Here in Cleveland I hope you will visit our Garden Center. Most of you know the places of interest and probably all of you have been to places you shouldn't go, so I won't mention those.

As I say, I am not here to take up a lot of time. There isn't too much I can tell you. I am here to learn, so I am very happy to be here again to see all of you. (Applause)

PRESIDENT CHADWICK: Thank you, Besse Howells.

I think most of you are familiar with the fact that Dick Fillmore, of Lake's Shenandoah Nursery, Shenandoah, Iowa, is chairman of the program this year. He has done an excellent job in preparing a fine program, but unfortunately Dick is sick in the hospital and will not be here at this meeting. I am sure that we will miss him greatly.

In the preparation of our program this year we felt that one of the topics that should be discussed was propagation within a small nursery. I think sometimes we tend to think of only the larger operator. We have on the program as the first speaker, Mr. Roscoe A. Fillmore, father of Dick. Mr. Fillmore operates a small nursery in Nova Scotia. He will address us this afternoon on propagation in the small nursery.

Mr. Fillmore presented his paper, entitled "Propagation in the Small Nursery." (Applause)

PROPAGATION IN THE SMALL NURSERY

ROSCOE A. FILLMORE
Fillmore's Valley Nursery, Centreville, Nova Scotia

Mr. Chairman, members of the Plant Propagators Society, and guests: I wondered when I was asked to talk here just why, and after looking over the exhibits in the other room I still wonder. I am afraid there isn't anything I can tell. It is true that I live, and grow nursery stock, in a quite different location and environment from that in which most of you are working.

I may say that I thoroughly endorse the purposes of this great Society and, therefore, I joined last year. I have always believed that each of us had more to gain through cooperation than through fighting each other and attempting to keep our particular methods secret from our neighbors.

Now I don't know just how much you may know about my location - Nova Scotia. If you will look at the map of North America or of Canada you will find that Nova Scotia sticks out into the Atlantic like a bent thumb. It is connected with the mainland of North America by a narrow isthmus, the Isthmus of Shignecto, some 18 or 20 miles wide, so the province is almost an island. We have the Bay of Fundy, famous for its high tides on the north, and the rest of the province is surrounded by the Atlantic Ocean.

Now that Atlantic Ocean is bound to have an enormous influence on our general climate and our temperatures. Our temperatures, for instance, range from a very occasional 90 in July or August, to a very occasional 20 or 25 below zero in January or February.

We have an extremely dry season, as a rule, from the 20th of June until the first of September. This particular year, that dry season extended

until almost the first of October, so that we have certain problems to meet that are perhaps not quite the same as have those propagators who live in California or New Jersey or near Cleveland, or Alabama.

The basic problems, I suppose, are much the same, but whenever we hear or read of a new technique in propagation of plants we know that we shall have to modify it somewhat, sometimes considerably, before we can make a success of it where we are. That type of experimentation, I may say, is a sort of love of mine. I was born with a curiosity, I think, that was immense and sometimes it has driven me into the armed valleys but sometimes into learning things. I believe that curiosity as an activating force, of course, is responsible for most of the things that we of the human family know today, for most of the things we have discovered.

Now, as for propagation of nursery stock, our nursery is comparatively small, only a few acres, but we grow a fairly wide line of plant materials. Most of you grow materials that wouldn't be quite successful with us. They would be borderline plants or in many cases would be too tender to take our winters or springs which are almost worse than the winters.

We grow a fairly wide line of plants. I might mention a matter of 30 or 35 varieties of conifers. We grow azaleas and rhododendrons, the hardier varieties and specie. We grow blueberries, various ericaceous plants, salvia, and so on, and also a wide line of flowering shrubs.

Now as a youngster I was brought up in a nursery. My father grew fruit trees, apple trees mostly. Thirty years ago, I located in Nova Scotia in the center of Annapolis Valley, which at one time was famous for apples. It shipped two to two and a quarter million barrels of apples to Britain. Today, that market is gone and the orchard business is in the doldrums.

I went to Nova Scotia with the idea of locating in the center of a fruit district where I could make my living growing fruit trees, and I soon found that my family could starve to death growing and attempting to sell fruit trees. If during the season there was a really good price for apples, farmers would mortgage their farms to buy trees. If it was a bad season and poor prices, you couldn't give trees away. You ripped them out of the field and burned them.

So in the beginning, as a sideline in order to feed my family, I started to grow a few shrubs, annuals, perennials, and so forth, and within a very few years I found that in so far as fruit trees were concerned, they were out. I didn't want to grow them any more. I had to go into the growing of ornamental plant materials, and I found in Nova Scotia, due to the climate largely, I suppose, but also due to the fact that there were no native nurserymen who were really growing anything, that a very narrow list of shrubs and of ornamental plants in general were being used. Forsythia, mock orange, and a half dozen others pretty well covered the list. I knew that in order to build a decent local nursery business it would be necessary to add to that list. So we went to work with that idea.

When I was a youngster I learned how to graft and bud. I had learned some of the simpler methods of propagation, such as picking up a clump of phlox and tearing it to pieces and planting a half dozen plants instead of one clump, and the same with shrubs. I soon learned that a lot of the shrubs could not be propagated in such manner because they didn't stool out enough and that you had to learn other methods.

So then we learned that we would have to buy lining-out stock. We bought it largely in Holland, although some from Shenandoah, and some from Ontario nurseries, and after making a lot of mistakes, we learned how to grow the greater part of this material we found hardy.

We had to carry out extensive tests that took a lot of time and a number of years in order to learn just what shrubs would be hardy, and in the course of those experiments, if I may call them such, we fell in love, for instance, with rhododendrons and azaleas. I had seen them in Boston and elsewhere and I was convinced by some means or other we could find some varieties that would be hardy. So we bought lining-out sizes, planted them and watched them be killed. We did it again and again, but it became evident that one or two indivdiuals among that lining-out stock was hardier than the rest.

Now bear in mind the buying of liners from Holland where the climate is very much milder than our own, left us in a situation with stock which had been growing in a climate that was no test of hardiness. The climate of Holland is not a test for hardiness if the material that you are going to plant is going to be planted in Nova Scotia or Quebec or northern Ontario. So we bought this material. We planted it. We took as good care of it as we could figure out and we watched it. Some of it did die, but we got the occasional individual that pulled through.

Now we found in the Province of Nova Scotia when we started looking around and making inquiries, a few odd plantings of rhododendron. We found, for instance, *Catawbiense* and a number of the hybrids which were growing to a height of 12 or 14 feet in places. The Public Gardens in Halifax has a quite large planting of *Catawbiense*. I wondered, at the time I found them there, if they were just what was left of a larger planting of perhaps an assorted planting. But I heard afterward that the old Englishman who had established the gardens was convinced when he had experienced a winter or two in Nova Scotia that there might be a chance that the specie could live through our winters but there wasn't a chance for any other variety to do so, so he brought out a hundred or so. The result was that I had evidence there and I also had thoroughly hardy stock plants from which to get materials.

Now my son Richard told me some ten years ago of the possibility of growing rhododendrons from leaf-bud cuttings and we tried it. We hadn't much luck with it because we hadn't installed heating cable, but once we installed the heating cable, we found we had possibilities.

We found a number of varieties would root readily. Our sweat box is a frame running the length of our greenhouse, 12 or 15 inches deep, and covered with sashes.

The first season we got some results. The second season something in the way of a fungus, I suppose, attacked the materials and the greater part of our rhododendron cuttings and of our coniferous cuttings simply died almost overnight. Se we took the sashes off and threw them away. We used cotton shading for a time. Today, taking a hint from Mr. Templeton's propagating frame, we use heavy wire bows over that frame and we toss sheets of polyethylene film over it, making a tent of a kind that is by no means airtight. We find we are getting wonderful results from this.

I don't know whether it would be of interest to you to give you an idea of some of the varieties. My memory isn't good, but I can tell you of a

few of the varieties we root in this propagating case. We root *Catawbiense*, the specie, *Roseum elegans* and *Alba elegans*, and Cunningham's white and Dr. Dresselhuys. Recently we have rooted a few of the Queen Mary and Princess Mary, but we are not quite certain as to the hardiness of those two varieties.

Now we have found some 40 hybrids that are hardy in Nova Scotia. We have confined ourselves to some 20, because we don't want to clutter our lists up with too many varieties because the more varieties you have of any particular plant the more danger there is of getting into a mix-up.

As a matter of fact, the greater part of our rhododendrons are sold on the basis of color. The customer doesn't care a darn what the variety is. He comes in and says, "I want a red one or a pink one or a white one," and that is what he gets, or I hope that is what he gets.

Oh, yes, there is another matter that I would like to tell you of. About ten years ago, in Boston I saw a little rhododendron, a small-leafed, small-flowered pink rhododendron, a *Carolinianum*. I bought some. I thought they were beautiful. I took some home and the winter killed them. So then I bought some seedlings, and I obtained some seeds from the Arnold Arboretum. Five years ago we had some of these seedlings flower and for them to flower in Nova Scotia means they are hardy. If anything is killed, the flower buds are going to be killed. We immediately saved the seed, planted them, and last year, the spring of '54, we had quite a nice lot of *R. Carolinianum* flower. We figure that we have a Nova Scotia-hardy selection.

This is the method by which we have discovered hardy strains of various plants, and I could go on for sometime and list for you the things that we have done in this line.

As a matter of fact, we have done more of this sort of work than we could afford to, because up to within the last three or four years our Canadian Federal Experimental Station was interested in poultry, beef cattle and apples. They paid very little attention to ornamental horticulture, so we have done the work they should have been doing. Within the past three or four years by putting pressure on the experiment farm, they have become interested in ornamental materials. I expect to drop some of this experimentation I have been carrying on and allow them to do it. That is the job they should be doing.

We also became interested in holly and some four or five years ago my son Richard, sent me 200 seedlings of *Ilex opaca*. Also he sent me *Ilex convexa*. Those 200 seedlings of *I. opaca* have now taken three winters outdoors in Nova Scotia and they have been reduced to about 40 plants. The rest of them made such a poor showing and looked so bad that I ripped them out and threw them away. There are still some among the 40 that are straggly miserable-looking plants and don't look as though they will make nice compact plants. Those will be thrown away, but we will have 25 or 30 plants of the original lot that apparently can take our Nova Scotia climate in stride. We have found that tip cuttings of those if taken in November or December will root very readily in our propagating case. We expect before too long to have a stock of *Ilex opaca* to offer to the public. It is possible it may be necessary to put them in sheltered spots in order to be sure they will winter well, but lots of people are good enough gardeners and enthusiastic enough gardeners to take the little extra trouble that is necessary in order to bring them through..

We have carried on this sort of work with dozens and dozens of varieties until we have either proven they couldn't be grown or selected hardy strains that we could propagate and safely sell to our customers.

Our market is in what is known as the Maritime Provinces, that is, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland. It is all pretty tough climate, although not quite so tough as some of you believe. Newfoundland looks to be far north, but anything that grows in Nova Scotia and a few things that will not grow in Nova Scotia will grow in Newfoundland. It is way out in the Atlantic and the Atlantic exerts an enormous influence, holding the temperature up in winter and down in summer, so the climate is far more livable than you would have any idea.

We had the same experience with azaleas. Nova Scotia has an acid soil throughout. Blueberries and that type of thing grow perfectly. Richard sent me, and at times when I visited him I took home, cuttings of various varieties of so-called hardy azaleas and worked with them several seasons. We found that most of them were rather hopeless in our climate. We found that early in the fall the first hard frost would split them right down the stem. So then we started them in the sheds and at the present time we are growing and have a considerable stock, for instance, of *arborescens*, which we find is perfectly hardy. We have known it to flower as early as April 20. That means something in Nova Scotia. There is a point that where we are located on the north central shore of Nova Scotia, we are at least two weeks and sometimes three weeks later than at Boston or at Niagara Peninsula of Ontario.

Dates mean so little when you are attempting to cover a territory as large as is represented here today, that I am not even attempting to use dates to any extent. They wouldn't mean a thing to you because you find your springs two or three or five weeks earlier than ours.

We use as a propagating medium mostly a sharp sand. I have grumbled every year for years that our sand is a little too fine, but there doesn't appear to be an easy source for getting any other. We also use vermiculite. We have found rhododendron roots very readily in vermiculite. I dislike vermiculite because you will pour four or five inches into a propagating bench and three or four weeks later you will find it has settled to three or four inches and the base of the cuttings are too close to the heating cable.

Magnolias are an old story to most of you and I presume the further south you live the easier it is to grow magnolias, but we have tried for a number of years by bringing in small liners, but we have found they grow too slowly or are nipped back by the frost.

Recently I saw a *Magnolia soulangeana* about five miles from my nursery which was about 15 feet high with a spread of 8 to 10 feet. It was in full bloom. I immediately asked the people who owned it for permission to make cuttings when the time was right and since then I have been able to root *Magnolia soulangeana* from a thoroughly hardy specimen. We know it is hardy because it couldn't have been there for less than 15 years and perhaps as long as 20 or 25 years.

Last fall I was amazed when I was in the City of Moncton, New Brunswick, which is almost 100 miles farther north than we are, to find a larger magnolia than the one just described. The man who owned it told me he thought hundreds had been planted and sold in Moncton and that this specimen was the sole survivor.

You can see what I am driving at. We are using, as a matter of fact, our climate to select hardy strains and hardy plants for use.

With conifers, we are lucky in a sense to be within five miles of a federal experimental station. It was landscaped about 40 or 45 years ago with various varieties of juniper, chamaecyparis, arbor vitae, and taxus. We have always had permission to use whatever we could use in the way of propagating material from these plantings. So we have specimens of evergreens that have proven over the years to be thoroughly hardy in our Nova Scotia climate.

Most of us are so situated that we have neighbors. You have nurserymen who are carrying on this work under practically the same conditions of climate as you, while we have been up there practically alone. As a matter of fact, in the Maritime Provinces we have a larger nursery and grow more nursery stock than all the other nurseries combined and we have been pioneering in this line. Even the newer methods of propagation that we read about, as I said before, have to be adapted before we can be at all certain that they will give us the result they give you.

You will be surprised to know that I have *Metasequoia* growing in Nova Scotia. True they winter kill a matter of three or four inches, but they are growing. Of course, mine are only five feet high, whereas, trees that were planted at the same time in the Arnold Arboretum are probably twelve. I believe if the quantity of seed were available, it might be quite possible to select a hardy strain of *Metasequoia* that would grow well in Nova Scotia. That is an objective I have in view, as a matter of fact.

We have learned not to waste propagating material. When you are beginning, as some of you undoubtedly are, you often find it difficult to multiply plants as fast as you would like. You may not, for instance, have anybody to consult with and unfortunately the books are so academic that you don't just understand what is meant. You will find that you must take advantage of every opportunity to get hold of propagating material even if it is only a handful.

Now we have bought, at various times in the past, climbing roses from Holland and they come in with 7- to 10-foot canes. They come in March and we have cut the canes and rooted a fair proportion of them several seasons. We did it and even though we lost a high proportion we were getting stock.

Last spring, we brought in from Holland a shipment of tall taxus - *hetzi*. They were tall, beautiful plants. I went to work on them with a pair of clippers and I made several thousand cuttings, six to nine inches long, and stuck them in our propagating case on the second day of April. Late in June I took 60 per cent rooted out. The rest were put back and about half the remainder rooted. We threw the balance out, though they were still alive. We take advantage of every opportunity.

I didn't know when I gave up the idea of growing apple trees and learned how to go about the propagation of shrubs. When I was 17 years old I worked in Rochester, New York, at the old Brown Brothers Nursery, and one spring I had helped to plant hardwood cuttings. So I started to make some hardwood cuttings of shrubs and found they did very well. It was only a few years ago, but we were handicapped by the fact that it was very difficult to line those out in the field and make them root. We found in order to get a decent proportion we had to put them in our shaded frames. That was due, I presume,

to our very low rainfall during the latter part of June and throughout July and August. They would just dry out and you didn't get any growth.

Only a few years ago we learned to make the softwood cuttings. Our first method of handling those was to make the cutting by tearing the twig off the plant, nipping the little heel of bark, treating with the hormones and sticking in flats of sharp sand inside the heavily shaded greenhouse. When we first started that, it was quite a common thing to find that the flats prepared at night were wilted the next morning. We hadn't any knowledge as to the stage of maturity required in order to root readily and, of course, we found some of the shrubs much more difficult than others. But that became our standard method of propagating a great many of these shrubs. We learned in time to tell from the feel of the wood whether it is mature enough. We always have had trouble with Hydrangea P. G. wilting for instance.

Last year, when I heard Leslie Hancock tell of his method of rooting leafy cuttings I thought that was a marvelous advance in propagation. It proved to be so with us this past season. Now remember, I have pointed out that we cannot make our cuttings as early as he does. It was about July 26 when we first started to stick leafy cuttings according to Hancock's method. Leslie Hancock's is a tobacco sand; ours is a little different though it is a sandy loam. We added 1-1/2 inches of sand on the soil before sticking the cuttings. We found that cuttings of the flowering shrubs rooted in from 12 to 19 days. Practically everything was rooted at the end of 19 days. After we had stuck a good many thousand in this way, we decided we would put some right into the soil the way Leslie does. There was no significant difference in rooting, so that from now on we will stick them in the soil.

I would like to go back a moment to Hydrangea P. G. which we have found a funny thing to handle. Under greenhouse conditions as we first propagated that shrub, we found there was such a great difference that perhaps the cuttings made today would all wilt and those made two days hence would root almost 100%. We tried hydrangea in the Hancock frame. We found they flagged badly the first two days, then they picked up and rooted practically 100%. When we put them into the constant mist frame, we found the same thing happened but that they perked up. We found that Hormodin No. 3 was altogether too strong.

For next year we have in mind a modification of the Hancock method that we believe will be practical and will save a lot of worry and the possibility that some day someone will forget to turn the hose on for a few minutes and let the cuttings dry out. We intend to set up sprinklers with a timing device so every three-quarters of an hour or every hour the burlap covers will be moistened without our personal attention. It may not save a great deal of time, but it may save us a few gray hairs just wondering and worrying.

Now another of the ericaceous plants that we grow to a great extent is the high bush blueberries. Some of you perhaps are familiar with them. We grow them as a fruiting proposition, that is, to sell to people who want to put some in their family garden or to plant commercially. Believe it or not, it is a beautiful ornamental shrub in flower, in fruit and in autumn color. These are grown mostly from hardwood cuttings by just a little different method from that used in growing the flowering shrubs from hardwood cuttings.

The cuttings are taken in the spring, usually in March when the fruiting bushes are being trimmed. The cuttings are about four inches long. Boxes, six or seven inches deep, are prepared with quarter inch wire mesh bottom and the boxes are filled with peat moss and either set over a pit or set just across the sides of a frame. The cuttings are stuck with just the tips showing. In the course of the summer they will root. You can pick up these boxes and carry them into the storage basement or storage room or put them flat on the ground and mulch them. They are planted out in the field the next spring.

I have tried, mind you, to root blueberries from green cuttings with rather poor results. We did root a small percentage in mist. We rooted a small percentage in the Hancock frame. Thinking we had something, we made a bunch in July and I think that it was just wasted time. Before I left home we made several hundred hardwood cuttings by trimming the fruiting bushes and we put them into our inside propagating case over the heating cable. We hope to root them during this winter so that if they root well enough to be lined up next spring we will have saved a part of a season.

I understand that mist is to be the subject of one of our discussions, so I am just going to mention the fact that we put in a little frame 3 x 12 feet and we tried a little bit of pretty nearly everything in that frame. I think that some of these materials that are otherwise pretty difficult to root will root under mist, but on the whole, I would trump for the Hancock method for most things. We stuck cuttings of some five or six varieties of *Philadelphus*, including *grandiflora, varginalis corinarius,* and *lemoine,* and others, and we found that the foliage broke down in the mist frame. Within two weeks the cuttings were practically denuded.

Now I thought it was a failure, but we found that almost all of them had rooted but the result was there was no growth. If you pull one out of the frame you find a little sprout starting from the lower node, the same node from which the roots came. I want to know whether I used too much water, since it appeared to me that the leaf itself just broke down into a jelly-like substance.

We are quite certain that the mist frame is going to be a boon in the rooting of coniferous evergreens. We did try some things that didn't root, for instance, we made cuttings of Kosters spruce of the current year's growth but they did not root.

Now "hetzi" taxus rooted practically 100 per cent. They were rooted by the third of July. *Chamaecyparis pisifera,* an item which we have found extremely difficult to root, rooted beautifully and believe you me, we will have a lot of them next year because I believe that is the only practical way of rooting them. We don't intend to concentrate on either the Hancock frame or the mist frame. We intend to root all the fairly easy stuff in the Hancock frame and to set up a mist frame large enough next year to handle the more difficult items.

By the way, we tried azalea cuttings taken from fairly soft and tip cuttings of *Rhododendron catawbiense.* I believe the reason they didn't root was that they simply didn't have the time. We have a short season.

Our business probably differs considerably from that of most of you here. For instance, as I explained when I found my family could starve growing fruit trees, I had to start another line, so I built up a big business in annual

plants and perennials. Today, we have in the field 185,000 pansy plants for next spring. Next spring we will grow a quarter million annual plants.

A third to a half of our business is in our own yard. We find that these lines bring people by the thousands. We have had 3,000 people over a week-end on our place. Now, to a considerable extent it is that bright field of pansies that brings them in.

You might be interested - I don't know - in knownig how we handle pansies, for instance. This is the method briefly: The last week in July and first week in August we prepare frames 6 x 40 feet. We put the soil through a screen. We use well-rotted manure and peat moss, so that probably the final 4 or 5 inches of that frame is 25 per cent peat, 25 per cent manure and 50 per cent soil, perhaps not quite so strong as that in manure.

We seed on the surface and immediately cover with sashes and cover that with tarpaper so the frame is warm and tight and dark. At the end of about five days, germination is under way. We examine it and we toss a little soil here and there to cover the sprouts of the newly-planted seed and we gradually remove the covers and shading and in three weeks' time the frames are bare. In six weeks they are ready to transplant and we run them into 4-foot beds, eight rows to a bed. The plants should be about five inches each way, and they winter beautifully under a light covering of coarse hay. That is the operation in brief.

Now another item we grow by tens of thousands is double flowering petunia. We grow them from cuttings. We buy seed normally when a new variety is advertised and just enough seed to get a few plants. About the first of September when the petunias are growing well we make cuttings and root them and they become the stock plants from which we grow our marketable stock towards spring.

We have rather restricted greenhouse space and it became a problem a few years ago to handle all these bedding plants. We found we were increasingly compelled to use our greenhouse space for the propagation of nursery stock. That was really the important thing, we believed, so we built ourselves fairly tight frames six feet wide and about 40 feet long. Since we have such a changeable climate in the spring, we suspend 100-watt frosted lamps about 6 or 8 feet apart. We use that not only to prevent freezing but during a cold day in April when it is snowing and too cold for anything to grow, almost too cold for a person to step out of doors, we switch those lights on. We get fine growth, so I take it for granted that the light is helping to give us strong plants.

One of the things we have made a complete failure of is roses. I have made up my mind since trying constant mist that we can root florabunda and polianthus and grow fine plants on their own roots. The hybrid teas are a horse of a different color. I don't know what to do with them. We have budded them for several years. We find they start in the fall and that the winter kills them. This year, we have grown a quantity of multiflora seedlings. We are going to try again and bud well down on the root and see if it makes any difference.

Now I suppose you are all just as well aware as I am of the fact that every species and almost every variety of plant is fussy as blazes, probably as tempermental as you and I, and it is an endless problem to discover just

the particular conditions under which this or that or the other will root or thrive.

Now we have run up against scores of situations where we scarcely knew what to do. The past few years I have to admit I have had the advantage of a son who has made somewhat of a study of this problem and has been able to give me a lot of this information. Even he, as a matter of fact none of us, knows the half of it. I suppose I felt when I came here that the main excuse for coming here and attempting to talk to an audience of seasoned nurserymen and propagators was the sum total of the experience of all of us constitutes all that is known on this subject. Our experience, our mistakes and our successes will add a little bit to human knowledge in this business of plant propagation and that really was my justification for coming here and attempting to talk to you today, because really our objective has always been to produce everything we sold from scratch, from seed, grafts, layers, divisions, and cuttings. That has been our objective and we have almost reached it.

Our nursery and lath houses contain tens of thousands of materials to go into the field next spring. It will mean, when mature and ready to sell, that we will have four or five times as much material as we have ever had in the past to sell. So I suppose a man could scarcely have gone through such an experience as this, covering a lifetime, without at least learning something and perhaps being able to help, at least in some particulars, even the biggest of you.

Ladies and gentlemen, I thank you for listening to me for so long. I hope I have contributed something. I trust that if any of you are in Nova Scotia at any time that you will call on me. We live just three and a half miles north of the town of Tenbrook in the Annapolis Valley.

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PRESIDENT CHADWICK: Thank you, Mr. Fillmore, for a very interesting discussion. I think we will take time for one or two questions. We want to keep on schedule as much as possible.

MR. HOOGENDOORN (Hoogendoorn Nurseries, Newport, R. I.): What interested me was the large hydrangeas you found 100 miles from home. Did you observe the elevation of those trees?

MR. FILLMORE: I wouldn't know the precise elevation. I would say neither of them would be more than 100 feet from the sea level.

MR. HOOGENDOORN: In rose budding, you budded hybrid teas and they died?

MR. FILLMORE: No, they start in the fall and the winter kills them, even though they are well covered.

MR. LESLIE HANCOCK (Woodland Nurseries, Cooksville, Ontario): I think what you said about the mist frame and evergreen production is quite significant. Were *Hetzi* cuttings of new wood or some old wood?

MR. FILLMORE: They would be last year's wood, that is, they were cut so actually there were two years, last year's and the early growth.

MR. HANCOCK: I would like some corroboration on that point. We have always understood in evergreen cuttings which were immature, they

did not root well. Would it not have been better than making them in July to have made them in May?

MR. FILLMORE: That is quite possible. I can't say I know, really. That is quite possible. You see the April second cuttings rooted fine, too, and of course, they would only have last year's growth.

PRESIDENT CHADWICK: I am going to ask you to hold the rest of your questions until the Friday evening session when we will have a discussion period.

You will recall last year we started an exhibitor speaker session at these meetings, and that appeared to be very successful. Consequently, we decided to continue that arrangement this year. Some of you may have had an opportunity to see some of the exhibits which are in the lounge room at the other end of the hall. If you have not, be sure that you do see them before you leave here. The man responsible for these exhibits and the panel symposium is Mr. Roger G. Coggeshall of the Arnold Arboretum. I would like to introduce him at this time and he will carry on the afternoon session.

Mr. Roger G. Coggeshall took the chair.

MODERATOR COGGESHALL: Thank you very much, Dr. Chadwick.

It certainly has been a pleasure for me to correspond during the past two months with the large number of persons who have contributed material for the exhibits.

Today, we are going to have seven speaker-exhibitors. In addition to these seven speakers, there are some ten other persons who have set up exhibits for this meeting. Any questions concerning these exhibits should be asked directly of these people who have them set up, as they will not speak from the platform today.

As you can see by your program, there will be four talks this afternoon and three tonight.

In general, we are allowing two minutes for an introduction, 15 to 20 minutes for the actual talk and approximately nine or ten minutes for a question period.

The first speaker of the afternoon is Mr. William Flemer III, Princeton Nurseries, Princeton, New Jersey. Mr. Flemer will speak to us on the "Propagation of *Mahonia aquifolium* from Softwood Cuttings".

PROPAGATION OF MAHONIA AQUIFOLIUM FROM SOFTWOOD CUTTINGS

WILLIAM FLEMER III
Princeton Nurseries, Princeton, New Jersey

Ladies and gentlemen, fellow propagators: You may wonder why I have chosen the subject of "*Mahonia aquifolium* From Softwood Cuttings", because as is generally known, *Mahonia* grows very well from seed, almost as well as barbery. You simply level off a piece of land, break up the soil, spread the seed in a suitable manner, cover with sand and wait until spring, when up they will come by the thousands.

did not root well. Would it not have been better than making them in July to have made them in May?

MR. FILLMORE: That is quite possible. I can't say I know, really. That is quite possible. You see the April second cuttings rooted fine, too, and of course, they would only have last year's growth.

PRESIDENT CHADWICK: I am going to ask you to hold the rest of your questions until the Friday evening session when we will have a discussion period.

You will recall last year we started an exhibitor speaker session at these meetings, and that appeared to be very successful. Consequently, we decided to continue that arrangement this year. Some of you may have had an opportunity to see some of the exhibits which are in the lounge room at the other end of the hall. If you have not, be sure that you do see them before you leave here. The man responsible for these exhibits and the panel symposium is Mr. Roger G. Coggeshall of the Arnold Arboretum. I would like to introduce him at this time and he will carry on the afternoon session.

Mr. Roger G. Coggeshall took the chair.

MODERATOR COGGESHALL: Thank you very much, Dr. Chadwick.

It certainly has been a pleasure for me to correspond during the past two months with the large number of persons who have contributed material for the exhibits.

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The reason for vegetative propagation of this variety lies in the tremendous variability of the seedlings and this talk should perhaps better be a talk on selection rather than on propagation.

It seems to me one of the most important functions of the propagator in any nursery, because of his peculiar position of working closely with the plants themselves and observing them from day to day in the field, should be that of selecting better strains of each and every kind. As most of the better strains that are selected do not breed true from seed they have to be propagated vegetatively.

