago. At the present time we have a tree at the American Bureau College at Temple in Amhurst. It has gone through two winters. Although it loses its foliage, it sprouts out the following spring and grows.

MODERATOR ROLLER: Thank you, gentlemen, for a very interesting discussion.

The next subject on the program for this afternoon was to have been Propagation of *Kalmia* by Means of Seeds, but John Ravenstein is on a trek to Europe, so we are going to make up a little time right here and call on Jack Hill for a discussion of Propagation of *Juniperus chinensis* in the Greenhouse and Mist Bed.

MR. JOHN B. HILL: I can't let this opportunity go past after the discussion on oaks. A hybridist by the name of Samuel Hovenstein wrote in a spoofing way a little poem and concluded with his theory that oaks were noble and eternal as compared to the wreckage of man's transient nature with these words of counsel: "Before the world goes up in smoke, ladies, get yourself with oak."

Now to get into this subject of the propagation of the chinensis group.

THE PROPAGATION OF JUNIPERUS CHINENSIS IN GREENHOUSE & MISTBED

JOHN B. HILL
D. Hill Nursery Company
Dundee, Illinois

As I approach this group of experienced and knowledgeable propagators, I wish it understood that I do so without any burden of vanity or overconfidence. The broad subject of propagating the various cultivars of *Juniperus chinensis* is, at once, so broad and widespread in its practical application that I feel it most useful to avoid frequent reference to the research of other workers and, rather, confine my remarks so that they apply to our experiences and observations made in Dundee. The published research is readily available to all.

Hasty examination of earliest records finds that there is reference to the rooting of *Juniperus chinensis* by cuttage in the Orient and England during the 18th century. Very little is said of the actual technique and equipment employed, but the strong inference in these