I brought some examples here this afternoon to show you some of the variability of *Mahonia* seedlings and to bring out the characteristics which I think are worthy of selection and worthy of the extra expense of vegetative propagation.

As you know, *Mahonia* seedlings vary in their habit of growth. Some are incompact growers, some are compact bushes, some are tall and shiny and some have a lot of foliage while still others are sparse.

Poor quality plants from a lot of seedlings will have rather dull, papery leaves, subject to windburn and sometimes partially deciduous under winter conditions.

The type of seedlings which we consider worthy of propagation have bigger leaves, better fall coloration and a shiny, waxy appearance. Naturally, we select not only for the glossiness of the foliage, but for growth habit, too. You want a plant that makes up rapidly into a nice compact rounded specimen.

Still another important variation in *Mahonia* is the resistance to winter burn, particularly in our location on the east coast where we have in the months of February and March, a combination of frozen ground and hard driving winds which dry out whatever moisture is in the plant.

In general, the waxier leaf you select, the more resistant that leaf is to drying-out.

One of our selections has a little different leaf habit. It has a leathery leaf - *Mahonia bealei*. This particular clone has come through winter relatively undamaged in our most exposed nursery blocks. That is an important point when growing *Mahonia*.

As far as the actual propagation is concerned, it is a very simple matter indeed. The long *Mahonia* cane can be cut up into a number of cuttings, but we found the terminal, the first cutting from the tip, roots much more readily and gives a better percentage than additional cuttings made down the length of the cane. In other words, there may be anywhere from 4, 5, or 8 leaflets. They are removed and just the last two are left intact.

The cuttings are then cut just below a node, or sometimes through the node. We don't scarify them or wound them in any way. They are put into Hormodin No. 3 and stuck in sand in a humid greenhouse under controlled conditions.

We try to get the cuttings in before we have a severe frost. Anywhere from the 1st to the 15h of September is about right. If you take them earlier than that, you have a high percentage of rooting, at least under our conditions, and later than that there may be frost injury which causes them to break down later in the bench.

A cutting stuck the 15th of September and removed from the sand just before I came here, it is now thoroughly rooted, almost rooted too much. It is ready to be potted.

There is one additional advantage in making mahonias from cuttings. The root system is highly branched in contrast to the average seedling, which has a taproot with very few feeder roots If you plant a seedling without cutting back the roots sufficiently you tend to get a sparse, straggly-root system which is not adapted to balling.

Our losses in balling from seedlings, which we have grown and dug, have run sometimes up to 15 or 20 per cent. The customers complain that the plants didn't live and when they send them back we see they had too sparse a root system. With cuttings the little roots grow out and form a nice bushy root system. This way our replacement losses on cutting-grown plants is much lower indeed than with seedlings.

The production cost of a seedling is at about five cents apiece, perhaps a little better - three and a half to five cents apiece. The cost of producing a cutting and potting it, then planting it in the field and picking up the pots, is about twelve and a half cents apiece. It may be fourteen cents apiece, but when you consider the amount of losses avoided and the fact that the plants are more immediately saleable, the advantages of vegetative propagation become heavy.

This is a very small subject and not worth going into too extensively, but I will be glad to answer any questions. (Applause)

* * * * *

MR JACK HILL (D. Hill Nursery Co., Dundee, Ill.): Have you made an effort to select one plant or a limited number of mahonias that you feel best or do you simply lift your seed lines and select the ones that appear best?

MR. FLEMER: That was the way we did it at first. That gave us a large number of plants. We transplanted them and grew rooted cuttings from them checking on the rooting percentage, which varied a good deal. Some rooted considerably easier than others. Now we have groups of 20 or 30 different clones, each of which is held separately. We are currently engaged in cutting down those to still fewer. What we would like to get is one ideal mahonia which we don't intend to sell at any premium.

MR. CONSTANT DE GROOT (Sheridan Nurseries, Sheridan, Ont.): Do you prefer glossy leaves over the dull. I came across a dull-leafed one which with us is the only *Mahonia* that doesn't loose its leaves during the winter.

MR. FLEMER: That was an exceptionally hardy seedling. Our experience is the more glossy the leaf the better it comes through. You can probably get hardy ones among the dull ones, but why propagate them since they aren't as saleable as the glossy ones?

MR. ALBERT LOWENFELS (White Plains, N. Y.): You didn't make quite clear how many leaves you left on the cutting.

MR. FLEMER: We have left 4 leaf stocks on the top and trimmed the individual leaves down to two leaflets on each little stem. It could be

2, it could be 4, sometimes trimmed down to the stalk. They can be stuck close in the bench. You either have to stick them further apart, if they have more, or cram them close together and water lodges in there. It facilitates sticking.

MR. JACK SIEBENTHALER (The Siebenthaler Co., Dayton, Ohio): Did you give any indication of the percentage of rooting on those?

MR. FLEMER: No, I didn't, but 75 to 80 per cent rooting is good.

MR. CHESTER E. HUGHES (Cincinnati Park Commission, Cincinnati, Ohio): You mentioned taking the cuttings in September under controlled conditions. What were they?

MR. FLEMER: A tight greenhouse. We don't have a mist system yet, so we use more primitive methods to get humidity. We have a good tight greenhouse. A man goes through 3 or 4 times a day and sprinkles down the walk and wets down the pipes so we get high humidity.

DR. J. R. KAMP (University of Illinois, Urbana, Ill.): You didn't mention the temperatures you are trying to maintain in the greenhouses.

MR. FLEMER: The temperature of the greenhouse at that time of the year runs in the neighborhood of 75 degrees during the day, about 60 at night.

MR. HANCOCK: I would like to add one point. We have propagated one shiny leaf variety with perfect success and our experience corroborates what you have said. One thing we have noticed when we had a humidifier we got practically 100 per cent and as soon as we left the Mahonia cuttings without adequate humidity the leaves dry and get practically no rooting.

MR. FLEMER: That is right, you must keep the humidity high.

Another thing we found, not only with *Mahonia,* but with rhododendrons as well, is to take the cuttings and invert them before the final cut is made, dip them into some of the plastic materials, leave them upside down until they dry, and then make your cutting. If your greenhouse is dry, you can up your stand considerably by that extra operation.

MR. PARK (Magnotia, Pa.): Have you had any experience with rooting *Berberis Julianae* or some of the evergreen types?

MR. FLEMER: We root many every year. They are not the same genus but in the same family as *Mahonia* and they are just as finicky in their requirements. You have to take them when the wood has become firm, but before they get considerable frost damage.

MODERATOR COGGESHALL: I am sorry, Bill, but I am afraid I must interrupt you in order to go on. Thank you very much.

The next speaker on the program is Mr. Merton L. Congdon, Congdon's Wholesale Nursery, North Collins, New York.

Prior to my correspondence with Mr. Congdon I never realized that layering was practiced to any great extent in this country. Perhaps some of you did not realize this also. It is then with great interest, that I am looking forward to his talk. Mr. Congdon will speak to us on "Mass Production of Deciduous Shrubs by Layers".

MR. MERTON L. CONGDON (Congdon's Wholesale Nursery, North Collins, N. Y.): Fellow members and guests: I consider layering, next to the actual division of plants, about as simple a method of propagation as there is. In order to cover it most thoroughly and perhaps to avoid some questions later on, I prefer to read my talk. I have a limited number of slides which I will show at the conclusion of my talk showing the actual layering process and the results we get at the end of two years in the field with these layers.

MASS PRODUCTION OF DECIDUOUS SHRUBS BY LAYERS

MERTON L. CONGDON
Congdon's Wholesale Nursery
North Collins, N. Y.

When I was asked to present this talk on the mass production of layers, my first thought was that there are many nurserymen that are much better qualified to present this subject than I. However, at our nursery we have perhaps developed some methods that have speeded up the actual layering process to a point that they may be worth presenting here.

In this discussion we are going to touch upon the following topics:

History
Types of Stock
Row Spacing of Beds
Soil Type
Time of Layering
Procedure
Follow-up
Gathering
Costs

HISTORY: Some history of my experience is necessary to present this subject properly. Prior to 1940 when my brother and I were operating the H. E. Congdon Nursery we were concerned only with the propagation of small fruits. It was at that time that we were approached by Mr. Ralph Lake and Mr. Bert Lake of the Shenandoah Nurseries, Shenandoah, Iowa about the possibilities of growing deciduous shrubs for them in our favorable climate and soil. At that time they were concerned most about a good source of Hydrangea A. G. and P. G.

At first we bought all of our lining-out material or Lake's had it sent to us. We noticed that in every case, layers produced better stands and growth than liners produced from soft wood cuttings. Liners grown from field grown hardwoods did better yet but we soon found that this method was unpredictable and expensive. We had considerable experience with tip layering of raspberry and felt that layering of deciduous shrubs was the field where we should start.

Armed with that information we set out to find the best method of establishing and maintaining a layer bed. It is at this point that I should give

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due credit to the following firms that were very helpful in showing us their methods:

Champion Nurseries, Perry, Ohio
Thomas B. Meehan & Co., Dresher, Pa.
Cedar Rapids Nursery Co., Cedar Rapids, Iowa
Foster Nursery Co., Fredonia, N. Y.
R. A. Hacker, Painesville, Ohio

I believe that all of these concerns except the last named are still in the process of producing layers and have many more years of experience than I.

In 1950 when the partnership forming the H. E. Congdon Nursery was dissolved, most of the layering beds were located on the property which I am now operating.

TYPES OF STOCKS: As time went on it became quite apparent to me that many more shrubs could be propagated by layering than the Hydrangea A.G. and P.G. with which we started. We have been most successful with the Deutzias - Gracilis, Lemoine and Rosea. Also with some of the Philadelphus but most particularly *not* Virginalis. Most spectacular of all is probably the Opuloides type of Hydrangea. We specialize in the varieties Nikko Blue and Domotoi but there is a whole list of these varieties that layer very successfully. I am now starting to work with some of the Viburnums but am not prepared to state as yet which varieties are practical to layer and which are not.

There are several other shrubs which we layer by the same methods but do not root. These produce an etiolated cutting that can be rooted the following year in field rows and produce a much better stand than cuttings that are not ediolated. We have had the most success with this method on *Weigela Variegated Nana* and *Philadelphus coronarius aureus*.

I should point out that the items I have mentioned produce layers in one season on the current year's growth. It is a well known fact that a great many deciduous shrubs can be layered if left for two full growing seasons but this wide range of material we must overlook if we are to use the procedure outlined here. In this discussion we are not interested in all items that it is possible to layer but rather those that adapt themselves to our labor saving methods.

ROW SPACING OF BEDS: If there is any disadvantage to our method of layering, it is the fact that it takes considerably more land on some subjects than the conventional methods. Our first error was in spacing the rows too narrow and it was later necessary to remove every second row.

Hydrangea A.G. and P.G. should be spaced in not less than eight foot rows. The Deutzias and Opuloides type of Hydrangea can be spaced in much narrower rows — five feet or less. Spacing in the row itself is not important except that the stock should present a fairly solid hedge effect before layering. We use two feet on Hydrangea A.G and P.G., eighteen inches on Deutzia and three feet on Blue Hydrangea.

SOIL TYPES: This is one of the most important factors in the whole operation and if the proper soil is used, irrigation will be found neither necessary nor desirable. A soil must be used that is sandy enough to work easily

with a common long handle shovel and at the same time maintain moisture within an inch of the surface at all times. Our soil is that sandy loam known as Chenango Loam and is highly adapted to this process. I am firmly convinced, however, that a wide range of soils can be used with the aid of irrigation. The only drawback being that this adds expense to an otherwise inexpensive method.

TIME OF LAYERING: This is the phase of the process where we begin to depart from the conventional methods. We are very particular to start layering just as soon as the subject has enough growth to permit it. Of course, fertile soil with plenty of nitrogen will stimulate growth and may make it possible to layer several days earlier than stock grown on soil with mediocre fertility. In the case of Hydrangea A.G. and P.G., in our area we get them down between June 1st and 10th. Other subjects about ten days later.

Now this early date of starting the process is very important from three entirely separate angles. First, moisture is important for the first few days or weeks after layering. In our part of the world, at least, the chances of optimum soil moisture, especially where the soil has been disturbed, is much better in the month of June than in later months. I have seen layers put down the first of July on a dry year that failed to root entirely.

Second, it is important in our mass production procedure to catch the stock before it has any tendency to harden or grow brittle toward the base. We are going to mound layer these plants and a few days makes a lot of difference as to whether this is possible or whether the layering has to be done nearer the end of the canes. When young and tender these canes can be bent at any place along the entire length of the cane.

Third, early layering means a more balanced layer in the end because all additional growth made by the canes, both in caliper and length may be useful. It makes a stronger plant and is much easier to handle.

PROCEDURE: Our first move is to plow up to the rows with a hitch design as firststandard tractor with two bottom plow of the three-point introduced by Ford-Ferguson. With shallow plowing and plenty of speed, a table about three feet wide can be built with just one round about each row. On subjects that are spaced in narrow rows it is necessary to build this table with hand shovels but we are fortunate that those subjects in narrow rows do not require as great a table as such subjects as Hydrangea A.G. and P.G.

After this table is built it is a simple matter for one person to hold down a large number of canes at once while the second person applies the soil in small quantities with a hand shovel - just enough to hold the canes down firmly. No pressure is required and with some experience a pair can move along at a rapid pace, layering several thousand a day. No wounding of the canes is necessary.

Now it is quite obvious that we are not putting enough soil on these canes to retain moisture and produce roots - that is not our purpose at this stage. These canes are now in a horizontal position and well up on the table of soil that we have built. Within 24 to 48 hours these tender canes will have again assumed a vertical position, held down at the base by our small amount of soil.

FOLLOW-UP: After the canes are again vertical and still growing vigorously - not more than a week after the initial layering, comes a very

important duty: that of placing additional soil at the new bend of the canes that we have produced. This is not a difficult nor tedious procedure. One shovel full of soil can well cover several canes at a time. However, it is important that plenty of soil be placed at the bend because this is the point at which we want the most roots produced.

We generally use a spring tooth harrow or small disc harrow between the rows before going into the beds the second time in order to produce plenty of loose, pliable soil. This last moving of soil about ends the real work involved. On some items such as the Hydrangeas, a stripping of the blooms later in the season is necessary, especially on P.G. If P.G. are not stripped or cut off they will produce a very crooked layer.

We have accomplished all this in the month of June - late enough so that weeds present no real problem for the balance of the season except that crab grass and pigweed are sometimes a problem. Herbicides have helped us some with this latter problem if applied at the right time. However, we have come to disregard crab grass to some extent because we have found that it has little or no effect on the end result.

GATHERING: We like to take up the layers in the Fall if possible but are not always able to accomplish this. If we fail, there is no damage done and we will take them up in the early Spring before the buds break. In taking up the layers, just a light disturbing with a fork is all that is desired. The actual lifting is done by grasping a group of canes in the hand and with a light pair of pruning shears cut the canes back to the point where they originally started from the parent hill. The stock is then taken to the storage and worked over at our convenience. The surplus cane at the base is cut away so as to produce a layer that has an optimum amount of root. If too much cane is left below the bend, it will provide a point that will break or split easily even after two year's growth in the field. After the layers have been worked over and tied in bundles of fifty, we usually heel the stock in until planting time.

PREPARING BEDS FOR THE NEXT CROP: About all that is necessary is to remove the mound that was produced the previous year and do some small amount of pruning on the parent hills. We try to do this as early in the Spring as possible to prevent any possible injury to the new buds that may be in the process of forming. We use a crawler type tractor with a drawbar that is offset so that a walking plow can be drawn about anywhere one would like to place it. In this way we can produce the equivalent of a back-furrow in the center of each row and it is possible to narrow the mound down to the width of the parent hills themselves - sometimes as narrow as six inches in the case of Deutzias and other smaller plants. It is then only necessary to draw this ridge down with hand hoes. We work up the back-furrow with tillage tools so that when the job is completed the bed is perfectly level.

Additional pruning consists only of taking off those canes that are obviously unnecessary or undesirable.

We use the crawler type tractor because we have one and it is sure-footed in working on these mounds. However, I am sure that a small wheel tractor could be used with a minimum of trouble.

COSTS: I am afraid that this is the point where I cannot give very accurate information. How much per thousand does it cost to produce this planting material? I can only give a vague guess. So many small operations scattered throughout the year are difficult to keep records on but my guess would be that in 1954 it cost us between $15.00 to $25.00 per thousand to produce these layers, depending some on the variety concerned.

We now produce more planting stock from softwood cuttings than from layers because we are working with many subjects that do not layer readily. We have developed a method of producing planting material from softwoods in western New York that would be of interest to this group in some future discussion. We think it cuts the costs way down from the conventional methods in common practice. However, from information that we have gleaned in working with softwoods, we know that we can produce layers at a much lower cost. Also, comparisons in the field thereafter are usually very pronounced in favor of layers.

The fact that the items that we have discussed today are now plentiful on the market and at reasonable prices is no accident. Five or ten years ago such was not the case. Once again modern methods are cutting the costs and making it possible to produce this stock cheaper than ever before. (Applause)

* * * * *

MR. JAMES S. WELLS: (D. Hill Nursery Co., Dundee, Ill.): What feeding do you give the stool beds each year?

MR. CONGDON: Well, we don't have a very cut and dried procedure. When the mounds are pulled out in the spring, we like to go down there and roll with the manure spreader. In addition to manure, we use superphosphate. Then we add ammonium nitrate, I would say at the rate of 200 to 300 pounds per acre.

MR. LOUIS VANDERBROOK (Vanderbrook Nurseries, Manchester, Conn.): Do you have to replace your stool beds? How long have you worked the stool beds?

MR. CONGDON: We have never replaced any of our stool beds. The oldest one we have is ten years old.

MR. VANDERBROOK: Your stock is held in - you have stripped your blossom off rather than cutting?

MR. CONGDON: No, from the fact we layer them so early, we are able with Hydrangea P.G., which I believe you are referring to, to cut back that cane by 3 to 4 inches, and we have destroyed that part that had to die back

MR. VANDERBROOK: When you strip that block by hand, you say heel it in the next spring. You don't get any rot on that tip?

MR. CONGDON: No, we never have.

MR. HOOGENDOORN: Have you ever tried almonds the same way?

MR. CONGDON: I never have.

MR. MARTIN VAN HOF (Rhode Island Nurseries, Newport, Rhode Island): Have you ever tried to stool malling apple stock?

MR. CONGDON: I always thought that was a good field to get into, but I havc never tried it.

MR. WELLS: One comment and one question. The age of stool blocks seems to be unlimited from what Jack Hill and I saw down at Chase Nursery recently, where they showed us beds of Magnolia soulangeana that had been used for 35 years. I was interested in your comment on cuttings of *Philadelphus coronarius*. Would you like to go through the procedure and say how you root them and with what results?

MR. CONGDON: We, of course, have tried rooting those items from hardwood cuttings in the field, and as you know, having been at our place, we have these complicated five-row planters in which we can go across the field and put in approximately 10,000 cuttings an hour. We thought if there was some way of bleaching these cuttings that did not root with a good percentage, that perhaps we could get better results, and so we established this stock block of variegated weigela and *Philadelphus coronarius* with the intention of mounding them instead of layering them, and bleach the ends of the cuttings. That is done at the end of June also, but we do not secure, at least in our climate and with the methods we use, exactly a rooted layer. In other words, it is not a type of material that you would want to go out and plant in the field in the regular spaced row. So we take those cuttings and place them into 18-inch rows very close together with our multiple row planter and get a very good stand. I would say we will have somewhere between 65 and 85 per cent, which we consider good for *P. coronarius*.

MR. HOOGENDOORN: You say you don't use irrigation on that. You must have a high water table.

MR. CONGDON: No, I wouldn't say so .

MR. HOOGENDOORN: You get a dry summer and your soil is as dry as dust. How do you expect it to root?

MR. CONGDON: The soil maintains moisture within an inch. On the Hydrangea P.G. we produce 65,000 to 80,000 cuttings a year and we can depend on it regardless of the kind of summer and regardless of the rainfall.

MR. WELLS: Will you explain again your technique of layering the first growth?

MR. CONGDON: In the case of *Deutzia* and the *Lemoine* type of *Hydrangea* we cut them back to the original plant each year. However with Hydrangea P.G. and A.G. it takes a couple of years to get the stock block to the proper condition for a mass production of layers. The reason for this is that the original canes are put down. These are about two feet in length and they are a part of the permanent bed. They stay down. By removing the soil each year, we keep them from rooting. We don't want them to root out that far. However the canes are there, the nodes are there and the new layers are produced each year. In other words, each node will produce two layers because they will come from both sides of the node. Each year we cut the layers back to the original cane, but not back to the plant itself.

MODERATOR COGGESHALL: I'm sorry, but we must stop now. Tahnk you very much Mr. Congdon.

The next speaker on the program is Mr. John Bogdany, South Norwalk, Connecticut. Mr. Bogdany's topic is one of great interest. It concerns the rooting of *Juniperus virginiana Canaerti* and *Juniperus virginiana Keteleeri* from cuttings, which as you know, are notoriously difficult to root. At this time I would like to present Mr. Bogdany.

THE ROOTING OF JUNIPERUS VIRGINIANA CANAERTI and JUNIPERUS VIRGINIANA KETELEERI FROM CUTTINGS

JOHN BOGDANY
The Stephen Hoyt's Sons Co., Inc., New Canaan, Connecticut

We usually trim our understock in March, or our stock plants of juniper in March, and it may seem strange to you propagators that we start our cuttings the last week of January - kind of late. In fact we haven't anything in the greenhouse yet. Even the old stand is in there.

We use a coarse sand, and we control our hot-water heating system pretty well. I use Hormodin No. 3 on these varieties, and it seems to root the *Canaerti* well. We use a sweat box and wet it down to within a quarter of an inch from the bottom. We get good results with *Canaerti*, up to 75 per cent. With *Keteleeri* we get only 33 per cent, however, I have tried it only twice.

I know Jim Wells uses some sort of tripple razor blade to wound the junipers. I haven't tried that, but am going to this year.

Over the benches we have laths spaced about an inch and a half apart. We don't use whitewash until almost May. On the west side we have a double row of cheesecloth tacked up. On the east side only one row to keep out the sun. We spray the cuttings about 9:00 o'clock in the morning.

A lot of propagators don't like to give air. We give air almost every chance we can. Sometimes in the winter the ventilators will be frozen, but we try to get them up to air our greenhouse.

On *Canaerti* we sometimes get a big callus and no roots. They stay alive a long time and you can stick them over if you wish, however, we didn't count those in the percentages mentioned here. I feel it is worth while to grow these two junipers from cuttings, that is, to root them instead of grafting them.

We usually pot our cuttings. We don't put them out into the field. They are potted up and put into a frame, mulched with sand and peat. They stay there until the next June. From there they go out into sections, and it seems as though we don't lose any, once we root them. Of course, the second year we try as much as possible to shake them up.

There are some rooted cuttings in the exhibition room which I believe some of you may be interested in (applause)

MODERATOR COGGESHALL: I'm sorry, but we must stop now. Tahnk you very much Mr. Congdon.

The next speaker on the program is Mr. John Bogdany, South Norwalk, Connecticut. Mr. Bogdany's topic is one of great interest. It concerns the rooting of *Juniperus virginiana Canaerti* and *Juniperus virginiana Keteleeri* from cuttings, which as you know, are notoriously difficult to root. At this time I would like to present Mr. Bogdany.

THE ROOTING OF JUNIPERUS VIRGINIANA CANAERTI and JUNIPERUS VIRGINIANA KETELEERI FROM CUTTINGS

JOHN BOGDANY
The Stephen Hoyt's Sons Co., Inc., New Canaan, Connecticut

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MR. HILL: Don't you believe there is perhaps an argument over the true classification of *Keteleeri?* I notice Rehder in his last book has classified it as *Juniperus sphaerica* instead of *Keteleeri.* We have always felt it was *chinensis.*

MR. BOGDANY: We have always advertised it as *virginiana.* Now I don't know.

MODERATOR COGGESHALL: What is the condition of the wood at the base of the cutting?

MR. BOGDANY: We take a bit of the old wood as a heel.

MR. HOOGENDOORN: Did you use terminal cuttings or side shoots?

MR. BOGDANY: Some were terminal and some were side shoots.

MR. HOOGENDOORN: But you had old wood on each one? Which one did the best?

MR. BOGDANY: That is right. That is what I am going to try to find out this year.

MR. WELLS: We ran a series of tests to try to root *Canaerti* and *Dauntty* last winter. We used terminal shoots, long vigorous shoots from current year's wood, firm at the base, but not in the two-year wood. We used a similar type of cutting, much smaller in size, from a side branch from the same age growth taken further down the tree. The strong terminal shoots were better than the side shoots. The highest percentage we obtained was 40 per cent. The rooting was not vigorous nor good. I didn't consider it commercially sound. The 40 per cent was obtained by treating the cuttings with the naphythalene acetamide at one per cent strength. We tried five other rooting compounds with results from 0 to 20 per cent. The only one that gave us 40 per ecnt was this one chemical. I plan to try it again, but I really don't think we had any commercially sound results.

MR. BOGDANY: Did you pot those up or set them in the field?

MR. WELLS: We potted them up and they are in pots now. They were potted up in March.

MR. BOGDANY: Are they pot-bound now?

MR. WELLS: They will be planted out next spring.

MR. BOGDANY: I should think the root system would be all right.

MR. WELLS: It wasn't a good plant. It didn't have any zip. I would like a well-rooted plant. The *Canaerti* rooted cuttings we had were not good.

MR. BOGDNAY: When they get into the field they make a better root.

MODERATOR COGGESHALL: You actually got between 5 and 8 roots per cutting?

MR. BOGDANY: Yes, not just a taproot.

MR. RAY A. KEEN (Kansas State College, Manhattan, Kansas.): I wondered what kind of growth you get on those after you get them in the field. Are they going to make up as fast as a grafted plant?

MR. BOGDANY: When you get them into the field they make up faster. We leave them in the pot until June.

MR. KEEN: Will they make you a saleable tree in three or four years?

MR. BOGDANY: The way it looks to me, I would say yes. I have three or four in the exhibition room. In six months they make a nice growth.

MR. CARL GRANT WILSON (Cleveland, Ohio): What age plants are you working with.

MR. BOGDANY: About 4 to 6 years old. They were about five feet high.

MR. THOMAS B. KYLE (Bohlender Nursery, Tipp City, Ohio.): You mentioned something about triple razor blade wounding, will you explain this treatment?

MR. BOGDANY: I think Jim Wells should describe it.

MR. WELLS: I have one of those razor blade wounders here and it will be on the table with our exhibit. It has four Gem razor blades, which you can buy in any drugstore, soldered along the back to hold them together.

MODERATOR COGGESHALL: Do you consider that type of wound better than wounding in relation to actually removing a piece of bark from the stem, as you would with rhododendron cuttings?

MR. WELLS: Yes, where you have a stem which is of small caliper, such as the junipers, I think the razor blade wounder is to be preferred. On a larger caliper stem, such as a rhodendron or magnolia, then I would prefer a wound base. I would just like to read into the record that the device was actually devised by Herman Schmidt, who is the propagator at the Hill Nursery.

MR. HENRY A. WELLER (C. W. Stuart & Co., Newark, N. Y.): I would like to verify something which I gathered from your talk, that it took about three months to root those things?

MR. BOGDANY: Yes, we stuck them the last week in January, and it seems to me we potted them up in the third week of June.

MR. WELLER: Therefore, it is three months. It is popular to talk about rooting practically anything, but I feel the time element has something to do with it, too. If you have a limited amount of greenhouse space, it may be of advantage to graft together some things that can be done and in four or five weeks pot them up and get them out of there.

MR. BOGDANY: We did graft the junipers before. This is just a trial.

MR. WELLER: I am merely getting to the fact if it takes an excessively long time to root something, it may be more economical to graft.

CHAIRMAN COGGESHALL: Thank you very much, John.

The last speaker this afternoon is a newcomer to this country. Many of you know him. He has propagated plants in this country for the past several years and while the subject material he is to speak on is not noted for its difficultness as far as rootability is concerned, the procedure he uses in putting roots on these cuttings is very interesting.

Mr. Stroombeek will speak on The Rooting of *Pyracantha*.

PYRACANTHA FROM CUTTINGS

E. STROOMBECK
Warner Nursery, Willoughby, Ohio

Like Roger mentioned, the propagation of *Pyracantha* from cuttings isn't a very difficult proposition. At first I raised my eyebrows a little when he asked me to give a short talk on this subject. On second thought, I realized that while the rooting process itself is simple, we usually get into differences of opinion and some trouble when we get to the point where we have to decide what we are going to do with our rooted cuttings in order to get first-class transplants and later on liners. Last year we decided that a propagators work is not restricted only to the rooting of shrubs and evergreens in the greenhouse, but definitely includes the proper care and handling of the plants during their first year, so I thought that I would put the emphasis of this short talk on the care of the plants following rooting.

Now, in short, let's go over the rooting procedure itself. We root our pyracanthas by the end of September. During the beginning of August we take our cuttings from field plants. We prefer ripe rather than hard wood, but you can take the cuttings in July, when they are still rather soft, through December. It depends on the kind of operation one has.

We make our cuttings about 5 to 6 inches long and strip the leaves and needles about half way up the cutting. This causes plenty of injury along the stem, which proves to be beneficial in the rooting process, especially if you use hormone powder. To root pyracantha, it is not necessary to use hormone powder, but we use Hormodin No. 2. In this way we get plenty of short, sturdy roots located on the base of the stem and this has its advantages when we handled the rooted cuttings later on in the transplanting operation. If we don't use powder, we usually see fewer roots which are distributed all along the stem . They are also usually longer and more tender.

The rooting medium consist of a mixture of Dutch peat and sharp sand but I know some propagators have excellent results by using only sharp sand. In this last case, we have to watch the time of transplanting. If you leave them too long in the sand, the roots usually turn bad and they die off in the sand. With light shading, a constant temperature of 65 and up, plus high humidity, we get good rooting in three weeks.

Now we get to the point where we have to decide what we are going to do with the rooted cutting and this in turn depends on what kind of an operation we have and what kind of plant we wish to grow. We have to keep in mind two qualities of pyracantha. In the first place, it naturally makes long, thin roots that don't branch out easily and in connection with this, it wilts very easily and doesn't seem to recover from the transplanting shock. This applies also to liners when they are transplanted in the spring. These two points are the reason pyracantha causes us trouble when we plant in the spring, or out in the field rows, especially if we have dry weather. So the question is: Are we going to have some dirt stick to the roots after the roots branch out?

The way a lot of propagators solve this problem is to pot their rooted cuttings directly into fairly large size pots, three's or four's, and after they are potted, plunge them into a frame and leave them there for a year. This

way isn't satisfactory to us in the nursery. In the first place, we don't have the space available, and in the second place, it proved that although the pyracantha make a nice tight ball, the top isn't satisfactory.

Our procedure is as follows. After they are rooted we pot our cuttings up individually in small pots, two to two and a half inches in size. The timing for lifting the cuttings is important. The shorter the roots, the easier they handle in these small pots. If you wait a little too long the roots get long and brittle and get damaged easily in the transplanting operation. Losses, then, are high.

As a potting medium we use Michigan peat. I know a lot of you propagators are familiar with it. It is a fine textured peat moss with the pH around 5. With us, it proved to be very satisfactory for all kinds of evergreens, including rhododendrons, magnolia, and hollies, and its advantage is that you don't have to go through extra mixing operations by adding sand, humus or other material.

After the rooted cuttings are potted, we put them into flats and bring them into the greenhouse where the same conditions prevail, as in the original house. Here they adjust themselves to the conditions and start new growth in three to four weeks. In the meantime the top starts. This is about October or the beginning of November. In the northern part of Ohio we usually have 3 or 4 nice days of Indian summer during which we put the plants in the frames. We keep the special greenhouse conditions up to the last day for the simple reason we keep bringing in potted plants and flatted cuttings all of the time. Before we bring them out we spray the plants, in the case of pyracantha, with a light mixture of Wiltpruf and this proves to be very beneficial. This adjusts the cuttings to the sudden changes in temperature experienced during Indian summer. Even on cold nights, with our treatment, the tops don't get damaged. The pots are plunged in Michigan peat again. On top of it, we place a layer of one and one half inches of Dutch tree peat. Under this layer the root growth goes on slowly nearly all winter.

We cover with sash and if you get real cold weather after the plunging, we cover the plants. In the spring we take the sashes off as soon as possible, usually by the beginning of April. Then during April we give one application of fertilizer. We use 15-30-15 for that purpose. We cut off the top of the plants around May 20th and we are ready for the bedding operation. In the meantime we have given the cuttings a light application of Wiltpruf. We have quite an extensive bedding operation. Our beds are about five-feet wide, so they are suited for all kinds of mechanical operations with tractors, sprayers, trailors, etc.

We shovel the paths out, because in these beds our soil is quite heavy. We gravel the paths. The beds have plenty of overhead irrigation all summer long. On top of the bed we use 6 to 8 inches of straight Michigan peat.

During June, after planting is over, we give one application of a dry fertilizer. We use Vigoro for this purpose and open up the irrigation line right after it is applied. Then by the end of June we go to the special job of digging around each plant individually with a trowel to cut the roots, raise the plant and push it down again. This seems to be a very complicated operation, however, the peat beds are soft and a couple of high school boys can easily do around 5,000 plants a day.

We use a dark day for this purpose because the tops will wilt very easily and if you get the sun coming out on a dark day we will open up the irrigation lines. Right after this operation we give an application of liquid fertilizer, usually Rapidgro, and repeat this same operation again in August at least once, and if we have the time, twice. I think you should do it at least twice. The last time is especially important, because in that way your plant will harden up well and you get an excellent liner. This was the point I wished to make in this short talk this afternoon.

We had difficulty this year on account of our crowded program and didn't have time to go around twice. I didn't know I was going to give a talk and I think the exhibited plants had only been dug around once during the summertime. We have plenty of top growth and a nice ball, which can be handled for all kinds of operation, for planting in the fall or springtime, fall selling and packing in wire crates, or which is getting to be more and more popular, planting and growing on in cans. (Applause)

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MR. JACK VERMEULEN (Weller Nurseries, Holland, Michigan): Don't you find these plants grow only in peat? They are very hard to transplant in any other kind of soil. Years ago, when we imported our trees from Holland they came in these peat balls which we could set out in the soil in America. We had a lot of loss.

MR. STROOMBEEK: We don't seem to have trouble. We get fairly good growth in rather heavy soil. Once the root system has originally developed well, it remains a good root system no matter what soil you plant it in later on.

MR. JACK BLAUW (Koster's Nursery, Bridgeton, N. J.): It seems to me it is a rather expensive way to grow *Pyracantha*. If you take them out of a two and a quarter, or a two and a half inch pot and plunge them in a tin can, you can leave them there two years. After the first year you have them just as big or bigger than those grown in Michigan peat. Of course, Michigan peat may be very cheap here, but in New Jersey it is expensive. The way we have to grow them those plants would cost us around $1.50.

MR. STROOMBEEK: We are located a little closer to the source of peat. We use it very extensively for all our bedding and planting operations.

MR. CARL GRANT WILSON: Do you use quite a bit of sawdust for mulching?

MR. STROOMBEEK: We cover the beds with sawdust in the early fall.

MR. WILSON: What precautions do you take to prevent nitrogen deficiency?

MR. STROOMBEEK: When we have planted for two years we give an early application of nitrogen fertilizer in the spring, usually in April.

MR. WILSON: Nitrate or sulphate?

MR. STROOMBEEK: We use a combination fertilizer with nitrogen in it.

MR. WILSON: You haven't produced any formulation of how much is needed?

MR. STROOMBEEK: No.

MODERATOR COGGESHALL: Thank you very much, Mr. Stroombeek. This concludes the afternoon portion of this meeting. The Exhibitor-Speaker portion will be continued tonight at 8:00 p.m.

The session recessed at 4:45 o'clock and reconvened at 8:00 p.m.

MODERATOR COGGESHALL: The first speaker this evening is Mr. Logan Monroe, Kingswood Nurseries, Mentor, Ohio. Mr. Monroe is to speak to us on the propagation of Forsythia Spring Glory and Lynwood Gold from cuttings. Mr. Monroe!

PROPAGATION OF FORSYTHIA SPRING GLORY AND LYNWOOD GOLD FROM CUTTINGS

LOGAN MONROE

Kingswood Nurseries, Mentor, Ohio

Forsythia has gained a place of importance in the nursery business mainly because of its early bloom and also because of its brilliant color. It is actually about the first really noticeable deciduous shrub to bloom in the spring, coming in April about the same time as the daffodils

There were two original species of *Forsythia* - *suspensa* and *viridissima*. *F. suspensa* is the low form which droops, the ends of the branches touching the ground and normally taking root. *F. viridissima* is just the opposite, a very tall upright form and a strong grower.

Years ago the nurserymen wanted an intermediate variety so they crossed these two and came up with *Forsythia intermedia*. It is from this species that most of the varieties that we know today have come, particularly the two that I would like to talk about tonight — Spring Glory and Lynwood Gold.

Spring Glory is a light lemon yellow and was selected because of its prolific bloom and its habit of growth. It has a rather bay-shaped form and has a definite intermediate tip. Lynwood Gold is a deep golden yellow. It has recently been introduced from Ireland and is actually more prolific, as far as, bloom than Spring Glory. Both varieties can be propagated fairly easily if a few of the simple rules of propagation are observed.

We use softwood cuttings almost entirely and we have propagated them in two different structures. We propagate them in a concrete block frame covered with sash and the sash in turn covered with unbleached muslin on a framework. We also have been able to propagate them successfully in our greenhouse. Now this latter method I won't cover too extensively. I will be speaking mainly of propagation in a frame.

I would like to tell you first of all, though, how we were able to use a greenhouse for propagating softwood cuttings in the middle of the summer.

We shade it heavily with a shading compound and normally we use Kemtone, a household paint, which is relatively inexpensive. Also, the major

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factor in keeping our greenhouse cool enough is that we have a row of oaks and elms which are 50 to 70 feet high, 50 feet west of a north-south greenhouse. This provides shade for the greenhouse from about 1:00 in the afternoon.

We make our softwood cuttings in our area approximately June 10. They can be taken a little bit sooner and they can be taken from June 10 on up into September. We like to wait until the new growth is about a foot long on the plant.

We make our cuttings in the early morning, bring them in, wet them down on a concrete floor and keep them until we are ready to do the trimming.

In the field, we take our stems approximately 8 to 12 inches long. That way, we are able to trim them down and get the wood in just the right stage.

In preparing our cuttings, we first trim out the soft tip that will wilt down very rapidly if used in a cutting. Then we make a clean basal cut to adjust the cutting to the proper length. In our case, we make the cuttings approximately 6 to 8 inches long. Now this would seem to be a little bit long probably for the normal propagator, but we grow the cuttings to finished nursery stock, and we use a planter in lining them out in the field. The extra couple of inches we have on the cuttings facilitates use of the planter.

After we get the cuttings to the proper length and the soft tip removed, we trim the leaves off the bottom half of the cutting and trim the remaining top leaves about half-way back. Now this actually is not necessary but we find that it helps us in two ways. It is easier to handle the cuttings since the forsythia leaf is a relatively long leaf and rather cumbersome. Also, one of the most important things, when they are stuck in the frame after they have rooted, if we are not able to transplant them right away, is a little bit of aeration between the leaves. There is less chance for formation of mold or fungus.

In the frame for rooting medium we use silica sand. It is relatively coarse and is actually sandstone that has been crushed and washed, so we have very little trouble with any fungus.

The cuttings are placed one inch apart in the row and the rows are spaced approximately one and a half inches apart. The cutting is inserted approximately half-way into the sand, which would, in our case, be 3 to 4 inches. The sand is at a depth of six inches, which we find sufficient for our purposes.

We treat the cutting before inserting it with, either Hormodin No. 2 or Rootone containing a fungicide. This is actually not necessary, but it does, we believe, produce more roots along the lower area of the cutting.

After the cuttings are inserted in the sand they are tamped in and flooded with water. The frame is closed with the sash and we use an unbleached muslin on a wooden framework about one foot above the sash. This allows for indirect light to enter from the northern part of the frame. We maintain certain conditions in this frame. The humidity we like to keep very high. We have no way of actually measuring it, but we estimate it is about 90 per cent or over. If the humidity does appear to go down we have to syringe by hand. As far as the temperature is concerned, we like to main-

tain a maximum daytime temperature of not more than 90 degrees. In order to do this, at times it is necessary to ventilate the frames. This ventilating necessarily dries out the frame and is one of the reasons for syringing to keep the humidity up.

The light, of course, is limited by the unbleached muslin and water is applied as needed. We figure under normal conditions that watering is necessary approximately every 10 days.

From these conditions we are able to produce strongly rooted cuttings in approximately four weeks. These cuttings we handle in one of two ways. We pot them up and carry them over to be lined out the following spring, or we line them out directly into the field. Lining them directly out into the field has one drawback — unless you have irrigation available you can take a severe loss in lining them out in the middle of the summer. We have stuck mostly to keeping the plants potted and using them for liners the following spring. (Applause)

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MR. VAN HOF: Have you found light lemon and dark lemon color ini the Lynwood Gold?

MR. MONROE: We got our stock from what we believe a reliable source. The entire stock actually has never bloomed. Every time we get stock big enough, it is either sold or made up into cuttings. When we get a cutting the flowers actually aren't significant enough to determine the actual color.

MR. VAN HOF: I would like to know if anybody else here in this room has had the same experience with color variation with Lynwood Gold?

MR. HOOGENDOORN: We got our Lynwood Gold from a reliable source, and we left some which we didn't use for propagating just to observe the bloom. Now Lynwood Gold has large petals and a large flower, but I have seen in one of the plants I kept for a check, one which I didn't cut back to make cuttings, that has large flowers and on all of the cuttings six inches from the base, we have narrow petals. It seems to me the thing is going back.

MR. WM. FLEMER III (Princeton Nurseries, Princeton, N. J.): I talked to the man who got the thing originally, Jack Lashona, and it was bud sport. It was a branch on a regular plant.

MR. HOOGENDOORN: I have started propagating Arnold Giant because that will hold.

MODERATOR COGGESHALL: How do you propagate the Arnold Giant?

MR. HOOGENDOORN: Softwood cuttings taken in the summer.

MR. WELLS: I think any member of this society ought to be a little more specific than "in the summer."

MODERATOR COGGESHALL: That softwood is sort of semi-hard - didn't you take the material in April?

We have run into all kinds of trouble propagating that plant from cuttings and have only been able to do so by taking cuttings from very soft wood

in mid April or early May. If you wait until the accepted time for taking *Forsythia* cuttings your results will be very poor.

MR. HOOGENDOORN: That is my experience. You can't grow them from hardwood cuttings. Once I grafted but I didn't get 10 per cent.

MODERATOR COGGESHALL: For those of you who do not know Arnold Giant, it is a tetraploid *Forsythia* introduced by the Arnold Arboretum. It has not taken hold too well in this country, however, in England it is a favorite plant.

MR. WELLS: I was going to ask how the Arnold Arboretum No. 13 variety compared with Lynwood Gold or Spring Glory;

MODERATOR COGGESHALL: The No. 13 variety, I believe is the one they now call "Farrand", named after Mrs. Max Farrand of Bar Harbor, Maine. On the other comment, I can agree with Case, as far as the color is concerned.

MR. WELLS: That has always seemed to me to be a splendid forsythia and I couldn't see the value in the Lynwood Gold. I think the Arnold Arboretum varieties, which have been on our doorstep for a considerable time, deserve more attention.

MR. KLEINMAN: How do you make the basal cut on the forsythia in relation to a node?

MR. MONROE: We don't pay too much attention to the node. We don't find that is too important. *Forsythia* calluses very readily. By using Hormodin we don't have trouble with the roots growing anywhere except around the callus at the base of the stem.

MR. VANDERBROOK: Does anyone produce Lynwood Gold from hardwood cuttings out in the field, or hardwood cuttings in the greenhouse? We have produced Lynwood from hardwood cuttings in the field.

MR. MONROE: I have had limited experience with that. We tried Lynwood Gold from hardwood cutting this past spring. Unfortunately, our weather conditions were unusual to say the least and we got about 10 per cent.

MR. VANDERBROOK: We got about 100 per cent.

MODERATOR COGGESHALL: I am sorry but I must stop you now, we do not have any more time. Thank you very much.

The next speaker on our program is Mr. George P. Blythe from the McConnell Nursery Company in Port Burwell, Ontario. Mr. Blythe will speak to us on "*Rosa Hugonis* from Cuttings". Mr. Blythe.

PROPAGATION OF ROSA HUGONIS BY HARDWOOD CUTTINGS

GEORGE P. BLYTHE

McConnell Nursery Company, Port Burwell, Ontario

Tonight we are particularly interested in one species of rose, called *Rosa Hugonis*. This exotic rose was found in Western China, and is sometimes called "Father Hugo's rose".

in mid April or early May. If you wait until the accepted time for taking *Forsythia* cuttings your results will be very poor.

MR. HOOGENDOORN: That is my experience. You can't grow them from hardwood cuttings. Once I grafted but I didn't get 10 per cent.

MODERATOR COGGESHALL: For those of you who do not know Arnold Giant, it is a tetraploid *Forsythia* introduced by the Arnold Arboretum. It has not taken hold too well in this country, however, in England it is a favorite plant.

MR. WELLS: I was going to ask how the Arnold Arboretum No. 13 variety compared with Lynwood Gold or Spring Glory;

MODERATOR COGGESHALL: The No. 13 variety, I believe is the one they now call "Farrand", named after Mrs. Max Farrand of Bar Harbor, Maine. On the other comment, I can agree with Case, as far as the color is concerned.

MR. WELLS: That has always seemed to me to be a splendid forsythia and I couldn't see the value in the Lynwood Gold. I think the Arnold Arboretum varieties, which have been on our doorstep for a considerable time, deserve more attention.

MR. KLEINMAN: How do you make the basal cut on the forsythia in relation to a node?

MR. MONROE: We don't pay too much attention to the node. We don't find that is too important. *Forsythia* calluses very readily. By using Hormodin we don't have trouble with the roots growing anywhere except around the callus at the base of the stem.

MR. VANDERBROOK: Does anyone produce Lynwood Gold from hardwood cuttings out in the field, or hardwood cuttings in the greenhouse? We have produced Lynwood from hardwood cuttings in the field.

MR. MONROE: I have had limited experience with that. We tried Lynwood Gold from hardwood cutting this past spring. Unfortunately, our weather conditions were unusual to say the least and we got about 10 per cent.

MR. VANDERBROOK: We got about 100 per cent.

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Tonight we are particularly interested in one species of rose, called *Rosa Hugonis*. This exotic rose was found in Western China, and is sometimes called "Father Hugo's rose".

It is easily grown, and becomes a great and graceful shrub. Early in the season, the large, single, clear yellow flowers cover this species.

The propagation of *R. Hugonis,* from hard wood cuttings, has been a simple procedure with us, for the last 20 years. We tried budding them, but never got a good take. It was hard to remove the thorns. We even tried leaving the thorns on the sticks, but the budders did not appreciate this method. We used *Rosa multiflora japonica* understock grown from cuttings. We tried soft wood cuttings with only fair results. We have tried growing them from seed, but you can't be sure of a good supply, nor of germination. Our "seed trial" lasted several years, but we had only one good stand, and the seedlings took three years to develop into Number One plants.

Finally we decided to try hard wood cuttings and used several different methods before reaching a satisfactory one.

First we took cuttings in the fall, planted them in October and covered them with straw. In spite of this they heaved in the winter, and the results were only fair. We tried storing them in yellow sand, then planting in April, but found that many of the cuttings had turned black during the winter. This drastically reduced the number of cutting for planting. Then we tried storing cuttings in fine gravel sand. This was much better than using the yellow sand, but the gravel dried out too quickly. Both sand and gravel were too heavy for easy handling. Now we make our cuttings early in the winter. They are cut 6" long, using one year wood, from plants grown in the stool block, expressly for this purpose.

We like to use cutting wood, the size of a lead pencil, using only the center parts of the branch, as base cuttings are not satisfactory and the tips are usually too soft. One good sized plant in the stool block produces 250 to 300 cuttings. We store the cuttings in sawdust, upside-down, and in boxes 12 x 18 x 36 inches. We use this size for storage of all hardwood cuttings. These boxes will hold approximately 5,000 cuttings, and they can be handled by one man. We use this inverted method, because we found that cuttings stored in this manner had less bud growth and more basal callous. They are placed in common storage and held at temperatures from 28 to 32 degrees.

Rosa Hugonis cuttings are planted in April, just as soon as the land is ready. We plant on sandy loam, with a cool bottom, which holds moisture for a long time without rain. *Rosa Hugonis* as you know, likes a poor soil, and will grow almost any place. We usually have a stand from 75 to 80%. Fifty percent of these are large enough to use No. 1's the first year. If you want the Jumbo or 2-3 foot grade, it would be necessary to transplant and grow them for another year.

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MR. HOOGENDOORN: Don't you have trouble down there with Rose borer? I used to raise it and you get swelling.

MR. BLYTHE: We didn't seem to get it with *Hugonis.* You get some trouble with root galls. That is the only thing we have ever seen affected.

MR. LOWENFELS: Did you try growing any under mist? I did last year and rooted about 80 percent from softwood cuttings.

MR. BLYTHE: We haven't. We expect to try it next year.

MR. WELLS: What was the difference you noticed between cuttings taken in the center of the stem and the base?

MR. BLYTHE: I don't know that we paid particular attention when we first started. The tip cutting seemed to be smaller and immature. We left six inches off the bottom and started from there on up.

MR. VANDERBROOK: Do you people have greenhouses? If you do, try *Hugonis* in the greenhouse and you can get 100 per cent propagation for planting out in June.

MR. BLYTHE: We have no greenhouse.

MR. WILSON: What is the control for that stem borer that Mr. Hoogendoorn speaks of?

MR. BLYTHE: The only thing our Canadian specialists can tell us is to cut out and burn the affected canes.

MR. WILSON: Is there anybody here that has had experience with a borer and can tell me what have they done to control it?

MR. HOOGENDOORN: Years ago we used *Rosa Hugonis*. They were standard roses and they always seemed to be attacked. We used tobacco dust first. That controlled it some, but it didn't eliminate them completely.

MR. BLYTHE: I imagine you would have to give the treatment when the borers were flying.

MR. DE WILDE: I would say probably any borer can be controlled to a certain extent by getting DDT on your plants, preferably with a hydraulic sprayer and using a sticker, so it will be there when the nymphs are flying. If not DDT, then use Lindane, 25 per cent Lindane to 100 gallons, would probably control them to a great extent.

MR. WELLS: I am interested in this factor of putting hardwood cutting upside down in the callusing box. I know a lot of books advocate such a procedure. Is it really necessary? Does it produce something worth while? I doubt it and I wonder if other people have had any experience with it.

MR. JOHN B. ROLLER (Verhalen Nursery Co., Scottsville, Texas): If you store them right side up, our experience has been you get shoots coming out on the top before you plant them in the field.

MR. FILLMORE: I started 50 years ago working in Rochester, New York. We turned them upside down in the sand bank. Now I can understand that very early in the spring there would be a little sunshine and a certain amount of heat and you might get some callusing there that would be of advantage to you, but today when you store them at 32 or 35 degrees what difference is there whether they are upside down or right side up?

MR. BLYTHE: I don't know what the difference is. Occasionally, you get a variety with a little more moisture in it than should be and the terminal bud will start to shoot. I have noticed that time and time again. If they are upside down, the terminal bud doesn't.

MR. FILLMORE: There shouldn't be any budding at 32 degrees.

MR. METZLER: I would like to know a little more about the storage. You put the cuttings in the box upside down. How are you going to keep the temperature at 28 or 32?

MR. BLYTHE: We have automatic fans and thermostatic control and when the temperature comes down at night the fans let cold air in. When it warms up in the daytime, the fans shut off. That helps keep the storage temperatures. The fans cool it down again at night. It is insulated. It is just controlling the temperature with an automatic thermostat.

MR. VAN HOF: We store our hardwood cuttings in a homemade cold storage. We are kind of sloppy propagators. When we do put our bundles upside down - the bundles upside down means when you get a layer of peat, or whatever you use - it touches all the bottom and that, of course, will give you a callus formation. I think the main thing is to get your cuttings out in time. Stick them as deep as possible and see that the ground is pressed down firmly so there are no air pockets.

MR. BLYTHE: In planting we rotohoe the ground and push in the cuttings to a depth of about six inches.

MR. DOUGLAS BUTLER (Rosehall Nurseries, Brantford, Ontario): What kind of sawdust do you use?

MR. BLYTHE: It is a mixed sawdust from a small sawmill. It is a new elm hardwood. There is a sample in the other room.

MODERATOR COGGESHALL: I am sorry, but I must interrupt now, if you have additional questions you can see Mr. Blythe later.

I have saved our last speaker for a very definite reason. He is Mr. A. M. Shammarello, of Shammarello & Sons, South Euclid, Ohio. In corresponding with him, he indicated a hesitancy to come before you this evening to speak, due to the fact that results he has obtained from year to year have not been consistent. However, certainly the subject he is to speak on has been worked on by a great many of you in the audience and he may possibly get a solution here to some of his problems. Mr. Shammarello will speak on the "Propagation of Rhododendrons by Stem Cuttings".

PROPAGATION OF RHODODENDRONS BY STEM CUTTINGS

A. M. SHAMMARELLO
Shammarello & Sons, South Euclid, Ohio

Ladies and gentlemen: The questionnaire we received this summer asked us to check plants we would be most interested in hearing someone talk about. I checked rhododendrons. Little did I realize at the time that I would be asked to tell you how to propagate rhododendrons by stem cuttings. I had hoped that some successful propagator would enlighten us on the subject. I am seeking information and I am sorry to say I do not have much to contribute.

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However, I will tell you of my experiences and hope to stimulate some interest and thereby obtain more information from the audience.

I have propagated rhododendrons by leaf-bud cuttings and by stem cuttings for the past 15 years. My results have been inconsistent from year to year. Some years I have rooted them easily and on hard varieties had 90 per cent. Some years I only got 10 per cent to root. Therefore, it is quite evident that the conditions and the methods used were not the same. Something was wrong.

We know that some varieties root easier than others, but I have discovered that timing, condition of cutting, hormones, media, and after care, each play an important part.

Timing is important, depending whether the cuttings are to be rooted in a cold frame, or a greenhouse. I suggest the latter part of July for cold frames and the early part of September to late December for the greenhouse. I have used both.

Condition of cutting is of utmost importance. That is, cuttings should be in a healthy, turgid condition. The size of a pencil thickness is just about right. A large cutting or very weak thin cutting are not good.

Hormones without a doubt aid in rooting. Hormodin No. 3 or one per cent indolebutyric acid both tend to be of some value.

The way I am situated, I use a sashhouse with no heat for summer propagating. I remove the sashes and cover with a No. 8 burlap. On the bottom of the frame I place a 3/8 inch screen and on this screen one inch of gravel and two inches of media, composed of one part of No. 7 silica sand, one part of a coarser sand and one part of moss culled or otherwise, all mixed together. Over this mixture I lay an electric cable about 3 to 4 inches apart, and finish filling the frame by adding 3 or more inches of the same mixture of sand, coarse sand and peat moss. I then cover the frames with sash. Now, for the propagations of the cuttings, I usually take my cuttings in the early morning, place them in a bushel basket covered with wet newspapers, and put them in a damp cool cellar until I am ready to make the cuttings. In making the cuttings, I leave three medium-sized leaves. If they are large, I cut those leaves back, and make the cuttings two and a quarter to two and a half inches long, with the wound on the side say an inch to inch and a quarter long. I then dip them in indolebutyric acid.

I use a pencil to make my holes in the media so that I don't rub off my powder. Then, I press them down slightly and thereafter I water them thoroughly until the water runs from underneath the benches. We do not water them that heavily again.

Thereafter, I sweat the sashes each morning and syringe with a fine spray. Again, I syringe about 10:00 o'clock and cover the sash with a cloth. About 1:00 o'clock they are once more syringed with the cloth being removed about 6:00 o'clock in the evening. My burlap is coarse enough so that I'd get light during cloudy days. Therefore, on sunny days I must cover those cuttings, or otherwise they will just burn up.

Cuttings are sprayed about every two weeks with Fermate and the electric cable is turned on the first part of November. Now this is my general procedure until the first part of December, and at this time the cuttings

that have rooted are potted and the cuttings that are not rooted are placed in a frame in my greenhouse and many more will root.

The potted plants are kept in a cool greenhouse until June first, and thereafter planted in beds under an irrigation system.

I hope this brief outline has been of some interest. (Applause)

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MODERATOR COGGESHALL: What is the temperature of the media?

MR. SHAMMARELLO: I would say around 65 to 70.

MODERATOR COGGESHALL: You only water the cuttings in; you don't pound them down?

MR. SHAMMARELLO: No, sir, I wouldn't pound them down.

MR. VAN HOF: What do you mean by thin cutting?

MR. SHAMMARELLO: A cutting about a pencil thickness, I think that has enough sap in it and is hard and healthy. I have never had any luck with a cutting half the size of a pencil with deformed leaves or a cutting as large as my thumb.

MR. VAN HOF: Which are the easiest ones to root?

MR. SHAMMARELLO: *R. roseum elegans* I believe is the easiest, also *Boule De Neige* and *R. Catawbiense album.*

MR. WELLS: I hesitate to say anything on this. I take issue with Mr. Shammarello on one or two points. I think I can best point these out, if I can take a few moments and run through the sequence of events, as I understand them.

I don't agree with his remarks about small cuttings. Jack Blauw will collaborate that we set out to produce small cuttings by pinching the stock plants after the first growth had been made following flowering. In other words, the stock plants grew the first growth in May and June. We pinched out the terminal bud. We got three or four shoots coming from the apex of the first growth. They were relatively small, certainly much less than pencil thickness, one half or one-third pencil thickness and we found such cuttings rooted much more readily. The timing was thrown back further into the winter, because the shoots had to develop from dormant buds, thus they had to go through their period of growth and be sufficiently ripe to take.

We found that the optimum time was from the end of September through October and November and with the easier rooted varieties even in December, and January. I also think we rooted some in February. Small cuttings reduced to 3 or 4 leaves. The mixture we found to be best was 90 or 95 per cent peat with very little sand, a heavy wound on most varieties and a quite strong hormone. The easy rhododendrons were treated with Hormodin No. 3. The less easy varieties were treated with 2 per cent indolebutyric acid, and the more difficult, such as Dr. Dresselhuys with 2, 4, 5-trichlorophenoxy-propionic acid. Considerable time was necessary to root the more difficult varieties, such as Dr. Dresselhuys. We have put cuttings of those in during October an did not get good rooting until the following March.

One other factor that I think enters into production of a good plant with which I disagree with Mr. Shammarello, is the time of planting the rooted cuttings. We followed out his procedure of potting them as soon as rooted. We found it advantageous to pinch the terminal bud from the cutting at time of potting. That induced side buds to develop throughout the winter. The plants were apparently dormant in the cold frames where they spent the remainder of the winter.

At the time the ground was fit to use in the spring, these terminal buds had developed. If we delayed pinching until we planted them out, we lost three weeks or maybe longer while the buds were developing and getting ready to grow. We like to plant those potted cuttings with a little fat bud at the top, as early as possible in the spring. If we delayed planting for two or three weeks because of the weather, we could see a difference in the growth of those plants for the following two years. The earlier they were planted the better they grew.

One final point: we found that humidication, or the use of a mist system in the greenhouses, was the greatest single help that we had in successful rooting. We rooted quite a lot of varieties, and as Mr. Shammarello said, our percentages varied from year to year, but on some of the more difficult ones I think that new Jack Blauw has obtained 75 or 80 per cent.

MR. SHAMMARELLO: We make just one cutting out of each branch, just below the node. I don't think it makes so much difference. I always believed you had to have good drainage and oxygen in your sweat box in order for those rhododendron to make roots. A friend of mine in Brookville, Pennsylvania, is using a frame called an "airing frame." There they built a box. It is all wood in the bottom as tight as can be, and in this wood he put in 3 or 4 inches of plain peat moss and then a mixture of half peat moss and half sand, on top another inch or half inch of sand. You flood those frames until the water rises a half inch above the sand. A couple of days later you insert those cuttings. Again you flood the frame until the water again rises a quarter to a half inch over the bottom of the sand but not over the leaves. You do that once every week.

MR. STROOMBEEK: I wanted to ask Mr. Wells a question about *Dresselhuys*. Do you put it in in October and leave it in the same peat until March? I have had the experience that in about three months the peat seems to be decomposed and loses its strength. What do you think?

MR. WELLS: Yes, it does.

MR. JACK BLAUW: I would like to answer his question too. I believe in high humidity, but I disagree with Jim Wells in that you can have high humidity without using the fogline on top of the rhododendron cuttings. I set up an experiment this summer with cuttings. This is the way we did it. About two inches of coarse gravel is placed on the screen. On top of that we had a mixture of 75 per cent peat moss and 25 per cent sharp silica sand. We had one bench filled with rhododendron cuttings. The bench next to us was completely empty. Over this empty bench we had a fogline and after we watered the cuttings in very heavily we didn't water the cuttings at all. We just used the mistline on top of the empty bench to keep the humidity

high. The humidity was maintained close to 100 per cent by turning the water on the empty bench. We kept the humidity high by covering the whole greenhouse with Polyethylene. In that way, we were able to keep the rhododendrons wet all the time without watering them with the fogline on top of the rhododendrons.

I believe it is very important not to pour water on the cuttings because rhododendrons especially don't like a high pH. As we all know, the pH of peat moss is around 4 or 4-1/2. In South Jersey where I am working, the pH of the water is about 6 or 6-1/2. By pouring all the water on top of the peat moss you are bound to raise the pH and I have found that by using other means of keeping the humidity high we have better results.

MR. SHAMMARELLO: I don't understand, where do you have the polyethylene?

MR. BLAUW: We have a rather low greenhouse, about 10 feet high and we cover the whole house from one end to the other.

MR. SHAMMARELLO: On the inside?

MR. BLAUW: On the outside, over the entire houses.

MR. BLAUW: We made our cuttings in September and the cuttings rooted close to 100 per cent.

MODERATOR COGGESHALL: There is one other thing. In talking with you previously Jack, you mentioned the advantage of polyethylene as a fuel saver.

MR. BLAUW: After we put the plastic on there, the temperature rose about 10 degrees, so we had to cut the thermostat down. I think by using polyethylene, which is not too expensive, you save on your fuel.

MR. CHARLES HESS, Jr.: There is a man near Jack's place in North Jersey by the name of Nippenburg, who has been causing the nurserymen in the area quite a bit of concern. He has a hobby of growing red rhododendrons of the more difficult varieties and he has worked out a system which is incorporating several of these ideas.

First, he constructs his beds of concrete and he puts copper tubing in the base of them and uses a type of radiant heat. On top of the bed in which the tubing is placed, he puts a layer of about two feet of cinders and on top of that he puts his layer of sand and on top of that he puts a layer of sand and peat in which the cuttings are inserted.

Before he inserts the cuttings, the medium is really saturated. Then the cuttings are inserted. It is a small and tight house. The radiant heat under the cinders causes the water to evaporate and it condenses to a certain extent on the upper part of the greenhouse and falls down on the medium again. That is the only water those cuttings are given.

He also sticks the cuttings in November and takes them out in March. By using this method, he has had very consistent results.

MR. HARVEY GRAY: Three years ago, on Long Island, Mr. O'Hagan started with a few rooted cuttings. At the present time, he has in a

greenhouse of his own construction something like 10,000 rhododendron cuttings. He has over 10,000 one- and two-year old plants in the field.

As I sat and listened to this discussion having to do with the media, I hear: wet the media, don't wet the media, dry it out, or don't dry it out. When Dr. Chadwick wrote his book he emphasized very nicely the one element that most of us are apt to play down a little bit, and that is the subject of oxygen.

Now, oxygen, I think, is one of the most important things in getting plant growth, particularly in the callusing and rooting of cuttings. Whether we soak that media, or we don't soak it, let's not forget it is oxygen we are looking for and to root anything successfully that is what we need - oxygen.

MR. CHARLES HESS, Jr.: For one thing, I do appreciate the importance of oxygen but I do not think it is that critical. Even under constant mist, as we had it in the greenhouses this year and last year, we had no trouble at all from lack of oxygen. We think that the main trouble was the temperature was too low.

To back this up a little bit, the year before last, Sidney Waxman, a graduate student at Cornell had a series of studies trying to find out just what amounts of oxygen were needed. I believe about 10 per cent was the critical point. There is 20 per cent oxygen in the air. In other words, if you have half of what is potentially available, you still will have enough.

Now whether this constant mist passing through the air is picking up oxygen, not dissolving it, and pulling it through, I can say. In our experience we have had no trouble with constant mist as far as causing trouble along oxygen lines. We will have more to say on why you should use mist tomorrow.

MODERATOR COGGESHALL: Sorry, gentlemen. I must cut this short, or we will go on all night. You have a whole morning devoted to mist.

I would like at this time to terminate this symposium, to thank each participant, and to turn the meeting back to Dr. Chadwick. (Applause)

PRESIDENT CHADWICK: Thanks, Roger, for conducting a very fine session this afternoon and also this evening. I would also like to thank all the others who have been on the program during the day.

The session recessed at 10:30 o'clock.

Panel on Taxus Propagation

FRIDAY MORNING SESSION

December 3, 1954

The session convened at 9:30 o'clock, President Chadwick opening the session.

PRESIDENT CHADWICK: As the result of the survey that was sent out regarding the program this year, one of the topics most frequently specified was *Taxus*. The decision was reached that perhaps we would go a little bit further than simple propagation in one sense of the word, at least, on this group of plants, and carry on through to at least the first stages of field production. Consequently, the program has been set up in that way and it is going to start from the beginning and go on through field production, covering seeds and cuttings and other methods of plant propagation.

The moderator in charge of the session this morning is Professor Ray Keen, Department of Horticulture at Kansas State College.

If you want to know anything about identification of *Taxus*, see Ray. Don't talk to me. I am just the guy who tells him what to do, but Ray is going to head up this session, and I am sure you are going to be interested in it. We hope we will have as good a discussion following the papers as we did yesterday. So I will introduce Ray Keen at this time.

Mr. Ray A. Keen took the chair.

MODERATOR KEEN: Thank you, Dr. Chadwick.

Mr. President, and fellow propagators: It is really a pleasure for me to come before you this morning and present this review of the propagation of *Taxus*. Chad, I am very glad that I can run back and forth between Kansas State and Ohio State, because, had I been at Ohio State, I am sure I would have closer to 1,000 papers to review than 100. Even though we live far beyond the range where taxus grows, commercially at least, we had a goodly number of papers to choose from in presenting this paper.

Mr. Keen presented his paper, entitled "The Propagation of *Taxus* — A Review." (Applause)

THE PROPAGATION OF TAXUS — A REVIEW

RAY A. KEEN

Department of Horticulture, Kansas State College

Taxus are commonly propagated by seeds and cuttings, a few varieties by grafting, and occasionally an amateur will propagate a plant by layering.

Seeds are used to propagate the species of yew and are preferred by many growers, according to Wells (34) and others (12, 21, 28), for producing the excurrent "capitata" form of the Japanese Yew, *T. cuspidata*. Hatfield (12) and Wells (34) have pointed out that the source of seed is impor-

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Mr. Ray A. Keen took the chair.

MODERATOR KEEN: Thank you, Dr. Chadwick.

Mr. President, and fellow propagators: It is really a pleasure for me to come before you this morning and present this review of the propagation of *Taxus*. Chad, I am very glad that I can run back and forth between Kansas State and Ohio State, because, had I been at Ohio State, I am sure I would have closer to 1,000 papers to review than 100. Even though we live far beyond the range where taxus grows, commercially at least, we had a goodly number of papers to choose from in presenting this paper.

Mr. Keen presented his paper, entitled "The Propagation of *Taxus* — A Review." (Applause)

THE PROPAGATION OF TAXUS — A REVIEW

RAY A. KEEN

Department of Horticulture, Kansas State College

Taxus are commonly propagated by seeds and cuttings, a few varieties by grafting, and occasionally an amateur will propagate a plant by layering.

Seeds are used to propagate the species of yew and are preferred by many growers, according to Wells (34) and others (12, 21, 28), for producing the excurrent "capitata" form of the Japanese Yew, *T. cuspidata*. Hatfield (12) and Wells (34) have pointed out that the source of seed is impor-

tant, since the yews hybridize readily, and seed from a mixed nursery planting may offer many potentially excellent new varieties. However, commercially, a block of such plants must be sold as "mixed seedlings . . . . and do not command a high price on the market", according to Wells (34). It was my privilege to observe several such blocks of stock, of all ages, this past summer. From them plants could be selected to fit the description of almost any of the yews in the literature except, possibly, *T. baccata adpressa,* the Shortleaf English Yew. Wells (34) prefers domestic seed, from nursery stock plants, to imported seed. The seed should be gathered as soon as ripe and cleaned by "macerating the arils in water and floating away the pulp and empty seed" (35). Yew seed remains viable up to four years if stored in moist peat below 40°F.

Yerkes (36), Bailey (2) and others (7, 12, 28, 35) classify yew seed as "two year seeds" which are stratified as soon as procured and planted the following spring. Germination occurs one year later. Sheat (28) recommends 15 to 16 months stratification, from the time the seed is gathered in the fall until March of the following year. Fall planting is preferred to stratification by Yerkes (36).

Crocker (7) classed *T. cuspidata* with seeds having a resistant seed coat, which require 90 days at 68° F. under good germinating conditions to permit soil organisms to break down the seed coat and moisture to enter the seed. This warm treatment is followed by 120 days at 34° to 41° F. to afterripen the seed. It will then germinate. Sulfuric acid was not effective in overcoming the seedcoat factor. The author of the article on *Taxus* in the Woody Plant Seed Manual (35) suggests several possible treatments for taxus seed but points out that, "Satisfactory methods for laboratory germination have not yet been worked out."

This should be a fertile field for scientific investigation, for it has been my observation that the embryo in the seed of *Taxus* is too small to germinate at the time the seed is collected. If this is true it would explain the necessity for a warm period, before afterripening of the seed, which cannot be replaced by acid scarification of the seed coat.

The seedlings are removed to transplant beds at the end of one (36) or two (34) growing seasons. They are field liners at the end of two seasons in the transplant beds.

The literature on propagating taxus from cuttings is abundant since taxus was included in much of the early work with growth substances (4), (8), (13). Prior to the general use of root accelerating substances taxus cuttings required six to nine months to root, and Bailey (2) allowed 12 months. Oliver (25) reports 60% rooting of untreated cuttings after six months.

Chadwick (4) found sand alone and peat alone to be better mediums than sand-peat mixtures. Durham (9) had best results in peat-sand and peat-cinders mixtures. Esper (10) and Chadwick (4) found that the results with different mediums changed as the season progressed. The conclusion was reached that the varied results of other workers was due, in part at least, to the time the cuttings were taken. Peat produced the best results from July to November. Sand gave the best results from December on. Roots from peat were less brittle and subject to less breakage than those from sand, according to Chadwick (4).

Sheat (28) and Wells (34) report good success rooting cuttings of yew in shaded frames in summer. The advantage of this practice lies in the low cost of frames and labor at that time. Better percentages of rooting were reported for cuttings rooted in the greenhouse in the winter. Esper (10) found late fall and early winter the best time to take cuttings. Swartley and Chadwick (30) found that January cuttings responded better than November cuttings based on the length of time the cuttings were in the bench. Klein (19) found that cuttings taken in November and December were superior to those taken in January and February.

Kirkpatrick (18) reported that cuttings with a heel rooted better than those without, and Wells (34) prefers such cuttings or at least some second season wood at the base. Longley (22) reported that Canada Yew rooted equally well with one, two, or three year wood at the base, but the latter had longer and more numerous roots, and the larger cutting gave a larger plant. Durham (9) and Chadwick (4) reported no advantage for any particular location of cut. Kirkpatrick reports rooting of cuttings of *Taxus cuspidata* twelve to eighteen inches long.

In the greenhouse bench, Wells (34) recommends a bottom heat of about 70° F. Chadwick and Swartley (6) report that a bottom heat of 70° —75° F. gave better results than 80°—85° F. While Esper (10) found a bottom heat of 65°—70° F., with an air temperature of 50°—55° F., to give best results

Prior to the discovery of growth substances a great many compounds, both organic and inorganic, were tested for their ability to increase the percentage of taxus cuttings rooted or to hasten the process. Most of these were of little benefit, though Chadwick (4) found some benefit from potassium permanganate, 1 ounce to 5 gallons water, soaked for twenty-four hours; and from sugar, 1 pound in 7 gallons of water. Klein (19) rated potassium permanganate, 5% glucose, and 10% glycerine in that order for soaking cuttings before sticking into the rooting medium.

Early trials with growth substances gave varied results. Chadwick and Kiplinger (5) reported that indolebutyric acid at 50, 100, and 150 p.p.m. did not significantly increase the percentage of taxus cuttings rooted, nor the number of roots induced in a three months period. Meahl (24) found that treated cuttings had a greater percentage rooted at the end of nine weeks, but this difference had disappeared at the end of 16 weeks and "The small difference in final rooting was not considered significant." Grace and Farrar (11) found napthylbutyric acid ineffective on percent rooted in 90 days, but the number and length of roots per cutting rooted were increased for all treatments. Poesch (26) found that *Taxus baccata repandens* and *Taxus cuspidata "capitata"* did not respond to treatment, while four other clons gave 10 to 50% increase in percent of cuttings rooted in ninety days. Hitchcock and Zimmerman (13), (15) reported earlier rooting, and discovered that *Taxus cuspidata* cuttings required higher concentrations of indolebutyric acid when taken in October and November as compared with other times of the year. They further reported (14) that deferring the treatment from six weeks to five months after sticking the cuttings, gave better results than treatment at time of sticking. Removing the callus knobs before deferred treatment was beneficial but not practical. Chadwick and

Swartley (6) found re-treatment beneficial but not consistent, and concluded that the benefit was not worth the time and labor involved. They also reported that watering the cutting bench with vitamin B1 did not stimulate root initiation but it did stimulate root growth after the roots are initiated.

Using a-napthyl acetic acid at 50 p.p.m. in water for 48-hour-soak, Tincker and Unwin (33) report 33% more *T. baccata* cuttings rooted in 7 weeks. Fifty percent were rooted in three months, while the controls required six months to root 50% of the cuttings. Oliver (25) rooted 60% of *T. cuspidata* cuttings in 46 days when treated with 80 p.p.m. indolebutyric acid in water for 24 hours. Untreated controls required six months to equal this figure.

Maxon (23), Yerkes (37), Kirkpatrick (18) and others (1), (16), (20), (27), report beneficial results with growth substances. More recently Wells (34) reports their use, as proprietary talc dusts, to be standard practice, mentioning incidentally that "*T. repandens* and *T. fastigiata* do not root well (with commercial dusts) but respond to 2% indolebutyric acid."

Other materials have been added to the growth substances: to control pH, Chadwick and Swartley (6); fungicides, Grace and Farrar (11), and Snyder (29). In general, they have not been effective, and the fermate used by Snyder had an inhibiting effect which lasted about 120 days.

Unlike most plants, taxus cuttings continue the habit of growth determined by the position they had on the parent plant. Cuttings from orthotropic branches or "leaders" produce excurrent trees or "capitata" Japanese Yews. Plagiotropic growth results in one-sided plants unless they are repeatedly sheared to produce spreading shrubs. Thus Wells (34) stresses the value of "straight leader cuttings", and Baltet (3) recommends "the young shoots which spring from the amputated head of the parent tree in the uppermost whorl of branches" as the best cions.

Baltet (3) reports that Yews are grafted by veneering (in February and September, under glass) on seedlings or cuttings. Wells (34) reports that grafting is "used for yellow and variegated forms which do not root readily." The "usual manner" is the method used, by which he probably means side or veneer grafts on potted stock in the greenhouse, as juniper and spruce are handled. Bailey (2) recommends August or early fall for veneer grafting the named varieties on the upright kinds. Sheat (28) concludes "grafting may be carried out but there is little justification for it."

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MODERATOR KEEN: I don't believe that we will take time for questions on the literature at the present time because, while there may be questions, it may be far better to hold your questions until we have heard

from some of these men who are well versed and experienced in handling the propagation of taxus.

The first of our speakers this morning has had considerable experience propagating *Taxus* by seeds. He is from Amherst, Ohio. Mr. Laddie Mitiska will discuss "The Propagation of *Taxus* by Seed."

MR. LADDIE MITISKA (Amherst, Ohio): Mr. Chairman, members and guests of the Propagators Society: From the material Mr. Keen has given us we can readily see that the work that has been done in the past good many years has given varied results. We know a good many of the practices used then are outdated. Among the various propagators that are handling yews, everyone seems to have his own method.

In presenting this paper, in which I have gathered the facts as they have happened to us, I know there will probably be a difference of opinion and it is fortunate that I am being followed on this program by two highly successful nurserymen.

Mr. Mitiska presented his paper on "The Propagation of *Taxus* by Seeds." (Applause)

THE PROPAGATION OF TAXUS BY SEEDS

LADDIE J. MITISKA
Mitiska Nursery, Amherst, Ohio

Taxus are propagated by seed for two reasons. First is to produce the *Taxus "capitata"* of the trade. The other is to produce seedlings of the clones in a search for new varieties, which, to be reproduced, are propagated by cuttings or, very rarely, by grafting.

Although some nurserymen propagate *Taxus "capitata"* by tip cuttings of upright-growing branches of particularly good strain most plants of this type are grown from seed.

Much of the success or failure of growing taxus frm seed depends upon the source and viability of the seed. If one is dependent upon a seed house or collector for the procurement of seed, it is important to know that the seed is from the current crop, and that it has not been exposed to undue heat or drying out. And too, one should make sure that the strain of seed has desirable characteristics. It takes several years before the true form of the plant is ascertained, hence it is important to start with good seed.

We have preferred collecting our own seed whenever possible and have found we could grow a very nice strain of Upright Yew by gathering seed from an especially large and nice specimen of *Taxus cuspidata*. Seeds of a true *Taxus cuspidata* tend to reproduce quite uniformly. Seeds gathered from some of the clones will produce an endless variation of seedlings. Although some may prove to have superior merit, the general picture is one of confusion in the genus *Taxus*. There is always room for superior selections in any group of plants, but instead of adding to the number appearing in the trade, some of the inferior ones should be dropped. Continuing studies by colleges and

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experimental stations in growing and evaluating taxus selections should be intensified.

Although we propagate the greater share of our taxus by cuttings, and this has all been accomplished in out-door, heatless frames, some seeding is being done.

Taxus seeds usually remain dormant after sowing until the second season, unless some means are provided to break dormancy and hasten germination. Gathering the seeds before the fruit was fully formed and planted immediately was tried. but no germination took place until the second year. With some seeds, this procedure gives relatively quick germination. Another procedure tried was to treat the seeds with a sulphuric acid solution for 30 minutes to soften the seed-coats—again the results were negative. It seemed to indicate rather, that the after-ripening process must be artificially controlled. A batch of seeds collected and stratified immediately was subjected to alternate periods of warmth and cold. First the stratified seeds were placed in a cool temperature of about 35-40 degrees for eight weeks (Nov. & December); then brought into a warm room for six weeks (until mid-February); then returned to the cool temperature where they remained until sown in March in a previously prepared bed. A very small percentage of the seed germinated the first year, with a high percentage of the remainder coming through the second year. There was also some germination the third year. We felt that the cost of caring for the few seedlings that first year did not warrant trying to hasten germination unless a higher percentage is realized. It is most advantageous to harvest a crop of seedlings of the same age and of uniform size, even if it means waiting the extra year. However, the fact that even a few seeds germinated the first year seems to indicate that some method could be devised to successfully secure good first-year germination. Perhaps some nurseryman or scientist has already found the solution.

Not having the time and facilities to devote to more experimental work, we are content for the present to follow the slower, but for us, a sure procedure.

In our earliest sowings, the seed was stratified in fall and held over and planted in spring. Sand was used as a stratification medium in the volume of at least five parts of sand to one of seed. It was found that if the concentration of seeds was greater, there was a greater incidence of fungus damage. The container was usually a wooden box with drainage provided. Peat moss was tried but if kept too moist there was again the danger of fungus damage. If seed was purchased, it was soaked for several hours in cold water before being mixed with sand to give it an initial wetting.

Our own seed is cleaned by soaking the berries for four to five days in warm water. Slight fermentation may begin and apparently is not harmful. The seed is rubbed over a screen to separate it from the jelly-like pulp and thoroughly washed several times. As an added precaution against fungus, we usually wash the seed in a solution of potassium permanganate. Some growers have been using any of the common detergents.

In the process of cleaning, any seed that floats on the water is discarded. These seeds are usually found to be empty or lightly filled. Once the seed has been cleaned, it is well to plant or stratify it before the seed coats dry out.

The stratified seed is kept in a cool room at temperatures from 35-40 degrees, and checked occasionally that the medium is slightly moist at all times.

If it is difficult to provide a storage place at these temperatures, we have also tried with excellent results, to bury the container with the seeds out-doors in a well-drained place, preferably on the shaded side of a building. The container is placed deep enough to be below frost and the temperatures remain quite constant for a long period. A mulch can also be used, but protection must be furnished so no rodents can reach the seed.

However, sometimes when seeds are stratified for long periods, they are forgotten and allowed to dry out; or they may begin germination before they are sown in the seed bed. Whenever possible, we do all of our seeding in the fall. This not only applies to *Taxus*, but to other plants as well, namely: *Viburnum*, *Magnolia*, *Ilex opaca* and *crenata* types, *Mahonia*, *Junipers*, Dogwood, etc.

The construction of the seed-bed seems quite important to us. Our propagation is carried on at small scale and we believe that, although some of the precautions we take are not necessary, the little extra time expended is well worth while. The seed-bed should be located where land drainage is adequate and where there is ample movement of air for good circulation. Protection must be provided against mice, moles, chipmunks and also some birds. So our seed-bed is completely enclosed. Sides are either of wood or concrete blocks, laid with-out mortar. On the bottom we use 1/2" galvanized hardware cloth. As a cover the metal cloth is again used on wooden frames in convenient sections. Mice and chipmunks will feed on the seeds even through underground runways of moles. Some birds were found to feed on newly germinating seeds. Hence these precautions.

The seedlings will remain in the seed-beds for two growing seasons, so adequate soil preparation must be provided. We find a fertile, sandy loam very good and like to work in a generous application of peat. Michigan peat or a similar product is excellent. This mixture should be fortified with a complete fertilizer, preferably one with an organic base as most of the nutrients will be demanded the second season after sowing. Soil depth above the protective hardware cloth is about four inches.

As to the method of seeding, we broadcast the seed by hand as evenly as possible. Our beds are made four feet wide and we cover about 20 square feet of surface with one pound of seed. Taxus seed runs approximately 8500-9000 to the pound, so this rate of sowing allows about 400 seeds to the square foot. With an expected germination of 50%, this gives us approximately 200 seedlings to the square foot. A higher percentage often results, but the finished stand will produce smaller seedlings due to crowding. If crowding is too severe, the seedlings will be thin and weak, and very susceptible to damping-off fungus.

We press the seeds into the soil slightly using a board or block of wood, and cover the seeds with a layer of clean washed sand about 3/8 of an inch thick. This is again firmed. Then the entire bed is covered with a layer of mixed wood shavings to the depth of 1-1/2 to 2". If shavings are not available, perhaps ground corn cobs or some other mulch material could be used.

This covering will remain the entire next year and until the following spring, when germination is expected. We find that there is no weed problem as long as the shavings remain, and that normal rainfalls will supply most of the moisture requirements. Only in periods of drought will any irrigation be required. So, aside from using space, the care of the seed bed the first year is negligible.

The shaving mulch is easily removed the second spring without disturbing the sand covering the seed. It should be removed very early in the spring as a mulch keeps the soil cooler, and it is desirable to have the warmer soil temperature to secure germination as early in spring as possible. Late germination brings the tender seedlings into hot weather when there is greatest danger from damping-off. The covering of sand prevents most of the weeds from growing, but if any should appear before germination begins, we have used a flame-gun to burn them off without damage to the seeds.

When germination does begin, the response is quite spontaneous and this period is over quickly. A light shade should be used as a hot sun can scorch the tender seedlings as they emerge and cause deformation of the stems.

Damping-off fungus poses the greatest danger to newly germinated seedlings. In the past we have resorted to some of the mercuric compounds at the first sign of damping-off. More recently, we have used oxyquinoline sulfate or Captan.

There has been a marked increase in the occurrence of damping-off fungus (*Rhizoctonia solani*) on taxus in the past few years. The fungus may cause the rotting of new roots, or it appears as a collar infection at the soil level. It has appeared in seed beds, cutting off the plants at soil level. It shows in liners also, being carried over from cutting beds. The infections have been severe enough to cause the death of even mature plants. Francis W. Meyer of the Department of Plant Pathology & Botany at the Connecticut Agricultural Experiment Station has made a considerable study of this fungus on taxus and other plants. I am quoting from his findings. "We are of the opinion that oxyquinoline sulfate, rather than being a fungicide is 'fungistatic' and that it is taken up by the roots of the plant which thereby makes the plant resistant to further invasion by the fungus. Oxyquinoline sulfate is used at the rate of 1:4000, or one level teaspoon to three gallons of water, or one pound to 500 gallons. It is applied to the soil at the rate of 1 pint per square foot. Often one treatment will halt the losses."

Our results using this material are still inconclusive, but we feel that from our past summers experience, our losses due to damping-off were minimized. The cost of treatment is small and good insurance. The appearance of a fungus in the seed-beds can wipe out much of a good stand very quickly.

As the season advances, the seedlings harden-up and the danger is lessened. During periods of heat and dry weather, irrigation should be plentiful and thorough. Watering should be done early enough in the day, when the seedlings are still tender, so that the foliage is dry before dark.

In early September, when the heat of the sun has diminished, we remove the shading to give the seedlings a chance to harden up for the winter. Early in December, the seed-beds are given a loose covering of clean straw and the lath shade restored. We use a double layer of lath shading for the first winter. There will be no heaving of the seedlings if the soil is shaded and not

subject to alternate freezing and thawing. Protection against rabbit damage must be furnished.

Early the following spring the shading is removed and as much of the straw as possible. At this time we give a surface application of a good complete fertilizer, broadcasting it by hand and washing it off the foliage and stems with a hose. Rate of application is approximately 1-1/2 to 2 pounds per 100 square feet. The seedlings will be removed from the seed-bed after this second growing season and we try to get all the growth possible. It has been proven that taxus will respond generously to supplemental feeding and watering.

The shading is not replaced the second growing season unless extremely hot and drying weather is encountered in June to August. Only a very light shade is then used. A late spring frost, as some sections of the country experienced last spring, should be guarded against and seed-beds protected. Frosted new growth of taxus seedlings will injure and deform the structure of the plant.

After the first surge of new growth has been completed and the terminal buds have attained full size, we give two or three applications of a liquid feeding at two week intervals. This feeding should end by early August as late new growths will be damaged by freezing weather and will not mature properly. Rapid-Gro or a similar formula applied at the manufacturers recommendations have been used. Heavy watering during the summer period has given an additional burst of growth to produce a vigorous seedling for transplanting. It is good practice to begin irrigation before the soil has reached too great a degree of dryness. After new growth nears completion, no irrigation is done. Of course, as with all plants, and with evergreens types especially, no plants should go into the winter in a dry condition.

For the second winter a light protection of straw is all that is needed. We cover this with a raised lath shade merely to protect the seedlings from being crushed by heavy, wet snows.

The seedlings are now ready for transplanting. Digging has been made very easy because of the hardware cloth in the bottom of the bed. A sharp spade is run along the bottom to dig and root-trim the seedlings evenly. From here, seedlings may be either potted, bedded, or lined in open beds for further growing on.

We prefer to dig our seedlings early while they are still dormant. even if planting can not be done immediately. They are heeled into a peaty bed and shaded until used. If any of our seedlings or rooted cuttings are planted out-doors in an advanced season, we spray the foliage first with Wilt-Pruf.

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MODERATOR KEEN: We will take time for a few questions right now on this subject of propagating taxus from seed.

MR. WALTER C. ALDRICH (Jos. Olsen Nursery, Birmingham, Michigan): What was your recommended seed count per squart foot?

MR. MITISKA: We try to sow at the rate of approximately 400 seeds per square foot.

MR. JACK HILL (D. Hill Nursery, Dundee, Ill.): What is the reason for the straw protection on your beds the second winter after germination? Is that to deal primarily with heaving or is that to reduce damage to the foliage by the winter conditions?

MR. MITISKA: We use straw the second season to reduce damage to the foliage because we are in a spot where we get a lot of wind. In the winter time the wind has a drying effect and sometimes discolors the foliage when it is unprotected.

MR. HILL: Heaving is no problem?

MR. MITISKA: No, probably the roots are quite deep.

MR. CHARLES HESS, SR. (Hess' Nursery, Mt. View, N. J.): You say you collect your own seed for *Taxus "capitata"?*

MR. MITISKA: We have a plant of *Taxus cuspidata* that we thought was a true strain and is quite isolated from other *Taxus.*

MR. HESS: We have discontinued collecting our own seed. We found we were getting "mongrels". We have cross pollination and the only true seed we can get today is from Japan. We had a *Taxus "capitata"* and a *Taxus media hicksi* and we found the seeds to be a cross of "capitata" and *hicksi.*

You mentioned the danger from birds eating the seed. I happened to be at Sheridan Nursery in Ontario, Canada, last summer and they have the most novel way of protecting the seeds. They mix their seed with powdered red lead and it stays on in the weather and sticks with the seed. The birds will not touch the seed. They have given up all other protection. They had seeds of taxus, pines, and spruce. As you know, when they germinate they carry the seed coat with them and the birds will nip it off and all you have is roots and no foliage. They found by treating the seed with powdered red lead, it would stop all damage by birds.

MR. MITISKA: Years ago we experienced damage by birds on other seeds. At that time, the only recommendation was to use poison baits.

MR. HESS: This doesn't poison the birds. They won't touch it.

MR. deWILDE (Rhode-Lake Nurseries, Shiloh, N. J.): I can verify what Charlie Hess said about red lead. We use it on dogwood to keep mice off. The mice won't eat it. They won't even start on it. If you want to improve the thing a little bit to make it stick, I have found adding a tiny bit of linseed oil to the seeds before you put the red lead on, will make it stay better. I mix a pound of red lead with the oil and the seed, run it over a screen, and saved what fell out for the next time.

MR. C. DeGROOT (Sheridan Nurseries, Sheridan, Ont.): The application of red lead might be a tablespoon to one pound of seed. It should be wet so it sticks to the seed. The dry lead won't stick to the seed.

MR. ALBERT LOWENFELS (White Plains, N. Y.): If you kept the seed for 90 days at a warm 68 degree temperature and then kept them for 120 days in the cold, wouldn't you get germination the first year?

MODERATOR KEEN: That is what they found at the Boyce Thompson Institute, that is what will end the dormancy. Theoretically, you would have time to do it during winter but I don't believe that is commercially feasible. If they work on that basis, that wouldn't be too impossible. You would have to handle the seeds in flats. You could hold them in the greenhouse for 90 days at warm temperatures and go to cold storage.

MR. MITISKA: In relation to the work we do, I mentioned in my paper, a good many times seed that is stratified is gone. In a large operation where a person has charge of sowing seed and does one thing, it may work out perfectly. We find so many times that when we try to do too many things, some are forgotten. Even if it takes a little longer, we like to gather our seeds and to forget them until time for germination to take place. It may use a little space and it doesn't require very much care. The seeds are there. When the time comes, they are going to germinate.

I also wish to comment that our experience growing *Taxus "capitata"* from seed is that a good strong source produces seeds with good characteristcis. I think that is the way to do it. So many times in the past we got seed in from some of the seed houses. Some was partly filled, some dried out. That is why we started collecting our own. If you do have a good source, I think that is the best way to handle the seed.

MODERATOR KEEN: Thank you a lot, Mr. Mitiska.

I want to commend all of you for the attitude of being willing to share information with the crowd. I heard, even as late as the breakfast table this morning, that one man was concerned with the sharing of propagation information that was going on at these meetings. He was afraid that we would just rush out and propagate more plants and would just swamp the market!

You know we can't all afford to make all the mistakes ourselves. When I can find 100 papers on the propagation of taxus in the small school where I am, - our library has only been there about 80 years - why there is no dearth of information for anyone who wants to dig! And that is our purpose here, to dig and share so that we all have enough information.

Our next speaker has had a world of experience in the propagation of taxus by cuttings. John Vermeulen has introduced a number of new varieties. He didn't follow Charlie Hess' example when he found he had a flock of "mongrels", which is the word Charlie used. John selected some of the better ones and has introduced them. At this time, we will hear from Mr. John Vermeulen on "The Propagation of *Taxus* by Cuttings".

Mr. Vermeulen presented his paper entitled "The Propagation of *Taxus* by Cuttings". (Applause).

THE PROPAGATION OF TAXUS BY CUTTINGS

JOHN VERMEULEN
Neshanic Station, N. J.

Thank you, Ray. Don't tell the fellows I am good at propagating! I am here just to learn. I am not here to teach anybody anything.

If you think you know a lot, you know very little. And if you know a little and you keep your ears and eyes open, sometimes, you learn a lot! So I will just make a very brief statement here of what we do in propagating yews from cuttings. I will make it so brief that some questions must be asked. I believe in questions and answers. That is how I learn and I think that is how most of us learn.

I am giving a short talk and dividing it into four parts. First, material; second, the time; third, the media; and fourth, the hormones.

Selection of material from which cuttings are to be made is a very important matter. If you take a branch from a sick plant, we all know it hasn't an opportunity to grow. If we take it from the plant, it continues on for a period of time in the rooting media, until it has a chance to make its own root or take its own feeding, it has to depend on the branch. By taking a healthy branch, it has more chance to work it out and stay alive until it has started to root. So always keep in mind; the healthy plant, a healthy cutting!

The color, too. Often we take taxus from yellowish plants. It doesn't work out as well.

The type of cutting I think is best suited for propagation has branches that grew the previous year. These branches are healthy; they are straight. They take less room in the greenhouse and we, as commercial propagators, have to put everything in the greenhouse we can to make it pay, so we try to get cuttings from the previous season's growth.

We make our cuttings about 8 to 10 inches long. We make them longer sometimes, but I don't think it is of any value. When a plant is cut back, you have a healthy plant. I think 8 to 10 inches is about the best size. If you haven't that type of wood, of course, as has been mentioned here before, you can take wood even if it is three years old, if you run short.

We had a poor growing season this year so we took cuttings of one year old wood, probably two or three inches of the old wood and the rest of it new, to make the same sized cutting. Sometimes they root even quicker that way, but it is more work to make the cuttings. We try to avoid work and take new wood, not the old. If you take the old, usually it takes more space in the greenhuse, so you can't get enough in and you can't make enough money. That is one of the big reasons we don't do it.

We used to take a lot of pains making our cuttings with a knife. I guess there are a lot of Dutchmen here! You had to have a good, sharp knife to make any cutting, they said. It didn't work. It took too much time. We can't get the proper help so we prefer to take a shears. We make all our cuttings with a shears and take four or five and cut them off and stick them in the sand. You don't have to be particular about it. It all grows.

The time of the cuttings — for our purpose we root all our cuttings in the greenhouses. We don't do any other propagating. We make our cuttings the latter part of November or during December. By making cuttings at that time, I find that we do not get as much top growth. If we make our cuttings late in January or cut them in January, we find on getting them in the greenhouse, that the branches start to grow right away. There is more care to watching these soft growths that may rot or get fungus in them. By making our cuttings early, we don't have it, and it is easier to take care of. In fact, we try to cut all our material in November. I happened to talk to Jim Wells about it this morning and he was kind of surprised that we do that. We cut all the material that we can in November and from any place.

In New Jersey, I had a girl working in the greenhouse, and I had to keep her going for the month when we really weren't working there any more, so in the latter part of November I started her making taxus cuttings. She made them and put a rubber band around them and piled them up. I threw them into a bench and the second week in January we had the best stand we ever had.

We make our cuttings in the greenhouse. We use about six inches of sand over a good clean coarse gravel. I use it for the idea we have more drainage. Our benches are all made with cypress board. When they get wet the cracks close tight. We put an inch of gravel in first. If we didn't put the gravel in sometimes the bottom of the sand becomes too wet and this means the cuttings die.

This year we took all our boards out of the benches and we put 1/8 mesh hardware cloth over. I think it will be much better. I hope we find the net result will be better. We take a 1/8 inch mesh and put that over the cross boards, and I have found we have an average of about 10 degrees more heat in the center. It is much easier to take care of and you don't have to worry about moisture sticking in the bottom.

We tried out the rhododendrons and—this doesn't fit into the taxus—but we had callus two weeks earlier this year on our Drusselhuys; well over two weeks, and it used to take from five to six weeks, and I think the taxus will work out the same way.

You can always put taxus in cold frames. It is a cheap method. You don't have to build a greenhouse. We used to do it years ago once in a while and it works out well. If you have a place where you have good drainage you don't even need sash. You can put a screen over and put a little burlap on. Use a mixture of sand and peat and stick them in there. Water them down well, but keep the sun on. I have tried it. It works out well. I don't do it any more. There are some fellows here that do it in a large way and could probably tell you more than I can.

We also root taxus in the fall in cold frames. If you take them in late July or August, I do think you should take a shorter cuttings. Your cuttings are soft and by taking a long cutting it doesn't work out so well. I think a cutting 4 to 6 inches would be well. Then I would use clean sand. It prevents a soft cutting from rotting and they are less work to take care of. You can forget them.

By growing them in the fall, they root in the early spring and most of the time you can take them up. You can bed them probably in June or

July. If you plant them in the spring you have to leave them in the beds all year. You can take them up next spring and bed them. It is a very economical way of doing it. In the greenhouse we have no time for those things, so we throw everything in the greenhouse.

The use of hormones! You know, I never went to high school. I never went to college, and I am awfully dumb in chemicals. I am quite thick-headed as a Dutchman and I didn't want to try a lot of things I probably should have, but we finally got to the point we are trying chemicals and have been working with chemcials quite a while. We use it at the present time for our cuttings in the greenhouse. Hormodin No. 3 for the hard varieties or No. 2 for the varieties with brittle type soft skin. We find by using stronger strengths we burn the skin. We have bad results by using No. 3 on them, especially if you have a good growing summer and the wood is soft.

We have been trying some commercial hormones in the last couple of years. With Rootone we had no extra effect at all. I didn't like it. I think we probably didn't use the proper strength. At the time we tried it, there was only one type of Rootone and we didn't find any success with it, so we didn't use it any more.

We have been trying for the last two years commercial hormone under the name of Cut-start, which I understand comes from the West Coast. It comes in different grades: numbers 5 to 13. We have been trying Nos. 9, 11 and 13. We find that with hard-rooting varieties all three of them were a big improvement over Hormodin No. 3. With the slower varieties we couldn't see any difference, but we also tried it on "*brevifolia*" and "*intermedia*" and probably two or three other ones, and we found we got skin burns. Perhaps the powder is too strong. I don't know the strength. I don't know where it is made up.

As I said, I am not a man who knows too much about chemicals. I have always worked by the touch and go. If it worked, it worked, and if it didn't work, it was just too bad.

Last year we also used some 2, 4, 5-triphenoxy propionic acid. I didn't have very good results with it except on the baccatas which made a big improvement. On the other varieties we had more stem burn. The leaves were yellow and the needles burned. It was over-stimulation. It makes them drop off and it didn't work out too well.

This year for the first time, we tried some indolebutyric acid, one and two per cent. I don't know whether it will work out. It may be a little bit too strong, but I am not alone down there any more, so they tell me I shouldn't be so old-fashioned, I should try some new things, too. We have to give in once in a while to the younger generation. So we have! So we are trying one and two per cent IBA and I keep a good check on it, we have everything in the same medium. We have three rows. I don't know how it will work out. Maybe next year I can let you know.

To be honest, we don't need hormones for taxus cuttings. Ten or fifteen years ago we made taxus cuttings and we never had hormones. We never thought of it. It may have taken a month or two longer. For saving of time, to use hormones is important. We want to start shipping our cuttings the middle of April. If we use hormones we can do it. Some years we can't. It may be May before we can take them out. That is the advantage. It is

not necessary. You can root almost any variety without hormones; some of the active varieties such as *baccata* types we grow relatively easy as *washingtoni.* Even without hormones we can really root anyone of those in less than six weeks if we take the *baccata* variety in November or December. If it is taken in December we rarely can take them out with decent percentage until late May. We leave them there until probably June and then pot them.

In the *baccata* types of our own introduction, it is very difficult to do. It takes an average of a month longer than the other varieties, the same with *Kelseyi* which I found to be a slow rooting *T. media* var.

We have a couple of new varieties of the verticals that we introduced a few years ago. They all came out of the same lot of seeds. I can't understand why they should root differently. It is all picked out of the same seed and there are two or three varieties of these vertical types that take twice as long.

That just about covers what I have to say. I hope there are a lot of questions because, like I said in the beginning, we learn more by questions and answers.

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MODERATOR KEEN: Thank you, John.

MR. WM. FLEMER III (Princeton Nurseries, Princeton, N. J.): I would like to ask two questions. One is whether you found that variety *densiformis* is harder to root than the other types.

MR. VERMEULEN: We found it so. It takes about a month longer to have them rooted sufficiently to take up.

MR. FLEMER: The other question is, what do you think your cost of the rooted cutting is and what do you think your actual cost of a potted plant is ?

MR. VERMEULEN: I don't know.

MR. CHARLES HESS SR.: I had these cuttings made with a knife and with a shears side by side—those made with the shears took about six weeks longer to root than with the knife.

You make a mistake in taking your cuttings late in February or January, because you get top growth before you have roots. Right? Dr. Snyder tells me that you can take them as late as February providing you give them an eight-hour day, and they will make roots before they make growth. Dr. Snyder informed me of that, and it is well worth trying. If you keep them an eight-hour day, they will not come in growth.

Another thing we found is cut your cuttings early. We pull them, put them in a polyethylene bag and put moisture on them and throw them in the barn and keep the things. We had a funny thing happen. We had a bag of *Ilex crenata helleri.* We found them in May and the things rooted in the bag, so you don't need a greenhouse!

MR. VERMEULEN: We tried the same thing and we put two or three rows of cuttings in, made with the shears along with those made with the knife. I found no difference; otherwise, I wouldn't have changed.

MR. LOUIS VANDERBROOK (Vanderbrook Nursery, Manchester, Conn.): You speak of making your cuttings in November and then not

sticking them until February. Why do you delay so long ? We take all our cuttings and cut them in October and fill the greenhouses right up then, with them.

MR. VERMEULEN: I didn't say we made them in February. I said at one time we made them and couldn't stick them because the greenhouse wasn't ready. Possibly I said it in a way it wasn't meant. We try to get all our cuttings in before Christmas. We cut them in November for the reason they will not make so much top growth. The other part I learned. A question to you—an eight-hour day—what do you mean?

MR. CHARLES HESS: At Cornell, they put them under black cloth and expose them to daylight for eight hours and then put them in the dark and they have found that will keep them from growing before they root.

MODERATOR KEEN: Did you publish that, Bill?

DR. SNYDER (Cornell University): Not yet. Actually, we were trying to find out why the shoots start growing in January. We took cuttings in September, October, November and December and put them under a controlled day length of eight hour days, which is about the day length we have in December under natural conditions. We found we could hold them for four or five or six months without any appreciable amount of new top growth. But within 30 days after you move them from there to a long day of more than nine hours, they all start to grow tops. It is more complicated than it sounds, since it is tied in with cold treatment. If they have not had a cold treatment they will tend to remain dormant even under the longer days. That is why if you take cuttings earlier, they are slower to break than if taken late in December and January. If they have had cold treatment, they will respond.

There has been quite a bit of work in Holland on daylength on woody materials. I think it is something we are missing over here very decidedly.

MR. E. STROOMBEEK (Warner Nursery, Willoughby, Ohio): What is the relationship between the eight-hour day and the time and the temperature you maintain?

DR. SNYDER: The temperatures were the same under both conditions, about 70 degrees.

MR. DAN CAVANAUGH (Atwater, Ohio): What do you do with your cuttings when you put them in—do you pot them all?

MR. MARTIN VAN HOFF (Rhode Island Nurseries, Newport, R. I.): We are not selling our stock. We are probably doing them for our own use and therefore, we are not crowded for time. We are not making any deadline to get those plants out and we let the plants, whether rooted, stay there as they are. Along about the first of April we might feed them one application of liquid fertilizer so they don't show any nutrient deficiency. They are planted out in the springtime after there is no danger of frost, bedded for two years and lined out.

MR. SEBIAN: I have a few comments regarding top growth. I don't keep a uniform temperature in the greenhouse. I have my thermostat under the bench and I have aprons along the side of the bench and I keep the temperature at 70 to 75. If it gets very cold I drop it to 70, and I disregard the

greenhouse temperature completely. It may drop down to 42 or even 40; when it is zero, that variation sometimes amounts to 20 to 25 degrees between the temperature under the bench and above.

I see no difference whatever. We take our cuttings practically 100 per cent in November, stack them in cold frame, four, five, six inches high and sprinkle them and put paper over them and maybe we don't use the last of them until around the middle of December. They will keep almost indefinitely but I think that the constant uniform temperature under the bench, we have aluminum benches, but I wish we had screens, - as Mr. Vermeulen stated, you would get a rise of temperature of 8 to 10 degrees.

My results—maybe Dr. Chadwick has been there—have been pretty close to 98 per cent year after year. I consider the propagation of taxus no problem whatsoever. If anyone questions it, come over and see me.

DR. SNYDER: I would like to point out that we have one greenhouse in which we are trying to have a number of different things. We have one temperature and we have to do all our things at that. We can't devote one house to say cuttings of evergreens and keep the air temperature low if we are trying to grow plants at the same time. This was at a high air temperature. You can maintain dormancy by low temperature also.

I would like to add, regardless of whether the topes grew or did not grow that there was not a bit of difference in the rooting of those taxus cuttings taken at the different monthly periods.

MR. VERMEULEN: I expected that to be a question—what temperature we keep in the greenhouse or in the upper part of the greenhouse. We keep the upper part of the greenhouse as low as possible—40 to 50. If we can keep it to 50, I like it better than 60 or 70, but we like to keep our medium temperature at 70.

MR. LESLIE HANCOCK (Woodland Nursery, Cookesville, Ont.): We are not really greenhouse propagators but we have a greenhouse which is only heated by cable. We have no heat at all in the air.

This question of taxus growing surprises me very much. We root all our evergreens and have no problem of top growth, for the simple reason in the greenhouse the air temperature—that condensation—will frost even on the top, but we keep an absolute control of our soil temperature. It is true under such conditions people think thev get air too cold but we have one electric cable in the air and we just keep that moisture down. We never have any problem with top growth.

MODERATOR KEEN: Our next speaker is Mr. Martin Van Hof of Rhode Island Nurseries, who will speak to us on the matter of bringing these yews on for production. I visited a lot of nurseries this past summer and the establishment where he works is unique in that, if the block says *Hatfield* on the end of the row, that row had nothing but *Hatfield*. I visited a lot of Nurseries and they are mixed 19 different ways sometimes. Maybe you buy from him and get some mixed plants but I am sure it happens in the packing shed or somewhere else. My experience was that those plants in the field are in pure blocks.

Martin will tell us of the culture of taxus in the frame and field.

Mr. Van Hof presented his discussion, entitled: "The Culture of *Taxus* in Frame and Field." (Applause)

THE CULTIVATION OF TAXUS IN FRAME AND FIELD

MARTIN VAN HOF
Rhode Island Nurseries, Newport, R. I.

About the third week in May we are generally ready for planting out our well hardened taxus cuttings, also by this time all danger of frost is past.

Preparing of the soil is, of course, highly important, we at the Rhode Island Nurseries, fertilize our soil at the propagation grounds with one year old cow manure which we apply quite generously. We rotohoe the manure in with a 60" hoe with tractor and power take off, and go over this ground three times with this Rotohoe so that the manure is thoroughly mixed with the soil to a depth of at least 12". After this we proceed to erect temporary frames, 8 or 10" boards are used, and the frames are 5 ft. 10 inches wide as we use 6 foot shades. As soon as a couple of the frames are up one of our men follows this up by tilling the bed again with a 20 inch Rotohoe and of course as soon as one bed is ready two men can start planting. I say two men because our beds are only an average of 90 feet long, but, of course, more men are put to planting as the beds are ready for them.

The cuttings are lifted out of the propagating bench, the roots are trimmed back to about 3 to 4 inches to insure a heavy root system later on and to facilitate planting. Cuttings are placed in boxes 10 x 10 x 16 inches and thoroughly soaked. The reason for such small and tight boxes is that the men can handle them easily and the roots won't dry out.

We kneel right inside the frame when planting, each man having a knee pad made of burlap and stuffed with hay. A trowel is used, one man does the leading of each row, planting about half the row and then the other man takes over and finishes. We do not use a planting board as this, in our estimation, is time wasted. Soon a man is able to gauge the proper space, which we think should be 4 x 5. We all know that plants are not proud as long as they are well planted, plenty deep, as the soil will settle quite a bit after the thorough soil preparation. We generally plant the upright varieties such as *hicksi, hatfield*, etc. closer than the spreading types as the land with us at the propagation grounds is at a premium.

We keep our taxus shaded for two full growing seasons as we are plagued with a blight which attacks the plants at the surface of the ground and really will do a good job in wiping them out, it takes the top first, that is why we plant them between boards so no direct sun can strike them at any time.

The weeding is done by hand with a three pronged short handled scratcher used to loosen up the soil. Weeds at the Rhode Island Nurseries are considered "Contraband" so we try to keep the place as clean as humanly possible. This also can be done by soil treatment, as we all know, but as our propagating plant is always crowded and there are always plants or seeds waiting to be placed, we just cannot spare the time and room to wait until the gasses have worked out so we have not applied them as yet. Also certain mulches can be used to good advantage to facilitate the weed problem sugar cane etc.

At the end of the first year our taxus are trimmed. This is done early in the spring to provide for a strong liner, and as mentioned before, the shades are kept on until the end of the second growing season. All the shades and

boards are removed in the middle of September in order to enter the winter with a well hardened product. The following Spring these plants are transplanted to the fields which were prepared for two years to receive them if evergreens were grown in these particular fields. If shrubs were grown, sometimes one year of preparation is sufficient.

The preparation of the soil is as follows: One crop of winter rye and two crops of buckwheat per year and a total of 15 cords of cow manure per acre. The manure is purchased over an area of about 25 miles. In other words, if a farmer is willing to sell, the Rhode Island Nurseries is willing to buy! A tractor with front end loader and three dump trucks are used for transportation. The manure is dumped along the edge of the field and from there it is spread, usually by tractor drawn manure spreaders. We usually cover the field three times, which gives about the amount we believe necessary to grow a good plant, or to provide a good finished product.

Our two year cuttings are planted on 2-1/2 foot rows and 10 inches in the line. Before they are planted all the roots and tops are trimmed which, of course, again provides a strong root system and a compact top.

We follow the following procedure in planting: The field is staked out on each end with pointed wooden stakes 30 inches long and 30 inches apart, driven into the ground with a sledge hammer so that the ropes can be tied and stretched tight on them. Usually two lines are used and a certain number of rows left open, depending on the amount of plants of this certain variety to be planted. Working in a rotating manner we start on one end of the field. If it is a large variety, we leave a certain amount of rows open and you start that same variety say 20 lines hence and you keep on going up and coming down with the same variety until you meet. If the varieties are small two varieties are planted at the same time. The foreman always knows about how many plants there are of each kind so he can judge how many lines to keep open for each variety. They are planted in furrows opened by plow, and in our case, drawn by mules. One man handles the spade and one sets the plants in. The man with the spade sees to it that the spot where the plant is placed is deep enough and shovels some soil on the roots which the planter tramps down as he puts in the next plant. We have several teams like that on the same line, of course. Behind the planters comes the Cub tractor with a scraper on an angle between front and rear wheels, on the right side, to fill in the rest of the trench or furrow.

For convenience in transporting plants to the fields we use planting boxes 15" x 19" x 4 ft. in which the plants are packed, roots well soaked, and placed at intervals down the lines. This keeps walking to replenish the planter to a minimum. After the field has been planted the plants are tramped down to insure that no air pockets are allowed to remain. This job finished, the whole block is cultivated to take advantage of any welcome rain, and if not welcome, it loosens the ground just the same.

The weeds are kept down by cultivation and long handled scratchers, no hoes are used anymore. This is to prevent scraping of or injuring the plants. The following winter these plants are trimmed. The following year they are kept free of weeds the same way and trimmed again in July. In September of the second year they are transplanted for the last time, for at least three years, which will give us the desired 18-30" or a solid 18-24" plant.

The second transplanting is done in the same manner as described before, except that they are spaced 30 x 30". This allows for cross cultivation. The field is marked out for the check row planting, the furrows are plowed to the inside of each row to prevent the cross markings being covered.

During these three years the plants are trimmed in the winter time and the last year before maturing, with a good growing season, the spreaders are lightly trimmed with the knife in July.

As you can see it takes us seven years to produce an 18-24" taxus but at the Rhode Island Nurseries we think we have grown, with the help of nature, as good a taxus as could be grown, uniform, symmetrical and compact. Good enough so that they can be sold row run, cxeept for a few small ones and even these so called "Culls" sell readily as they have a good solid body of at least 12" x 15". In other words the plants are so well grown that, by the time the shipping season is ended, the fields are absolutely cleared off and ready to be prepared for receiving the next crop.

I hope I have convinced you that we have grown a good top and this, of course, goes hand in hand with a good root system. Naturally we have to take care of this also, and with some of the mean spoilers in that respect we have up our way, we have to do something about that. I refer of course to the insect pests.

One of the more serious pests affecting taxus with us has been the Black Vine Weevil which, if left uncontrolled, can cause untold damage in the taxus plantings.

Our first experience with this pest was back in the 20's before the modern insecticides were on the market. The old standby at that time was arsenate of lead but this was found to be merely a repellent to this particular insect. We did find, however that they were very partial to magnesium arsenate and after a year of extensive and intensive spraying we found that we were able to obtain a 100% control. A few years ago magnesium was taken off the market but by that time we had DDT which, while very effective, always presented the problem of a mite build up.

We are now using Chlordane and think this is as good as anything available; and gives a good residual deposit. It has been our experience, that spraying for control of the adult weevil is the only way in which control can be obtained. Grub proofing the soil for the larvae is very ineffectual. It is of course, the larvae feeding on the roots that causes the damage. But our approach has been that killing off the adult before egg laying takes place, is the simplest way to eliminate the larvae.

The Weevil starts emerging from the soil with us about the middle of June, depending on the weather, and after feeding for two or three weeks, start laying their eggs in the soil. During this two week period we spray all of our taxus and on the more susceptible varieties we try to make two applications. On or about the 1st of July we feel that egg laying has started and any further spraying is useless. Naturally the date of emergence and egg laying will vary in different localities, due to weather, and only through close observation can the date be determined.

It is of particular importance that an effort be made to make a very thorough coverage of the bottom branches and also the interior of each plant. With this in mind we find that the hydraulic sprayer gives much better re-

sults than the mist type machine. Merely as a preventive measure we have included the spraying of all of our taxus every year in our spray schedule and think it pays off in the long run.

We have been using Chlordane at the rate of 2 pounds per 100 gals. of water but Aldrin or Dieldrin has also been found to be very effective and no doubt some of the newer insecticides will be equally as good.

In the past two or three years scale in great numbers have been infesting our taxus and have proved most difficult to control. There are two species which work simultaneously, which in itself is of some help, in that spraying can be done for both at the same time.

These two scales are the Fletchers Scale, a dark brown hemispherical scale and the Pulvinaria scale, a white cottony egg mass. The life histories of both of these pests are similar and they both secrete a honey-dew which in turn grows a sooty mould and soon the plants appear black. If not controlled the small lice-like nymphs, if in sufficient numbers, devitalize the plant by sucking large amounts of juices leaving the plant yellow and weakened. For control it is necessary to kill the nymphs when they emerge from the egg masses and with us this means spraying the early part of July when they are most susceptible.

To date the only effective insecticide for the control of the Fletcherii is 1 quart of nicotine sulphate to 100 gallons of water with the addition of about 8 ounces of a spreader. The Pulvinaria is easily controlled with 2 pounds of DDT to 100 gallons of water.

The nicotine and DDT are compatible and one spraying should suffice but again it is very essential to make a very thorough coverage as the scale are usually found on the underside of the foliage and hard to get at unless a special effort is made to cover well. It is just this inaccessibility that makes these scale so troublesome. We hope that some of the newer insecticides will prove effective against these pests.

* * * * *

MR. HANCOK: Martin, I would like to ask whether it occurred to you that the browning is due to the sun in June? We had the same trouble and we took the same answer. We shaded two years. After introducing irrigation, the second year I found we eliminated it. One day I noticed we had lost some in the hottest corner of the ground. I examined them and they were burnt three-quarters of an inch. I pulled the plant up and it was absolutely perfect. It went on growing. In one or two June days, the sun was hitting the ground right at the surface, and the plant which was killed was one which had no branches at the surface line. The plant was not killed, if it had covering. I suggest that is not a disease but killing by sun-scorching in June.

MR. VAN HOF: We call it a blight. It is excessive heat, I suppose, that causes it. Keep the shades on, I tell you no irrigation will stop it.

MR. HANCOCK: It will if you start with a circular sprinkler at 10:00 o'clock in the morning before the sun becomes too hot. It is sun killing, I am sure.

MR. VAN HOF: All right, let it be sun killing. I will surrender on that. We licked it by accidentally leaving the shade on.

MR. VANDERBROOK: One of the new wrinkles that was advanced at our place was the thought we didn't need lath shades over these yews all the time, so the method was tried of keeping them shaded when they were first planted. This was the first year when they came out of the greenhouse, keeping them shaded until about the 15th of July, then take all the lath off. Strange as it may seem, we haven't had any burning. The lath were left off until the first of November and then we covered again.

MR. HILL: Martin, what measures have you found most effective against this serious defoliation of the cuspidata foliage?

MR. VAN HOF: A good question. You know we have for two years now had young lads from the University of Rhode Island work on that. I don't think they have come up with anything concrete.

MR. HILL: Have they assigned it to a pathological cause, a disease or have they said no, it is systemic, something in the plant, not enough water or its nutrition? Have they broken it down to that extent?

MR. VAN HOF: No, they have not.

MR. TED WOLF (Cleveland): I just had a little experience with *brevifolia*, trying to solve the problem, and was only partly successful; but taking the cuttings in December, early December, for a few years and have them all defoliate and get into real trouble. I did step the time up and found, in this section, taking the cuttings either late October or early in November at didn't rot andthat you get a pretty good stand. They got rooted. Wh spoil at least came out with a pretty decent yield.

MODERATOR KEEN: There seem to be variations in *nana* or "*brevifolia*" strains. Some seem to hold their foliage and others in the same row will be defoliated, so there are some differences there.

MR. HILL: Perhaps a little further information of benefit. My question was to deal principally not with cuttings but more with the field culture of plants whereby we had some rather large plants which were well established. I don't think they were of your origin, I think they were of our own. In the summer of '53 and summer of '54 those plants displayed very definite defoliation along in early June when the plant would lose, in a period of two or three days, 70 per cent of its foliage. We were completely unable to assign any cause for that problem. I simply wondered if Martin with his long experience had found anything.

MODERATOR KEEN: Did you observe that the internal part of that leaf had little brown corky areas, or a resinous area, just in dots in localized areas with no pattern?

MR. HILL: No more than plants immediately adjacent that did not defoliate. It was not the entire block but just plants within the block.

MR. deWILDE: We found that if you use concentrated lime sulphur dormant spray that that helped considerably. We used 12 gallons of concentrated lime sulphur solution to 100 gallons of water and put on with the hydraulic sprayer and after a few years we stopped having that trouble.

MR. HESS, SR.: What time?

MR. deWILDE: In February. If you were going to use the cutting pretty soon, I would do it two or three weeks before taking the cutting. You run into trouble sometimes with the lime sulphur causing burning in the bench. It pays to wash the cutting off with a solution of water. That is found to be fairly effective.

MR. VAN HOF: You know it is strange but it is generally the year after the transplanting of *T. cuspidata* that we get it. Then the following year most of them grow out of that and they are really nice, compact plants again. But the trouble is, we ship them and our customer has the same trouble again. So what it is, we don't know. As I said, they will work on it and some day they will come up with the answer, no question about it.

MODERATOR KEEN: I saw mature specimens at some nurseries, out by themselves, that just let go suddenly last year, and the ground was covered with needles beneath them.

MR. WELLS: Do you find *densiformus* difficult to root, as was reported earlier?

MR. VAN HOF: No, we don't.

MR. WELLS: We don't either. We find it one of the easiest and the most vigorous rooters of any. I wonder if there aren't two strains.

MR. FILLMORE (Fillmore's Valley Nursery, Centreville, Nova Scotia): I have been wondering, regarding the application of manure as the last operation after you have disposed of your cover crops, it strikes me that you are introducing a lot of weed seeds which you might have done away with had you used at least part of that manure on your cover crop.

MR. VAN HOF: My answer to this is no. I will tell you why. We might have put the manure in at the end of the first year, yet you will bring it up or mix it up with the soil. Now, I haven't found a way yet of getting the weeds in so deep that they wouldn't come back any more. I don't think anybody has so far, so I don't think your problems of cultivating more weeds is on account of the application with manure; the seeds are just in the ground and you bring just a few more in there.

MR. FILLMORE: My suggestion was a large proportion of your weed seeds would have germinated and perhaps almost be a failure as plants while so heavy a crop of probably buckwheat or rye was on the surface, and in that way, finally you wouldn't get so many weeds. Also, the manure would have encouraged, I believe, a much heavier growth of cover crop to turn down.

MR. VAN HOF: The green crop will bring in our humus again and, of course, we are just not interested. We want humus. How much do we take off?

MR. HESS: Two inches a year.

MR. VAN HOF: It takes a lifetime to put one inch back. By bringing that green crop right in there, we build up the humus and at the end of the final thing, before all the manure has deteriorated, we bring in the manure and work it thoroughly because it is going to feed those plants for three long years. I hope this answers your questions.

MR. A. M. SHAMMARELLO (South Euclid, Ohio): How many crops have you raised on the same land?

MR. VAN HOF: My bosses' father was growing nursery stock on that land 20 years before I came there and I have been there 31 years.

MR. SHAMMARELLO: You still have topsoil?

MR. VAN HOF: We still have topsoil left. It is by bringing in the green crops all the time. Jack Hill has been there several times. Several people here have been through our place. The propagating place, one part of it is 58 years old. We just put in and take out.

MR. LOWENFELS: I am surprised somebody hasn't brought this up. In the town where I live, the town collects leaves and I happen to be in right with the street cleaners and such, and they leave leaves at my place, and in a year I have fine soil. Isn't that of benefit? Why isn't it done more? It is like adding soil.

MODERATOR KEEN: It is a source in some places.

MR. JIM ILGENFRITZ (Ilgenfritz Nurseries, Monroe, Michigan): I would just like to add another note of confusion to this transplanting business that Martin is talking about. At Monroe, Michigan, across the lake from here, we take those little cuttings out of the greenhouse bench and we treat the field in the hot sun the latter part of June or early part of July and we plant in 28-inch rows, and we water very carefully. We don't do this carelessly. We do it carefully. We don't put any shade on whatever and those plants never see a pot. They never see any shading and I think we get growth comparable to what Martin has shown us. The reason I mention it is because I think all of us have learned from our grandfathers that we had to shade these tender little plants, but I don't believe we do.

MODERATOR KEEN: We, each of us, live in a different spot too! them not with Wiltpruf but with Plantect and we take them right out into

MR. VAN HOF: You know we haven't the room to put them in rows.

MR. ILGENFRITZ: Four inches in a row?

MR. VAN HOF: We couldn't do it, then, because we give them four inches each way!

MODERATOR KEEN: It is too bad to break off this discussion but we have to get back here.

PRESIDENT CHADWICK: Thanks to all the speakers on the panel this morning. I think we have had some very good information. Certainly there has been a free exchange of information about *Taxus* propagation and planting.

The session recessed at 12:00 o'clock . . .

RECESSED.

Round Table on Mist Propagation

FRIDAY AFTERNOON SESSION

December 3, 1954

The session convened at 1:55 o'clock, President Chadwick calling the meeting to order.

PRESIDENT CHADWICK: Those of you that have attended the meetings of this organization the last two or three years certainly are aware of the fact there has been as much interest expressed in humidity and mist propagation as any one single phase of the subject. Knowing that was true, Dick Fillmore decided to give the matter of mist propagation a thorough work-out on the program this year. I imagine that this session this afternoon is going to bring out more questions and comments perhaps than any session we will have the entire afternoon.

This afternoon Dr. Snyder of Cornell University is going to moderate this panel on mist propagation, and at this time I want to turn the session over to Dr. Snyder.

Dr. Snyder took the chair.

Dr. Snyder presented his paper entitled "Possibilities with Mist Propagations". (Applause)

POSSIBILITIES WITH MIST PROPAGATION

WILLIAM E. SNYDER
Cornell University, Ithaca, New York

Many standard horticultural procedures have developed as the result of years of practical experience. In more recent years, some of these standard horticultural procedures have been found to be unjustifiable on the basis of research and of practical trials, but many have been found to be completely justifiable practices.

The plant propagator has long realized that the maintenance of the turgidity of a cutting is essential for rapid and successful rooting. Thus many standard horticultural procedures are followed which are aimed to minimize the loss of water from cuttings. Some of these well known practices are:

1) Collection of the cutting wood in the early morning when the tissues are fully turgid,
2) Protection of the cutting wood from bright sunlight and from warm, dry wind
3) Covering the wood with moist burlap or, in some instances, inserting the base of the cuttings in an inch or two of water
4) Making the cuttings as rapidly as possible and inserting them in the rooting medium soon after being made
5) Thoroughly watering-in the cuttings and frequent syringing the tops until the cuttings have rooted

6) Shading the cuttings in various ways from bright sunlight
7) The use of special structure or facilities, such as double-glass, bell-jars, specially constructed cases, etc.

The excellent discussions of the use of polyethylene frames by Mr. Roger Coggeshall (2) as well as the specialized technique described by Mr. Leslie Hancock (10) at the Third Annual Meeting of this group serve to illustrate the necessity of employing these standard horticultural procedures to propagation schedules and to illustrate the highly successful adaption of special structures and methods.

In the past fifteen years, and especially since 1946, the nurseryman and the experimental plant propagator have become interested in mechanical and automatic methods of preventing or reducing transpiration—the loss of water from leaves—from cuttings in the propagation bench. Basically these new methods fall into two categories—humidification and mist. Because of certain similarities in appearance and in apparatus, these two methods frequently are confused and in some instances these two terms are considered to be synonymous. However, the humidification and mist techniques are different and should remain distinct in our thinking.

Before considering these two propagation techniques, it might be wise to briefly review the process of transpiration.

An examination of a thin section cut across the leaf shows that there is an outer layer of cells surrounding the entire leaf. This layer is known as the epidermis and in turn, it is covered on the outside by a layer of waxy material known as the cuticle. The cuticle is relatively impervious to water. Scattered throughout the epidermis are pairs of slightly different cells, called guard cells. These cells resemble elongated balloons and when filled with water, i. e. turgid, separate in the center, thereby causing an opening in the epidermis. These openings are known as stomata. When the guard cells lose water, the cells become flacid and collapse and thereby close the opening. Characteristically most plants possess guard cells and stomata on the lower surface of the leaf, however some plants have them on both surfaces, or in some cases only the upper surface.

Immediately below the upper epidermis is a row of elongated cells. These resemble the logs used in the stockades of times past and are called palisade cells. Immediately below the palisade cells is an area of cells in which there are large air spaces between the cells. It is called the spongy parenchyma because it resembles the structure of a sponge.

Water from the cells of the spongy tissue evaporates into the air spaces. As more water evaporates the air of these passages gradually becomes saturated with moisture.

If the air immediately surrounding the leaf is "drier", water vapor passes from the air spaces inside the leaf through the stomata to the outside.

Actually water vapor passes from the leaf to the outside because the water vapor pressure is greater on the inside of the leaf than on the outside. When the stomata are open, the rate of transpiration depends upon the difference in the vapor pressure inside and outside—and the greater the difference the more rapid the rate of transpiration. (In this discussion it has been assumed that there is a greater vapor pressure inside than outside, however, sometimes the reverse is true.)

Humidification can be described as any method used to increase or to maintain a given level of relative humidity in the atmosphere. As it relates to plant propagation, humidification is based on the concept that with increased relative humditiy there is an increase in the vapor pressure of the atmosphere, and consequently a decrease in the difference between the water vapor pressure inside and outside the leaf. In this manner, then, the rate of transpiration is reduced. Actually at the same temperature, a cutting will transpire more at a relative humidity of 60% than 95%. However at the same relative humidity, a cutting will transpire more at 80 degrees F. than at 60 degrees F. This is because there is a direct relationship between the water vapor pressure and the temperature. Actually a plant or a cutting can lose water through transpiration even though the atmosphere is saturated, i. e. 100% relative humidity.

In practice, humidification may be very beneficial in reducing water loss from cuttings, but it is actually not as effective as one might think at first. In the actual operation of a humidification system, the leaves of those cuttings immediately near the apparatus may actually become covered with a thin film of water, but those removed from the apparatus are not so covered.

Mist propagation involves the use of apparatus which disperses fine droplets or particles of water in such a manner that the surface of leaves and stems are covered with a thin film of water. In practice, the relative humidity of the air immediately surrounding the cuttings is markedly higher, however the important thing is that the leaf surfaces are covered with water. Water evaporates from the surface film to the atmosphere, but little or no water is lost from the leaf tissue.

The application of mist functions also to reduce the temperatures of the leaf tissues and consequently lower the vapor pressure in the air spaces and there is a reduction in the loss of water from the cells.

Our main concern, this afternoon, is neither the mechanics of transpiration nor a comparison of the relative merits of humidification and mist. Instead, we are concerned with the possibilities of the use of mist technique in various propagation procedures, specifically as related to the rooting of cuttings.

Introduction of the mist technique in scientific literature was by Raines in 1940 and 1941 (17, 18) and in the trade literature by Gardner (8) and by Fisher (6, 7) in 1941. The timing on these reports indicate a simultaneous development of the concept by these men. In a paper published in 1951, Evans (4) refers to the use of mist in 1936 by Spencer in unsuccessful attempts to root cuttings of cacao. Although some additional reports were published prior to 1946, the rapid development of the mist technique can be laid directly to the early work of O'Rourke (15, 16) at Michigan State College, of Watkins (20) at the University of Florida, and to the enthusiastic and energetic endeavors by the first president of this Society, Mr. James S. Wells (21-27). Between 1940 and 1949 there were only about eight publications concerned with mist propagation, but in the past five years the number of papers has been more than double this number.

Basically the mist technique can be described as mechanical and controlled syringing. It is simple and inexpensive to construct and the operation of the apparatus is easy. The danger lies not in the apparatus, but in the plant propagator—the way he uses the apparatus and handles the plant material after rooting has occurred.

Fundamentally the apparatus consists of water pipes to which nozzles are attached at various intervals and a shut-off valve which can be operated either manually or automatically. Mist apparatus are of two basic types:

1) the over-head system in which the pipes and nozzles are suspended over the propagation bench
2) the in-bed system in which the pipe is on or below the propagation bed and the nozzles are located on up-right pipes.

Most over-head systems have a single line of nozzles located over the center of the bed (as was shown in the first illustration), however a double line may be used in which case the lines are located along each side of the bed (13). The in-bed system is advantageous in that no support is necessary for the feeder line and because dripping of water, which may occur during periods when the nozzles are not in operation, will run down the upright pipes rather than drip onto the cuttings. Use of the in-bed system does not reduce the number of cuttings which can be placed in the propagation bed.

The type of nozzle to be used is an important consideration. An ideal nozzle for universal use may never be a reality, but important considerations for the selection of the nozzle include:

1. efficient operation at the water pressure available. Nozzles are now available which can be used effectively at low water pressure (20 lbs.) as well as at higher pressures (80 lbs. or more).
2. delivery of a small amount of water. Under most conditions, the actual amount of water necessary to maintain the film of water on the tissue is exceedingly small.
3. coverage of as large an area as possible with a uniform distribution of mist. A nozzle which would deliver a rectangular rather than a circular pattern would be ideal, but the mechanics is such that nozzles which have a rectangular pattern also have a center which is devoid of mist.
4. so constructed or have devices included which prevent clogging of the aperature. Screens and self-cleaning devices are employed in some types of nozzles. Use of copper tubing is also helpful.
5. it should be of simple operation and easy to maintain.
6. capable of being turned off individually, thereby permitting work in one part of the bench without either turning off the entire system or of getting the worker wet.
7. last, and by no means least, it should be inexpensive.

Nozzles used in mist operations are of three basic designs:

1) oil burner nozzles
2) self-cleaning nozzles
3) deflection nozzles

The oil burner nozzle was first used by nurserymen and is still in use by many nurserymen. Water is broken into fine droplets by passing through very small grooves set at an angle to each other. This nozzle delivers a small quantity of water (7 quarts to 3 gal./hour), produces an even distribution of the mist, and is inexpensive. Disadvantages are that it frequently cloggs,

even though a screen is employed, the mist is easily blown away, and there is considerable dripping in the over-head system when the mist is shut off.

The self-cleaning nozzle also depends on fine grooves to form the mist. It differs from the oil burner type primarily in having a spring loaded pin which cleans the aperature each time the nozzle shuts off. Although there is less dripping with this type of nozzle than with the oil burner type, there is still enough dripping to make the nozzle unsatisfactory when used over-head. Nozzles of this type deliver about 7 quarts per hour. The main disadvantage, however, is the cost.

With the third type of nozzle, the deflection type, a fine stream of water is emitted through a relatively larger aperature. The mist is produced when the stream of water hits a flat surface. Templeton (19) uses a nozzle of this type in the "Phytotector" method of rooting cuttings. Since the aperature and the resulting stream of water are relatively larger, there is less chance of clogging. Most nozzles of this type also have a screen incorporated into the nozzle to further reduce the possibilities of clogging. The area of bench covered by the mist from the deflection type nozzle is considerably larger than that covered by the oil burner nozzle. The cost of the deflection nozzles is more than the oil burner type, but considerably less than the cost of those of the self-cleaning type.

Considering the area of coverage and consequently the number of nozzles required, the cost is about comparable for the oil-burner and the deflection types. Cost for self-cleaning nozzles would be considerably more. One disadvantage of the deflection type nozzle is the quantity of water used (six gallons per hour at 20 lbs. water pressure). If interrupted mist rather than continuous mist is used, the disadvantage of the delviery of the larger volume of water is largely avoided.

With regard to mist propagation, a question frequently raised is "How long should the mist be on?" Most of the published work about mist is concerned with the use of continuous mist, either during daylight hours or on a 24-hour basis (4, 6, 8, 15, 17, 20, 21-27) but more recently the use of interrupted mist has been advocated (5, 11, 12, 13, 19).

It will be recalled that the basic concern with mist propagation is to keep the surfaces of the leaves covered with a film of water at least during those periods when the cutting is apt to be transpiring rapidly. Consequently it would be expedient to use only enough water to maintain this film continuously, and additional water would be unnecessary. As will be discussed in the next paper, the use of excess water not only is unnecessary but actually may be harmful by lowering the temperature of the rooting medium to such a level that rooting is impaired. Under continuous mist systems, the temperature of the rooting medium may be maintained at an optimum level by the use of electric heating cable or other means of supplying bottom heat. Less practical would be the use of heated water.

If the principle of interrupted mist is acknowledged to be valid, then, the next consideration is the method of operating an interrupted system. The most obvious method is the manual operation of the mist by an individual. However this is really nothing more than an elaborate hose-syringe system and involves the judgement of the operator. It must be born in mind that serious damage can result if the leaf surfaces are allowed to become dry during the

rooting period, especially on hot, sunny days. Actually if the leaves are dry for as little as ten minutes on a hot summer day, softwood cuttings may be a total loss.

The value of the mechanical mist system lies in the fact, as so often stated by Mr. Templeton, that the mechanical apparatus is a better judge of when the mist is needed than is man.

Mechanical operation of interrupted mist can be accomplished by timer mechanisms, by electric eyes (solar control), by humidistatis, by season clocks, and by electronic control.

Timer mechanisms have been described by Hess and Snyder (12) and by Langhans (13). The timer mechanism described by Hess and Snyder at the previous meeting of the Society, outlined the steps in the construction of the timer and involves a single clock mechanism with disks attached to concentric shafts. One disk operates on a 24-hour cycle and serves to regulate the daily cyclic application of mist, for example from 6 a.m. until 7 p.m. The second regulates the specific periods the mist is "on" and "off", for example 30 seconds "on" and three minutes "off". Langhan's timer control involves two separate time clocks which perform the same operations described above. These are available from commercial sources.

A solar control mechanism has been developed and is being tried by Langhans and Petersen as a means of regulating interrupted mist for the propagation and growing of florist crops. The apparatus is basically a photoelectric cell. When a given quantity of light has accumulated since the last period of mist, the photoelectric cell control unit activates a timer which permits a short period of mist. Whether or not this system will prove feasible remains to be seen.

Templeton (19) employes a humidistat to control the period during which the time clock controlled mist is on. Thus, if the humidity drops below a given level, the time mechanism is activated to produce the interrupted mist. When the humidity rises above this given level, the timer mechanism is turned off.

Still another method of controlling the daily beginning and ending of the interrupted mist involves a time mechanism utilizing cams which supposedly take into consideration the changes in day-length during the year. This apparatus also is available commercially.

During the past year, an electronic leaf was developed by Mr. Charles E. Hess, a graduate student at Cornell University, and was used very effectively for controlling the mist operation. The electronic leaf consists of a small rectangle of plastic about one inch long and 1/2 inch wide. Two carbon points are inserted in the plastic and a wire leads from each point to the Thyraton tube control unit. An electric current passes between the contact points when there is a film of water on the "leaf" and the control mechanism causes the solenoid valve to remain closed. However as soon as there is a break in the "leaf current", the control mechanism causes the solenoid to open and the mist starts. When sufficient moisture has collected on the "leaf" surface to enable the circuit to be completed, the solenoid again becomes closed. In actual operation it has been found that the film of water on the "leaf" surface actually dries more rapidly than does the water film on the leaves of the cuttings The "on" period for the mist varies from a minimum of three or four seconds to a maximum of about twenty seconds.

Advantages of the electronic leaf control mechanism for mist propagation include:

1) it is weather sensitive—factors which effect the rate of transpiration from cuttings also effect the evaporation of water from the electronic leaf.

2) it operates on a continuous basis—thus for outside bed propagation, the electronic leaf will operate day and night, thereby affording automatic protection on a 24 hour basis.

3) it requires a minimum of water but affords maximum protection.

4) it is relatively easily constructed (and is now available at a price less than that of many time clock controls).

Several experimental mist systems have been established in one of the greenhouses at Cornell University and recently, a comparison has been made of the operation of several methods of controlling the mist. An examination of the data in Table 1 shows that there is about ten times more water used by the time-clock controlled interrupted mist system than by the electronic leaf system, and that with the continuous mist system more than 500 times more water is used. It is also apparent that if the propagation bench is closed, the electronic system not only uses less water, about one-fourth as much, but operates significantly fewer times per hour regardless of whether the day is cloudy or not.

A course grade of sand has generally been used with the various mist systems (5, 6, 7, 9, 18, 15, 21-27), however in some instances sand and peat mixtures are employed (11, 21-27). Templeton (19) actually roots cuttings in the soil. Water-logging of the medium may be a problem if fine sand is used or if provision is not made for removal of excess water in outside beds. However, with normal soil drainage and if short intervals of mist are used, water-logging probably will not be a serious factor.

Several reports indicate, as will be illustrated later, that use of root-inducing chemicals are as beneficial to cuttings rooted under mist as to those rooted in standard ways (5, 8, 11, 21, 24, 25, 26).

Another question which is almost invariably raised concerns the problems of disease and insects in relation to mist propagation. Gardner in 1941 (8), and most authors since, have written that disease and insect problems are negligible. Langhans (13) has reported that mildew and leaf spot are not problems with Better Times roses grown under mist. However, plants with a systemic disease are apt to show signs of the disease faster under mist conditions.

Timing, or the selection of cutting wood in the best condition, is still an important factor. Gardner (8) states that the five species which failed to root under the mist the first season were successfully rooted the second. He attributed the latter success to proper timing. Wells (22, 25, 26) has also stressed timing, especially in reference to rhododendrons.

Mist propagation is not without its problems and even the most staunch advocate of the use of mist would surely caution the beginner to start slowly and to gain some experience before employing mist for the rooting of all cuttings.

One problem relates to a point raised by Mr. Ilgenfritz at the annual business meeting last year. Once the cuttings are rooted—how are they han-

TABLE 1. A Comparison of frequence of mist operation and Delivery of water for several mist systems

Measurement	Weather Condition	Continuous Mist Open Bed	Interrupted Mist		
			Timer Operated Open Bed 1 min on - 9 off	Open Bed Electronic Mist	Closed Case Electronic Mist
Delivery (qts/sq ft/hr)	Cloudy (700 f.c. light)	1.9	.3	.04	.01
	Sunny (5000 f.c.)	1.9	.3	.05	.02
Frequency (Mist Operations /hr)	Cloudy (700 f.c.)	Continuous	6	5	5
	Sunny (5000 f.c.)	Continuous	6	5	1

dled? Even the most novice of us recognize that cuttings under mist—regardless of whether they were rooted under glass or in open beds—cannot withstand an abrupt shift from the mist.

One procedure is to pot the cuttings and to return them to the mist bench. The potted plants are then hardened by gradually decreasing the period of exposure to mist. In some instances this has been quite satisfactory but in others the results have been most disappointing.

A simpler method is to leave the rooted cuttings in the bench under the mist until maximum rooting has been obtained. The cuttings are then hardened by a gradual decrease in the mist periods until they are capable of withstanding the more severe conditions of the greenhouse or outside planting. In most instances there is little or no harm from allowing the rooted cuttings to remain from some period under the mist. In some areas cuttings, rooted in outside beds, may be left in place over-winter, and some nurserymen are experimenting with the storage of rooted cuttings until the spring planting season. With regard to hardening the cuttings, the value of a nozzle which can be turned off can readily be appreciated.

Another problem, which apparently is rather serious with certain plants, is leaching of the cutting. It is obvious that the more water that is sprayed on the cuttings, the more leaching will occur. Evans (4) reported that with cacao cuttings under conditions of continuous mist and 33 to 100% full sunlight there was a slow breakdown of the chlorophyll resulting in a yellowish green appearance. If the cuttings were shaded so that 20% full sunlight reached the leaves, there is no destruction of the chlorophyll and rooting was not impaired. Analysis of the leaf tissue of cacao cuttings showed that leaching of nitrates and phosphates occurred primarily during the first two weeks, but that potassium was continuously leached from the tissue. Under mist conditions, the new growth of *Taxus* cuttings is also yellowish-green in appearance. The most severe leaching occurred under continuous mist, the least under the electronic leaf mist system. With *Taxus*, the discoloration appears in the new growth and occurs regardless of whether the cuttings were made in the summer or the winter.

It would hardly be appropriate to conclude this discussion without considering the responses of some plants. The list of plants which have been successfully rooted with mist propagation is constantly growing. Until the report of the Field Trial Committee is made available, the best sources of information are the references cited in this discussion.

Although generalizations are frequently dangerous, it is fairly safe to state that easily rooted plants root quicker under mist, more difficult-to-root plants also root more quickly and the strike is frequently greater under mist conditions, many difficult to root plants can be rooted with relative ease under mist, but that many "non-rooting" plants do not root with any greater success under mist than under the standard methods.

At this time, it would perhaps be wise to briefly consider some of the results obtained during the past year in experimental work. All results are based on multiple lots of cuttings and the illustrative material was selected to represent the average response.

In late January and early February, cuttings were made of a variety of narrow-leafed evergreens. The cutting wood was very hard and dormant and

somewhat better results might be expected with cuttings made a month or so earlier. Representative groups were placed in open benches or under interrupted mist of the overhead type. The open bench cuttings were syringed numerous times each day and shaded from bright sunlight. The interrupted mist was operated from 8 a.m. to 6 p.m. and was controlled by a time clock. The cycles were one minute of mist and four minutes without mist. (See Table 2).

Taxus media Hicksii (165 days) represents plants in which there is little difference between the two methods. New growth of the cuttings under mist showed considerable loss of green color.

Juniprus chinensis Pfitzeriana (123 days) represents plants in which mist is of marked benefit in the rooting response—number of cuttings rooting, average number of roots, and length of roots.

Thuja occidentalis elegantissima (98 days) — another illustration of plants in which the rooting response is markedly benefited by the mist. The use of root-promoting materials show corresponding beneficial effects regardless of whether mist is used or not. (Table 3).

TABLE 2. Comparison of the Rooting of narrow-leaf Evergreens in Open-bench and under interrupted mist

Species	Number of Days	Measurement	Open Bench	Interrupted Mist
Taxus media Hicksi	98	% Rooting	1	47
		Ave. No. Roots	1.5	2.6
		Ave. Length	4.8	7.8
Juniperus chinensis pfitzeriana	123	% Rooting	99	98
		Ave. No. Roots	15.3	15.8
		Ave. Length	4.1	4.5
Thuja occidentalis elegantissima	98	% Rooting	1	41
		Ave. No. Roots	4 0	18.9
		Ave. Length	.4	2.6

TABLE 3. Percent rooting of cuttings of *Thuja occidentalis elegantissima* rooted in open-bench and under interrupted mist and treated with root-inducing chemicals. Time in bench: 98 days.

Rooting Condition	No Treatment	Talc Only	Rootone	NAA 2%	Hormodin No. 2	Geige 2%
Open Bench	1	1	11	7	4	0
Interrupted Mist	41	56	71	60	51	71

Other evergreens tested included *Juniperus chinesis Sargentii, J. horizontalis plumosa, Taxus baccata repandens, Chamaecyparis obtusa,* and *C. Lawsoniana.*

A more extensive set-up, made for the summer experimental work, included the following:

1. A wardian case
2. Constant mist (sunrise to sunset)
   open bench
3. Constant mist (sunrise to sunset)
   closed case
4. Interrupted mist—electronic leaf control.
5. Interrupted mist—time clock controlled
   cycles, one minute on, four minutes off
6. Outside bed—continuous mist first three weeks to interrupted mist
   (one minute on, 4 minutes off)

Narrow-leaf evergreens can be rooted during the summer (Table 4). Both Pfitzer's juniper and the spreading yew rooted well under mist, poorly in the wardian case. Again there was leaching of the soft new growth of the yew.

An easily rooted softwood cutting is *Forsythia intermedia spectabilis* cv. Spring Glory (Table 4). Rooting of the cuttings in the outside beds was somewhat poorer than those under glass. Temperature as recorded by maximum-minimum thermometers indicate that there were many nights during which the minimum temperature was below 60 degrees F. and a few nights below 50 degrees F. It is considered probable that the low temperature account for the reduced rooting. Based on the number and length of roots, the wardian case, the time-interrupted mist, and continuous mist open bench resulted in poor rooting. As will be discussed in the next paper, it is believed that one of the most important factors involved in this retardation is temperature.

Weigela Eva Rathke (31 days) — the rooting response was poorest in the wardian case. Best rooting occurred under conditions of continuous mist —closed case. The electronic mist—open bench was superior to either of the other open bench mist conditions. Use of root-inducing chemicals had a slight beneficial effect and tended to reduce somewhat the variation between the different mist conditions.

An interesting and significant difference between the wardian case method of rooting cuttings and the mist method is shown by *Prunus serrulata* (32 days). There is a significant difference between the two treatments in regards to the strike:—the mist treatment resulting in 87% rooting and the wardian case in only 37%. Almost half of the cuttings in the wardian case lost their leaves within the first week and subsequently died. In striking contrast no cuttings under the mist lost any leaves.

It has been the purpose of this paper to review the mechanics of the mist techniques for rooting cuttings by bringing together the various ideas and concepts of various writers on the subject and to present some hitherto unpublished work. In the paper which will follow, an examination will be made of some of the environmental factors which can account for the differences frequently encountered between standard methods of rooting cuttings and the use of mist.

TABLE 4. Comparison of the rooting of Softwood Cuttings (July, 1954) in Wardian Case and under various types of mist

Species	No. of Days	Measurement	Wardian Case	Constant Mist Closed Case	Electronic Controlled Mist	Interrupted Mist 1 min. on 4 off	Constant Mist Open Bench	Outside Mist-bed
Forsythia	21	% Rooting	97	100	100	100	97	87
		Ave. No. Roots	13.3	19.8	19.2	16.9	17.0	14.3
		Ave. Length	1.8	5.5	4.5	4.3	3.8	1.7
Weigela Eva Rathke No treatment	31	% Rooting	79	97	89	83	85	
		Ave. No. Roots	3.8	9.4	6.8	6.8	5.7	
		Ave. Length	2.4	4.9	3.4	3.5	3.5	
Hormodin 1	31	% Rooting	88	100	100	97	97	
		Ave. No. Roots	5.5	12.3	7.8	8.3	7.1	
		Ave. Length	3.6	7.4	6.1	5.5	6.3	
Prunus serrulata	32	% Rooting	37			87		
		Ave. No. Roots	6.0			8.1		
		Ave. Length	1.9			2.5		
Pfitzer's Juniper	79	% Rooting	2	80	66	94	90	
		Ave. No Roots	0.2	3.1	2.0	1.9	3.2	
Taxus	81	% Rooting	12	58	78	74	78	
		Ave. No. Roots	1.5	2.7	4.0	3.1	4.6	

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MR. SEBIAN (M. P. Sebian Nursery, Painesville, Ohio): Does the mist system reduce the temperature to any extent, say on very hot days during August and September, inside the greenhouse?

MODERATOR SNYDER: Very definitely, but let's defer a discussion of this until after Charlie Hess' talk, if you don't mind.

MR. ROGER PEASE (West Va. University, Morgantown, W. Va.): I have been interested in closed cold frame for about four years except I haven't intermittent mist. I put it on in the morning and off at night. Two things you mentioned, one of which will operate; the other I think may be dangerous. You certainly do get where you have the cuttings in there a long time, waterlogging, where the sides are enlarged. You lose cuttings from that excess water even if you have adequate drainage. Again, from that excess of water from the constant mist from morning to evening on cuttings of serrulata and rhododendrons and chestnuts, I lost a few because I got water. Secondly, if you have boxes put in at different times and you want to harden them off and put in a frame the way I have to do, you may lose very definitely the first batch because I think there would be the reason, because you are keeping it in there so long you get a root system so big and a little growth. It is in sand. You don't feed it, so it ups and dies.

MODERATOR SNYDER: That is outside. Actually, my remarks should apply primarily to material to be used in the greenhouse.

MR. CASE HOOGENDOORN (Hoogendoorn Nursery, Newport R. I.): That Weigela Eva Rathke you showed there—do you leave the tips out or leave the tips in?

MODERATOR SNYDER: Those were short cuttings taken from what we call milk soft. Actually just the tips were used.

MR. ROSCOE FILLMORE (Fillmore's Valley Nursery, Centreville, N. J.): Under the mist, the philadelphus dropped its leaves within about two weeks. They were practically defoliated, a very large percentage being rooted but there was no growth. We only used two inches of sand and the rooting would take place in the lower layer. Remember, we had a fairly good soil, so on most of the cuttings that we put in the frame, as soon as they were rooted they began to grow, but the Philadelphus of all the varieties we stuck got their foliage and failed to make any growth.

I understand that the growth of fungus is almost inhibited under the mist. It appeared to me that the tissues of the leaves were simply broken down from too much water.

MODERATOR SNYDER: I think that is quite probable.

MR. JOHN B. ROLIER (Verhalen Nursery Co., Scottsville, Texas): I ran into the same trouble with one of the viburnums under continuous mist from 6:30 a.m. to 5:30 p.m. They defoliated and had a ball of roots on them, like that. The eyes were plump but like Fillmore's plants, they started to shoot up from the bottom and never yet have they broken out on the top. Those plants were potted off the first of August. I believe Mr. Watkins in Florida advocates the cuttings should be removed from the mist when the root becomes a quarter of an inch long.

MODERATOR SNYDER: I think he does. We haven't seen any harmful effect from leaving a wide variety of cuttings under the mist with this possible exception of a leaching or yellowing of taxus.

If there are no other questions, let's go on to the second half of this topic, which Charlie and I have divided, in which an explanation will be made of why some of these differences have been encountered. Actual measurements have been made of many of the environmental factors which will substantiate or will explain these differences. Charles Hess Jr. is a graduate student at Cornell and is the holder of the Newark (N. Y.) Commercial Enterprises Fellowship in Nursery Research. His background is the nursery business and I am certain that you will enjoy his remarks.

Mr. Charles Hess Jr. presented his paper entitled "Factors Influencing Propagation under Mist." (Applause)

FACTORS INFLUENCING PROPAGATION UNDER MIST

CHARLES E. HESS
Cornell University, Ithaca, New York

At this point I feel we are faced with a problem. Almost every report concerning mist propagation reveals outstanding results, results far and above those obtained from other methods of propagating cuttings. Just what can account for these results? Let us start when we first make a cutting and trace the events which follow and see if we can find some of the reasons why mist propagation can be expected to give outstanding results.

The first factor to consider is that when we make a cutting, the most important thing we leave behind is the water supply. Almost all of the water the cutting uses during the propagation period must come through the small cut area on the base of the cutting; a very small area when compared with the extensive root system that supplied the twig before it was cut.

If we are so concerned with the water supply, just where does the loss of water take place ? The great bulk of the water used by the cutting is lost through rhe leaves. On the under side of a leaf there are thousands of small holes, sometimes referred to as "breathing pores". These pores are the doorways to cavities within the leaf where gas exchange takes place, similar to our lungs. All the cells lining the cavity are covered by a film of water. This film is maintained by water which diffuses from within the cell. The cell water is replaced by water from small veins. The demand for water is passed from the small veins to the larger veins, from the leaf to the stem, and eventually to the roots. But a cutting has no roots. If the rate of water loss from the leaves of a cutting is not cut down from what it was on the parent plant, water will be lost at a rate greater than it can be replaced. As more and more water is drawn from the cells, a point is reached where the cells start to collapse, and the leaf wilts. The point to be made here is that the most important job of the propagator is to control water loss.

There are two basic ways in which water loss can be controlled. The first, is to build up the water vapor in the air so that it approaches the water vapor content within the cavities of the leaf. Then there is a tendency for the water to enter the leaves as fast as it goes out. This method is the one that is in general use today, double glass and polyethylene tents are examples.

The second way water loss can be controlled is to cool the leaf. In so doing we decrease the activity of the water vapor within the leaf and actually decrease the amount of water lost.. Mist is an example of this method. Of course by using mist, besides cooling the leaf, we also increase the amount of water vapor in the air, and as a result utilize both of the fundamental methods of controlling water loss from cuttings. Thus one of the advantages of mist over other methods of propagation is that it provides positive control of water loss.

The cooling effect of mist was mentioned in relation to the control of water loss. It also influences the rooting results in another very important way. It should be realized that the temperature difference is large, amounting to a 15 to 20 degreess F. difference between cuttings propagated under double glass and mist. This difference is created largely by the cooling effect of the mist but also by the fact that the temperature in the confined air under double

glass tends to build up. Without heavy shading and some ventilation the temperature under double glass would reach a point where the cuttings burn up. Continued exposure of the cuttings to the high temperatures under double glass results in the respiration or the rate of utilization of reserve carbohydrates being more than double the rate of respiration under mist.

It was mentioned that shading is necessary when propagating under double glass. This brings out another great difference between mist and double glass propagation. Light is essential for photosynthesis or the manufacture of food. The cuttings under double glass must be shaded to keep the temperature within reasonable limits and are exposed to low light intensity. Because of the low light intensity the cuttings are not able to manufacture foods at the normal rate. The cuttings under mist, however, are exposed to full light intensity and are therefore able to manufacture food at a fast rate.

Cuttings under double glass can be compared to a candle burning at both ends—they are utilizing reserve carbohydrates at a fast rate because of the high temperatures, yet they cannot manufacture food at a high rate because of the low light intensity.

Cuttings under mist however, do not utilize food at a high rate because of the lower temperature and are able to manufacture foods because they are exposed to full light intensity. Figure 1 expresses this same idea. Here the cuttings are represented by storage tanks with two valves, an inlet valve controlled by light intensity and an outlet valve controlled by temperature. The

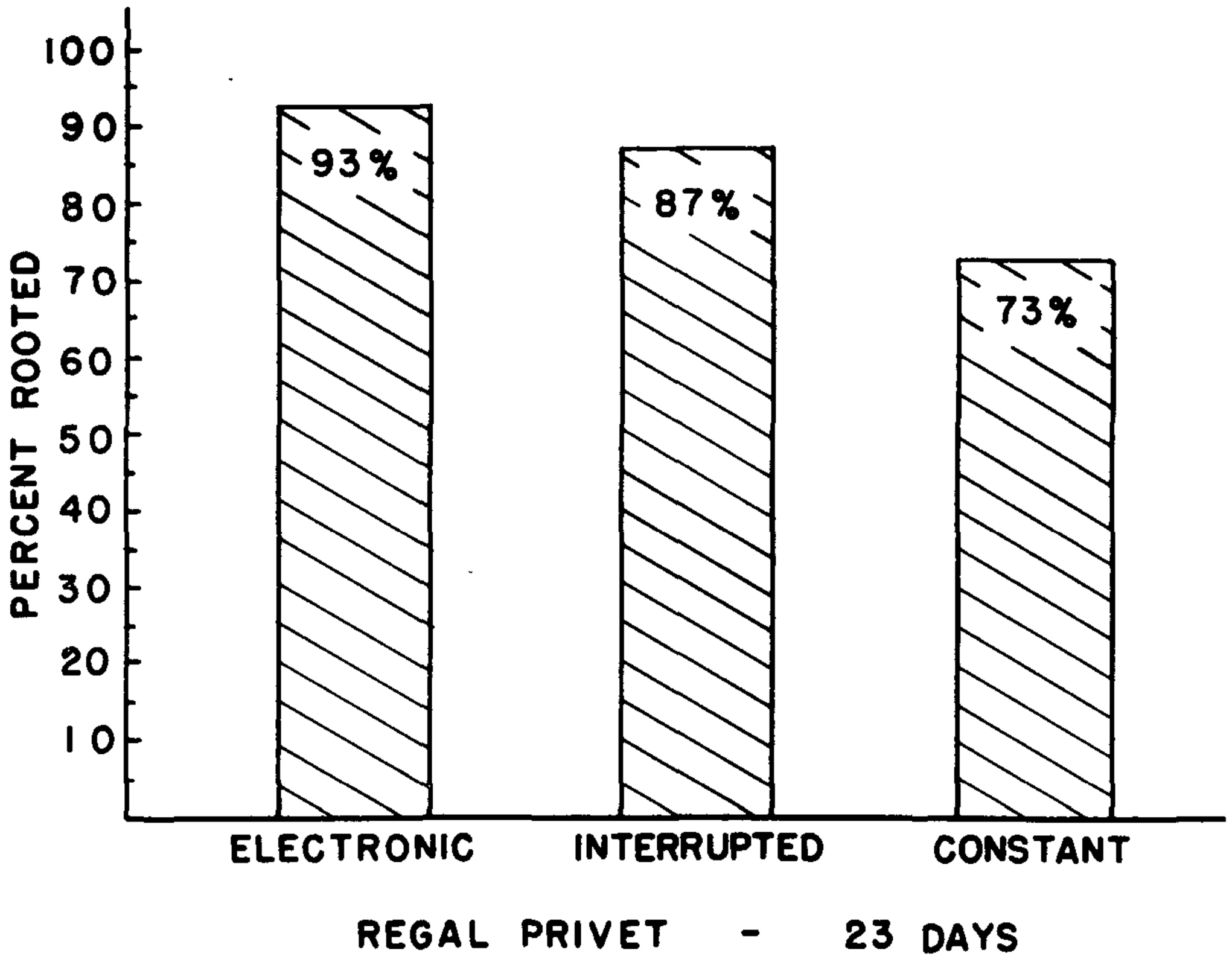

Figure 1—Effect of electronic, interrupted, and constant mist upon rooting results as represented by Regal Privet.

tanks store reserve food. You will notice that the tank on the left represents the cutting under double glass. Notice that the inlet valve of food manufacture is nearly closed because of the low light intensity. The outlet valve, however,, controlled by temperature, is wide open. Thus very little reserve food is accumulated. The tank on the right represents a cutting under mist. The inlet valve of food manufacture is wide open due to the full light intensity and the outlet valve is nearly closed due to the lower temperature. Thus a large amount of reserve foods have accumulated in the cuttings under mist. If we consider that these foods are utilized in the rooting process you can see that the rooting potential of a cutting under mist is much greater than a cutting under double glass. Not only is the larger amount of reserve foods important in the rooting process but they play an important part in the rerooting and establishment of the cutting after it is removed from the propagating bench. In brief, some of the reasons mist can be expected to give good rooting results are that it utilizes both fundamentals involved in controlling water loss—cooling the tissue and increasing the water vapor in the surrounding atmosphere, by cooling the tissue it decreases the rate of respiration, and by permitting propagation under high light intensity provides maximum photosynthesis or food manufacture.

Next, consider the comparison between interrupted and constant mist. Figure 2 will show that better rooting was obtained under interrupted mist and best rooting was obtained under electronically controlled mist—a form of interrupted mist. Figure 3 will show the main reason for these differences in rooting response. The horizontal line on the graph represents the op-

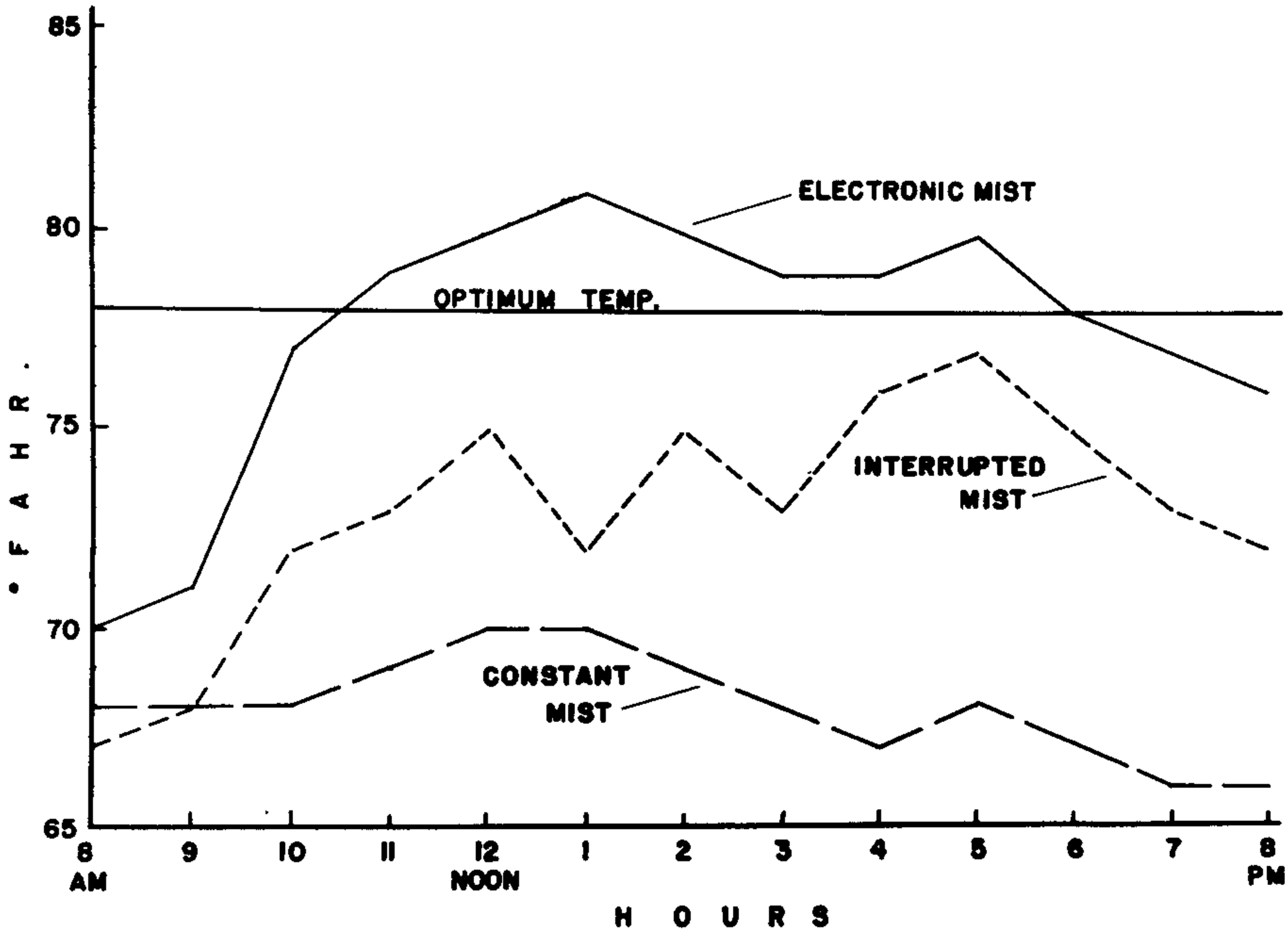

Figure 2—Temperature of cutting tissue in rooting medium compared to optimum rooting temperature.

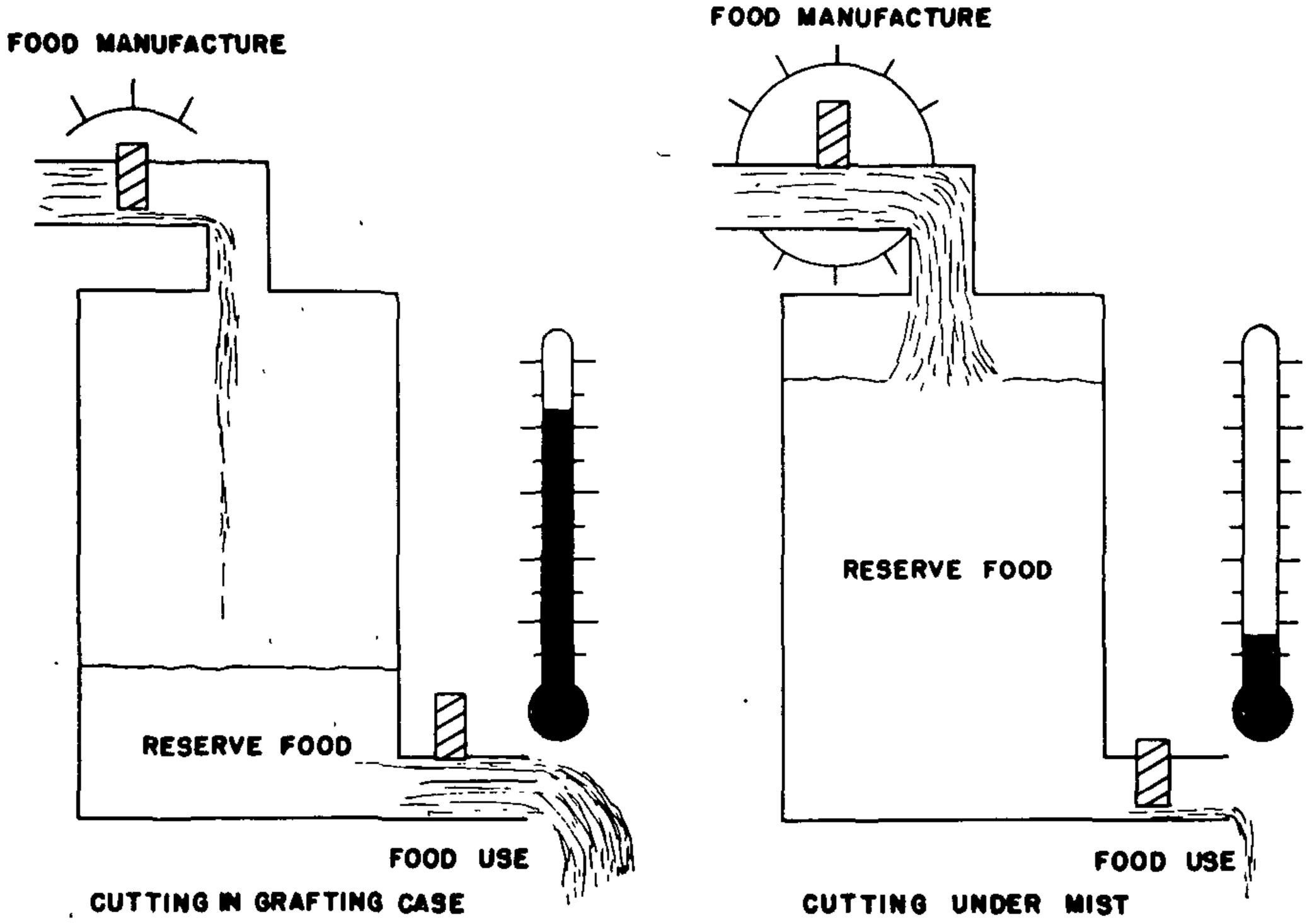

Figure 3—Diagramatic comparison of cuttings propagated in grafting case and under mist.

timum temperature for rooting the majority of ornamentals. Constant mist falls far below this optimum because the excessive amount of mist that was applied reduced the temperature of the medium to a point where the rooting response was actually inhibited. Since less mist was applied under the interrupted mist, the temperature of the medium approaches the optimum for rooting. The temperature of the medium under electronic mist was always near or above the optimum because just enough mist was applied to maintain a film of water on the foliage of the cuttings. There was no "excess misting" leading to low medium temperatures.

There are several other advantages in using interrupted mist. The problem of leaching is decreased. Since less water is applied with interrupted mist, there is less possibility for the nutrients to be leached from the cutting. Along the same lines, the problem of foliar breakdown should be controlled by use of interrupted mist. Draniage and displacement of oxygen from the medium are other potential problems which are largely eliminated through the use of interrupted mist.

Another important advantage of using interrupted mist is the ease in which cuttings may be hardened off during the rooting period so that no time is lost in handling the cuttings once they are rooted. When the cuttings are first stuck frequent, short intervals of mist are applied. After three to seven days conditioning period the number of intervals is decreased by 1/3. As the cuttings begin to root the number of mist intervals is decreased by another

third and one or two days before potting or shutting off the mist system the number of applications are decreased to a minimum application of the control apparatus. By following this procedure, the process of hardening off is essentially completed at the time of potting.

In closing I would like to offer a three point plan to utilize the mist technique most efficiently.

1. *Use soft cuttings*—the cool temperatures of the mist cuts down the water loss and food use and therefore makes it possible to use very succulent cuttings, cuttings which have greater cell activity and thus greater rooting potential.
2. *Use interrupted mist*—interrupted mist approaches the optimum rooting condition of cool top foliage and warm rooting medium.
3. *Use a light shade in the summer*—a light shade consisting of a single layer of cheesecloth permits the use of less mist and thereby decreases the possibility of over misting and cooling the medium and does not cut down the rate of photosynthesis.

Once again use soft cuttings, interrupted mist, and a light shade in the summer.

* * * * *

MR. SHAMMARELLO (South Euclid, O.): Would light burlap be too heavy in place of the cheesecloth?

MR. HESS: Yes, I think that it would be. It would probably reduce the light intensity below the optimum level for maximum food manufacture.

MR. SEBIAN: Should the extremely soft condition of the cuttings apply to azaleas too?

MR. HESS: I have not had any experience with azaleas. The American holly is definitely an exception to the softwood cutting. Holly should be taken when the leaves begin to become a dark green. I think that others may respond in a similar manner to holly.

MR. ROLLER: How long does it take to harden the cuttings in the bed by cutting down on the mist?

MR. HESS: Give the maximum amount of mist for the first four or five days after inserting the cuttings. Then reduce the amount of mist about 1/3 for the next four or five days, and another 1/3 after that period. By the time the cuttings are rooted, they will be receiving mist only occasionally. Three or four days before they are to be removed, stop the mist, except for an occasional squirting.

MR. ROLLER: Last summer we removed the cuttings without reducing the mist and we did not lose a plant.

MR. HESS: That is very good. Most people have had trouble if the cuttings are not harden-off some before removal.

MR. HANCOCK (Woodland Nurseries, Cookesville, Ontario.): What is the difference between my method and the use of mist plus light shade in regards to light and moisture?

MR. HESS: I believe that you will have to allow more light through and probably use a little more moisture.

MODERATOR SNYDER: May I suggest in deference to the other three speakers we let them present their discussions; then you can direct questions to whichever one you want.

Mr. Ward, of Lake's Shenandoah Nursery, Shenandoah, Iowa, was unable to be with us this afternoon. While it is not the general policy to have papers read, we feel his paper is of sufficient interest on the subject that it should be included.

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MIST PROPAGATION IN OPEN FRAMES

WILLIAM F. WARD
Shenandoah Nurseries, Shenadoah, Iowa

INTRODUCTION

Members of the Plant Propagators Society, Ladies and Gentlemen. I was very happy when several members suggested to Mr. Fillmore that I present the topic "Mist Propagation in Open Frames", a method of propagation with which we have had two years experience. Since we were dissatisfied with the old closed case or tent house method of propagation it was quite natural for us to attempt to root cuttings during the summer under the new mist technique. At the Shenandoah Nurseries we began investigations in 1953 with a mist bed 6 x 15 feet, expanding those facilities to a bed 6 x 105 feet during the 1954 propagating season. With very few exceptions, we have consistently obtained better results with mist propagation than with our frame method under shaded sash. With two years experience behind us the management has expressed the desire that we expand our mist propagation setup to take care of the largest part of the summer propagation schedule dealing with the rooting of deciduous shrubs and selected types of evergreens.

I will speak briefly about the method by which we make the cuttings for mist propagation, the method of hormone application, and the spacing in the bed. Then with your permission I would like to describe the units which we have used during the 1953 and 1954 test as well as the mechanics of applying water, hardening-off the cuttings after rooting and a few of the problems we have encountered with each unit.

GENERAL CONSIDERATIONS

Making the cutting. Cutting material is collected from stock plants in the field. These are selected about the same time as we would ordinarily collect cuttings for the old method of propagation which is based on the deve-

MR. HESS: I believe that you will have to allow more light through and probably use a little more moisture.

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lopment of the stock plant. The material is then brought to the bench where the girls orient the cuttings. They are then cut to a uniform length, varying between 4 and 6 inches, depending on the plant material by the use of a paper cutter. Since the old cutter which has been used to make over 3 million cuttings is in use, I could not bring it along to demonstrate the method of making the cuttings. However you should take the same care in making the cuttings with a paper cutter as you would with a knife; the method of course has the advantage of being considerably faster and larger quantities can be turned out.

Hormone application. The method by which we apply rooting powders makes use of a large salt shaker which is filled with the particular rooting powder we are using for a certain type of cutting. A thin film of powder is shaken on a clean piece of paper. A handful of cuttings is then taken, tapped gently to even up the bases, moistened at the base with a stationery rubber sponge and rotated gently in the powder. When the paper becomes soggy or wet it is discarded with no great waste of expensive chemical. Since the paper cutter makes a straight cut, rather than a diagonal one, all the cuttings get uniform coverage and ample material to do the job.

Sticking the cuttings. After the cuttings are made they are transferred immediately to containers and stuck in the mist bed. The spacing we use in the bed between cuttings and between rows varies from 1 3/4 inches for types as privet, which have a relatively compact, small leaf area to 2 1/2 inches for such cutting types as weigelas and viburnums or snowballs, which have a large leaf area.

EARLY TESTS WITH MIST, 1953

First mist bed. Construction. The first mist bed that we constructed at the Shenandoah Nurseries was made from an ordinary coldframe 6 x 15 feet. The bottom of the bed was excavated to form a "V" bottom, the bottom of which was filled with broken pots and small rocks to permit adequate drainage. The frame was then filled to a depth of about 6" with a good grade of propagating sand, in our area known as Platte River sand. The frame was then enclosed with 4' muslin siding which could be rolled up to permit the operator to get into the bed either to stick the cuttings or to inspect them periodically for rooting. The mist was provided by a row of "T" jet nozzles spaced about 15 inches apart on 3/4" pipe. The pipe was connected to the water supply by means of reinforced spray hosing.

Operation of mist. The bed was put in operation on June 5th and was operated as a constant mist unit through the middle of August. During this time some difficulty in lateral movement of mist was experienced in that a fan shaped pattern of atomized water from the nozzles was not distributed evenly on days without air movement. The leaves on all cuttings however were continuously wet during the rooting period.

Observations and problems. Since we attempted to evaluate this method of propagation against our old setup, small numbers of a great many species were tried. In brief we successfully rooted 73% of the species and varieties we tried. However after rooting, the problem of hardening them off was of more serious importance.

Although various methods were tried, only the method in which we hardened the cuttings off in place proved successful. Poor results were obtained when we flatted the rooted cuttings and moved them in and out of the mist bed. Another method was tried in which the cuttings were potted and placed under sash and shade; this, too, proved unsuccessful and not adaptable to a large scale operation.

Hardening-off cuttings. After having such poor results with various techniques for handling the cuttings after they have been rooted under continuous mist I concluded that the only way to cut down these losses would be to harden them off in place. In order to work out a suitable sequence for this operation I stuck a full bed of *Hydrangea paniculata grandiflora* cuttings in the usual manner. As soon as we noticed that rooting was starting, the water was held off for varying periods of time making certain that during this period the cuttings did not wilt. As soon as the cuttings had an established root system I cut the water off at 5 p.m. and again started the unit around 9 a.m. After a short period of time (about 2 weeks) following this procedure we potted them off and placed the cuttings in frames covered with lath and burlap. As a result of this method of handling we realized about 90% survival, from cuttings which were in the propagation bed a total of 31 days.

Conclusions. From this one test we concluded that cuttings can be satisfactorily rooted under 24-hour mist. However when considering the economics of the method it would be desirable to start the cuttings under constant mist, and then slowly reduce the time interval until such a time as the cuttings have been hardened off in place in the propagation bed. Continuous mist propagation followed by immediate potting had no practical method for hardening the material off with any degree of success.

RECENT TESTS WITH MIST, 1954

Consruction of the bed. Early in the spring of 1954 we constructed and equipped a mist frame which was 6' x 105'. In construction the bed was quite similar to the one that I described earlier, although a different nozzle was used and automatic controls to provide intermittent mist was installed. For this purpose we have used successfully the "Florida 550 A" spray nozzle spaced at 5' intervals in 3/4 inch pipe located about 6 inches above the cuttings. In sticking a frame of this type all the nozzles can shut off from the main control point. As the cuttings are placed in the bed the main valve is opened and the cuttings syringed by hand until they have passed the perifery of the spray cone. The individual nozzle then can be turned on by hand and the procedure repeated until the entire unit has been stuck. After the bed has been stuck we have turned over the misting chore to a 24-hour time clock fitted with a 1 minute timer which operates a spring solenoid valve.

The mist bed was again enclosed using new burlap 4' in width and cut into 10 foot sections. Each section was fastened to the bottom of the bed with eye screws, spaced along the bottom of the burlap section. Again sand was used as the propagation medium. Complete construction cost was $275 not considering frame and sand.

Operation of mist. Convinced of the feasibility of using an intermittent system for applying mist we operated our nozzles 30 seconds out of the

minute on very hot days between the hours of 5 a.m. and 9 p.m. On cloudy days and 80 degree temperatures the mist was operated 10 seconds out of every 60, while after the cuttings began to show root formation this often was cut to a 4 second on, 56 second off cycle.

Hardening-off procedure. This procedure is difficult to describe and actually is acquired only through careful watching. In practice we start to cut down the mist at a time when the roots are just beginning to show; gradual reduction then takes place until a point is reached where the cutting has a good root system and the mist is applied only on very hot days and only in quantity enough to prevent wilting. During this time immediately prior to potting when the cutting is being hardened off the material is fertilized about three times with a liquid fertilizer.

Results obtained from this method of handling were far superior to any tested to date. *Viburnum, Weigela, Forsythia, Cornus, Berberis* (Red Leaf), Willows (*Salix*), Honeysuckle (*Lonicera*), and privets (*Ligustrum*) all were rooted very successfully following this intermittant mist technique. We did notice that even though the beds ran in a north, south direction, the cuttings in the center of the bed that received the most sunlight often were the ones which produced the greatest number of roots. In addition we were impressed with the importance of timing, especially when sticking cuttings of those deciduous shrubs which were particularly sensitive to this phenomena. For example:

Variety	Condition of wood	Date Stuck	Percent Rooted
Berberis thunbergi	Soft	6/29	90%
var. atropurpurea	Soft	7/29	75%
Philadelphus lemoinei	Soft	6/22	80%
var. Enchantment	Soft	7/27	30%

In another experiment we attempt rooting arborvitas treated with various rooting powders the results were as follows:

Variety	Date Stuck	Date Lifted	Treatment	Percent Rooted
Thuja	6/22	11/18	Geigy L/16	82%
var. Berkmann's	6/22	11/18	Hormodin No. 3	22%
Golden	6/22	11/18	Untreated	26%
Thuja orientalis	6/22	11/8	Geigy L/16	59%
var. Lakes Hardy	6/22	11/8	Hormodin No. 3	32%
Green	6/22	11/8	Untreated	51%

From these results it is obvious that different responses to the hormone rooting powders were obtained. However in general, we believe that they can be successfully rooted under light misting during the summer months.

Conclusions. From our most recent experience with mist propagation we believe the 24-hour or constant mist application is not necessary nor is it practical. The cuttings propagated under intermittent mist appear to be more vigorous and responsive after potting than those propagated in tent houses or shaded frames. We also believe that the cuttings that are stuck each day should be handled as individual units each with its own timer and solenoid valve operating from a master time clock which can be hooked to the whole system. For this purpose we intend using beds 6' x 30'.

Summary. In summary then, I have discussed with you the subject of mist propagation in open frames, a method of propagation in which I have great confidence, provided careful attention is paid to details. I have described our experiences of the past two years together with our future plan for commercial application of this method of rooting cuttings during the summer mnths.

* * * * *

MODERATOR SNYDER: What happened to the cuttings that were hardened up in the sand? Were they fed over winter?

DR. MAHLSTEDE: Various methods are being tried. The first year under constant mist they were taken up, rolled and wrapped in polyethylene, that is, a little moisture placed in the bottom of the polyethylene, rolled over and put in a roll and put in storage, common storage at temperature outside. It wasn't too well insulated but it is a method you can use to carry cuttings over winter and lighten your fall load and give you a little more to do in the spring if you don't have enough. It is just a method of handling.

Another method they are attempting is to put the sand on top of the soil. I think it has been described here earlier. The cuttings will root and during the rooting sequence the mist will be cut down. The roots will develop in the soil later.

MODERATOR SNYDER: The next speaker this afternoon comes to us very highly recommended. His nursery in Missouri, The Forrest Keeling Nursery, is one of the outstanding in the area and he is a very personable individual and a strong member of this Society. His topic, "Mist Propagation under Lath Shade," will be of intense interest to us all.

Mr. Hugh Steavenson presented his paper, entitled "Mist Propagation under Lath Shade". (Applause).

MIST PROPAGATION UNDER LATH SHADE

HUGH STEAVENSON

Forrest Keeling Nursery, Elsberry, Missouri

Our system of mist propagation at Forrest Keeling Nursery varies in several particulars from other mist systems I have seen or with which I am acquainted. These variations are not necessarily any better nor any worse than other adaptations. And I think "adaptation" is an appropriate word in this connection. It seems to me that almost all mist systems are adapted to an earlier propagation system or technique that happened to be in use at the nursery in question.

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And this, if anything, points up the flexibility and adaptability of mist. For example, where the propagator has been using a greenhouse, he adds or adapts mist to this structure. Or he will integrate mist into his sash house operation where this type house is in use. If he has been using cold frames or hot beds he will simply remove the sash, install a mist line a few inches above the bed and raise translucent windguards around the frame to keep the mist at home.

We happened to have a convenient slat house, or shade house as we call it. With this structure it was both convenient and economical to install a set of lines and nozzles in an overhead position. The side walls of the house are 9 feet high. There was, therefore, ample height to install our lines at a 7-foot level which permits one to walk and work freely beneath.

I'll get into the simple details of our structure in a minute, but permit me to digress for a moment to say that we are enthused about the use of mist beyond the immediate problem of rooting cuttings. We do some mail order business and have been seeking a practical means of preparing conifers and broadleaf evergreens of a small finished size—say 12 to 15 in.—for shipping through the mails. Even with the revolutionary development of polyethelene for wrapping, there remains the problem of sending a bare-root evergreen to a customer with reasonable assurance that the plant will live and grow on satisfactorily. For several seasons we have followed the practice of digging such plants early in the fall; heeling them in sawdust or peat in the shade house where the plants could be syringed frequently; and thereby "re-establishing" the plant, usually with a new secondary root system, so that it would ship and transplant with far greater certainty of success.

Now it is at once apparent that mist is made to order for this method of handling plants. Mist can allay the terrific unbalance of top and root when evergreens are dug bare-root. It can obviously supply the necessary water to keep the foliage and stems turgid and fresh until the root system has recovered and is again functioning. Constant or intermittent mist can do the job more surely and economically than even the most careful and diligent syringing with a rose nozzle. So we now have considerably more area under mist in our "heel-in" shade house than we do in our propagating house. Here we use the Florida 550-A nozzle which can be spaced farther apart then the Monarch nozzle, thereby reducing the installation cost.

We also use mist over our B & B truck delivery orders as they are assembled and held awaiting shipment. We adopted this procedure for the first time this fall and we like it. We constructed a loading dock at one end of our mist heel-in house and during the hot, windy days of September we no longer had the usual "willies" when a customer was a couple of days late in picking up his load of balled evergreens, or when our delivery truck got a few days behind the balling crew. In the mist atmosphere the plants would actually take on a freshness not always apparent in the field.

Everyone who has handled container stock knows how badly a deciduous plant can wilt if the container is lifted during the flush growing period, and if, through neglect of frequent moving, roots have entered the soil beyond the container. Here again the mist-covered shipping dock is ideal to hold such plants fresh and vigorous pending shipment.

Surprisingly enough, we haven't used mist thus far to establish our freshly-potted soft wood cuttings that have been rooted under mist, and this establishment has been a difficulty with us. There are some problems here, but I would guess mist could be useful in this connection.

In discussing mist, I do not want to wander too far from propagation, *per se*, but I do want to express my opinion that as propagators and nurserymen we may well find mist has a broader and more extensive application beyond the actual cutting bed or frame. With mist we can create what might be termed a rain-forest atmosphere in situations otherwise highly forbidding to certain plants or plants in a critical condition due to root disturbance or soft foliage. Mist controlled with timing devices or suitable spacing of nozzles can be economical in use of water, and distribution of the mist over a given area within an allowable cost then becomes a matter of engineering.

Referring now to our shade house mist installation for rooting cuttings: the title given my paper by the program committee was "Mist Propagation under Lath Shade." Actually this is somewhat of a mis-nomer. We placed our mist lines in a shade house as I have indicated, but before we ever stuck a cutting in 1953, our first year of operation, Dr. Chadwick and Jim Wells came by, thank goodness, and these gentlemen suggested we should remove our overhead slats. This we did and we have never put them back. There have been times when the slats might have been beneficial—to control wind and to provide added protection when someone failed to turn the valve on at the proper hour in the morning or promptly following a couple of rainy days. But when mist is applied properly we, at our place, can only concur in the principle that a cutting covered with a film of water needs no shade protection.

Now on the basis of some of the things said this afternoon I guess I might modify that statement, yet, I don't know. Apparently in Shenandoah they got the best results out in the center of the frame where there was no side shade. In our shade house with our 9-foot sides we do get a good deal of shade from direct sun in the morning and again in the afternoon.

Our initial mist installation covered an area of shade house measuring 52' x 24'. This area was provided with three one-half inch copper lines running lengthwise of the house and fed by a 3/4 inch main running at right angles to the lines through the center of the house. This center feeding appeared to provide uniform pressure to the jets. Monarch H261 3.00.120 jets were installed at two-feet intervals along the lines and set facing downward at a 45 degree angle from the line, first to the right and then to the left. Generally, Wells' recommendations on choice of nozzle, strainer, sweat joint installation and on other points were followed.

It will be noted, however, that our lines were 7'8" apart and 3'11" from the wall. This is a wider spacing than is customarily used for this nozzle, giving each nozzle 16 sq. ft. to cover. Indeed this summer we were able to reduce the nozzles by half and still have adequate coverage.

This reduction in number of nozzles was possible because (a) the lines were at a high level—7 feet above the ground-line and because (b) air movement entering the open-topped structure created enough turbulence of the atmosphere of the house to give a fairly good dispersion to the mist droplets as they descnded to the floor. Even on the quietest days this air movement factor seemed present. Incidntally, we quickly learned that wind shields were

necessary on all sides of the house and these were simply and inexpensively provided by tacking two mil polyethelene panels to the full 9 feet height of the house.

We went to some means to assure adequate drainage in this house by providing a 12-inch-deep coarse gravel floor over tile lines spaced 8 feet apart.

Now in the use of this house we made what I believe is a major departure from usual practice. We decided to stick our cuttings in flats, place the flats under mist and remove each batch to harden when rooted. Thus we proposed to use our house much as a baker would use a constant temperature oven and to be able to use the available space more fully than where cuttings are stuck in beds. This procedure proved satisfactory and we followed the same practice this year. I think I picked up from Bill Flemmer the idea of using tomato lugs for flats. These have more depth than a standard flat, which we like and they can be picked up in truckload lots from Produce Row in St. Louis for a nickle each, which we also like.

We have tried a number of varieties under mist and I will append a table which summarizes our results this past season but a few comments will suffice to point up our experiences. We are interested in propagating quite a number of broadleaf evergreens—*Ilex*, *Euonymus*, *Viburnum*, *Berberis*, *Buxus*, *Pyracantha*, *Hedra*, etc.—and as a class, the results with this group have certainly been encouraging and rewarding. We do not grow many of the usual line of flowering shrubs and haven't had occasion to work with soft woods extensively in this group, but the few we have worked with have rooted quite well. Our rooting results with coniferous evergreens, particularly junipers, have been disappointing, probably due to timing in taking wood. We can do so much better with our winter polyethylene house with this group there seems to be no reason for us to try to work out a satisfactory outdoor mist technique with conifers. Nor does mist seem to us to have a place where hardwood cuttings are satisfactory. For example, we use a good many Dwarf Blue-leaf Willow (*Salix purpurea*). This, of course, roots like a weed under mist but is difficult for us to establish after rooting. One year plants from hardwood cuttings, ready for sale as hedging, are less expensive than the production of a potted liner in this instance.

Our hormone treatments have been standard recommendations. We have not run enough checks to comment on hormone treatments of cuttings under mist. I presume each outfit finds a suitable rooting medium for its particular set of conditions, but I couldn't tell our story without mentioning our experience. We assumed our river sand would be satisfactory and we used it throughout in 1953 except for check flats of other media. Lo and behold, the darn stuff waterlogged under constant mist and where cuttings did not root promptly—as with junipers—they rotted in this sand. Fortunately, we had some check flats of vermiculite and here drainage and aeration appeared satisfactory and rotting was not a problem. We have also tried silica sand and Perelite, but with us, vermciulite has been the most satisfactory. We use the coarse house-fill grade rather than the more expensive horticultural grade and I believe this coarse grade is better. Another big advantage of vermiculite is its weight. We use women for our cutting work and sand flats are too heavy for them to pack around efficiently. The nursery profession is plagued with far too much lifting and straining at best.

I believe it has been observed over and over again in mist propagating that wood can be taken very soft with good results. Our 1954 against our 1953 experience pointed up this factor. We simply started too late in 1953. *Euonymus alata compacta* is a case in point. In 1953 we took cuttings on July 28 and rooting was virtually nil. In 1954 we took cuttings from the same stock plants on May 27 and got a 97% rooting and rooting was rapid.

I mentioned last year that we "ran out of summer" with a number of slow-rooting items. This year with our house all set in the spring this was not a problem. Second and third batches were limited to quick-rooting varieties.

We haven't used any timing devices in this summer house, although we are installing an intermittent mist system in our winter house. As I have indicated, we have been able to space our nozzles to an extent that constant mist does not use an undue amount of water. After hearing Dr. Snyder's remarks, I think we may send our intermittent mist system back and get the electronic leaf. It sounds very good. Actually, on an 8-hour day operation, and with our low pressure, our nozzles deliver only about .4 inch water per day which does not seem excessive. After the first week or so we found we could turn our mist on about 8:00 o'clock or 9:00 o'clock in the morning and turn it off at 4:30, as soon as the sun went down and when we spaced our nozzles out we were only with constant mist delivering about .4 of an inch of water per day, which does not seem excessive.

After rooting and before potting we harden the cuttings by placing the flats on a bench adjacent to the mist area. Here a slight drift of mist gives the effect of gradually removing flats from mist to no mist.

Last year the problem of a whitish precipitate forming on cuttings under mist was discussed. Our water is quite hard and this is a definite factor with us. This precipitate appears to cause no injury to the cutting but it does adhere to the leaf for months afterward. We tend to forget about it until a customer asks what is the matter with the foliage on a potted plant.

After the new foliage comes out, it covers up the white leaves. I dare say a suitable intermittent system would reduce that problem, too. Doubtless our biggest problem at present is establishing cuttings rooted under mist. Our technique needs a great deal of improvement in this direction. You will note in Table 1 that establishment was excellent in many instances, but with about a third of our subjects the losses were well above an allowable or economical figure. We were bedeviled this year by the hottest summer on record, which didn't help any, but we do feel we will have to use Roger Coggeshall's procedure of covering freshly potted plants with polyethylene sheets or else use some mist over the potted material until established. I don't think we would like to carry the cuttings over, such as has been used at Shenandoah. If we can establish them quickly we can get them out and many of them planted that same fall. I don't think we would care to carry the things over into the following spring. Unless the mist is very light, and here I think intermittent mist would come in again, however, I am afraid we would be back to our old problem of a saturated soil and root-rotting. I dare say the right use of intermittent mist would overcome that problem in establishing potted mist-rooted softwoods. I know of some others who have this same problem of establishing mist-rooted cuttings and I trust the question can be resolved in this discussion.

If I were not in the plant band business, I would be tempted to point out that we have less difficulty in establishing cuttings in cypress plant bands than we do in clay pots, but such an observation considering my commercial connection would be highly unprofessional and I will say absolutely nothing about it.

I shouldn't close without saying that we, at our nursery, have been disciples of Wells. I say Wells, but other people have also been responsible for mist spraying. We follow his articles pretty carefully not only in the use of summer mist for rooting cuttings but also in the use of John Innes Compost for potting or more properly, banding them. It seems to be all our English cousins claim. We got a little anxious to secure maximum growth and I believe burned some items by using the base at double strength. I would suggest propagators stick to John Innes No. 1 until they have tested the stronger mixtures.

* * * * *

MR. STEAVENSON: I would like to take about two minutes to comment on mist versus poly. I think I am in a position to do that because as I mentioned, we have this winter house which is simply a sash type pit house, except instead of sash it is completely covered with polyethylene, tight, so we have a continuous blanket of polyethylene. We used it the first time last winter.

It is 15 x 100. It has worked out very well, but I can't see how we can get along without extra moisture in the house. We were all set to put up mist lines in his house. After Mr. Gray's comments, I thought maybe we were going off the deep end of the thing, maybe we didn't need them. When I consider the problem we had last year, I believe it is an economical way of getting the extra water into the house, which I know definitely we need, because we can't maintain anything like a saturated atmosphere in this house even during the winter without daily syringing with water, and a good deal of it.

In this tight house, I might mention, we use electric cables for bottom heat and that is all the heat there is. Temperature at night, on a cold January night, will go down pretty close to freezing, which is perfectly all right, but on a clear sunny day the temperature will pop up as high as maybe 90 degrees. Obviously, if we have no more moisture than what comes from the cuttings or media and with the same amount of moisture the relative humidity goes way down and our cuttings get very dry and we have had a problem of keeping them syringed throughout the heat of the day.

Furthermore, if the air temperature, let's say, is 80 in the house, the outside temperature is 40, much of what moisture there is in the house condenses on the poly which further removes moisture from the house and we have to have extra moisture in that poly house. We couldn't get away from it.

We didn't use it this summer, and the reason we didn't use it, it simply gets too hot. It would burn the cuttings up. Now we didn't have mist in it. Maybe when we get mist in it we can use the poly house.

The summer temperature in this particular house, without mist, would certainly burn the cuttings up, and of course, we went back to our outdoor mist without any poly largely because of temperature factor. Thank you very much. (Applause)

MODERATOR SNYDER: And now questions for Mr. Steavenson.

MR. HOOGENDOORN: Did I understand correctly that you use polyethylene on the sash house instead of sash?

MR. STEAVENSON: Yes.

MR. HOOGENDOORN: Does that keep warm enough in the winter?

MR. STEAVENSON: As I said, we use electric cables for bottom heat. That is all. During the coldest days the air temperature approached freezing. It never did freeze, but it approached freezing. Of course, during the daytime, even during a cloudy day it got warm. General rooting was pretty good.

TABLE 1. RESULTS WITH MIST PROPAGATION at FORREST KEELING NURSERY DURING SUMMER OF 1954

Variety	Date Taken	Date Banded	Number Taken	% Banded		% Established
Buxus - Carr Hardy	6/1	7/ 22	132	93%		93%
Berberis julianna	6/9	7/23	115	84%		55%
Berberis mentorensis	6/4	7/10	3,527	90%		80%
Cotoneaster r sonngar	6/5	7/26	202	65%		37%
Euonymus alata compacta	5/27	7/13-19	6,773	97%		85%
Euonymus carrieri	6/2	7/9	859	100%		100%
Euonymus fort. colorata	6/1	7/9	280	100%		100%
Euonymus fort Wild	5/25	7/9	1,505	100%		90%
Euonymus fort. vegetus	6/3	7/12	29	100%		100%
Forsythia Lynwood Gold	6/2	7/9	642	99%	(160)	25%
Hedera helix baltica	6/4	7/26	436	80%		80%
*Hedera helix bulgarian	5/27 6/14-17	7/20 7/27	27,210	46%		40%
**Ilex opaca	6/3	7/26	2,509	67%		57%
Ilex crenata hetzi	6/9	7/26	894	80%		30%
***Juniperus H. douglasi	6/10	7/22	1,541	36%		32%
Juniperus V. Keteleeri	6/12	8/24	3,223	18%		18%
***Kolkwitzie amabilis	6/25	8/24	650	54%		50%
Magnolia grandiflora	6/2	7/23	194	41%	(38)	20%
Magnolia soulangeana	6/25	8/24	616	68%	(267)	43%
***Metasequia glyptostr.	7/9	8/25	464	44%		40%
Prunus lavro. zabell.	6/2	7/27	54	85%		61%
Pyrancantha coccinea	6/3	7/12	1,095	92%		7%
Rhus cotinus purpurea	6/2	7/26	159	40%		6%
Salix purpurea nana	5/26	7/8	5,518	100%		0%
Salix purpurea nana	7/27	8/23	6,425	96%		86%
Philadelphus - Snowfl.	6/1	7/21	921	82%		61%
***Syringa chinensis	6/7	8/23	1,303	85%		76%
***Syringa chinensis alba	6/10	7/27	935	77%		59%
Viburnum burkwoodi	5/26	7/21	1,668	77%		71%
Viburnum chanulti	6/2	7/20	843	78%		72%

(1) This figure taken at the close of the summer season when all cuttings were firmly established and growing in the plant band. John Innes Compost No. 1-1/2 was used as a potting medium on all varieties.

* Many improper cuttings were made.

** Approximately 250 cuttings died in Mist house due to improper water distribution.

*** Cuttings possibly taken too late.

MR. HOOGENDOORN: Along in March does it get too hot and burn up your cuttings then?

MR. STEAVENSON: Yes, it did get awfully hot. We used some camouflage over it, particularly on the west side. We took a spray gun and went over the house with aluminum paint and cut the light down about half. Sometimes it got pretty hot. The primary objection we had in using only electric cables for bottom heat was the fact our electric rates are very high. We thought we would use a double poly wall over the ceiling, putting poly on the outside, and we have rafters about 8 inches deep and putting a layer on the inside to cut down our heat loss because our electric bill was pretty rough during February and March.

MR. HOOGENDOORN: It seems to me you would have better control of heat in the house using sash rather than with polyethylene.

MR. STEAVENSON: What we want is a tight house so we can keep the moisture up.

MR. HOOGENDOORN: You don't want to burn your cuttings up after you get them rooted in March.

MR. STEAVENSON: Well, we didn't. It worked much better with our conifers than the outdoor mist did.

DR. MAHLSTEDE: Does it snow down where you live? What do you do when you have heavy snow?

MR. STEAVENSON: It rolls off like it does on glass. People ask us about hail. I expect a good hail storm would tear it up. This is a 15 x 100 foot house and by getting polyethylene direct from the manufacturer in 100 foot rolls instead of buying from a fabricator, you can cover the whole thing for about $15.00.

DR. MAHLSTEDE: What thickness do you use?

MR. STEAVENSON: I am using two mil. Probably we should use three or four. I don't know what hail would do. There is quite a little give there. If hail did tear it up, you could get more on in a couple of hours.

MR. SHAMMARELLO: How do you get it fastened down?

MR. STEAVENSON: We have 1 x 4 stringers at intervals over this house, so we do get some shade effect from the stringers, about a third shade, and we have the edges of the poly strip. We run it vertically. Last year, we ran it horizontally. We simply make a lath and tack it down at the joint and we get a pretty tight seal.

MR. EDWARD CROSS (Haynesfield Nursery, Bristol, Tenn.): How wide?

MR. STEAVENSON: This house is 15 x 100 feet.

MODERATOR SNYDER: The last member of this afternoon's panel is in a very enviable position. He is last on the program and can, if he so desires, vary his remarks based on the comments of the previous speakers. His topic, too, is a different approach to a general subject.

Mr. Vincent K. Bailey, of J. V. Bailey Nurseries, St. Paul, Minnesota, is well qualified to discuss "Controlled Humidity in Greenhouses".

Mr. Vincent K. Bailey presented his paper, entitled, "Controlled Humidity in Greenhouses." (Applause)

CONTROLLED HUMIDITY IN GREENHOUSES

VINCENT K. BAILEY
J. V. Bailey Nurseries, St. Paul, Minnesota

The discussions you have just heard about mist propagation are an effective method of preventing loss of moisture from the softwood cuttings but there is another method which we have found very effective. I refer to controlled humidity in greenhouses as a means of keeping the cutting in good condition until rooted. We have used this method in St. Paul for the past seven years and we feel that it has some advantages.

As an introduction to our discussion of "Controlled Humidity in Greenhouses", I wish to briefly describe our physical plant. This consists of two greenhouses, one 25' x 100' built about 1938 and another 25' x 116' built in 1942. These houses are heated with hot water boilers using oil.

Our propagation is primarily for the purpose of supplying lining-out stock for our own field planting. I wish to make it plain that we are not producers on a large scale in the way that many of you are accustomed to. As you can see, these two houses are only a fraction the size of the facilities of many nurseries.

We produce one crop of deciduous greenwood cuttings and a crop of coniferous plants annually. The softwoods are stuck June 15 to July 24, and removed in October and November. About December 1st we start planting the coniferous cuttings, consisting of the following varieties:

Savins	Golden Communis	
Pfitzer	Kosteri	Globe Arborvitae
Andorra	Tamariscifolia	Golden Arborvitae
Von Ehron	Pyramidal Arborvitae	Dark Green American Arborvitae
Hetzi	Siberian Arborvitae	Compacta Erecta Arborvitae

These are removed in late May when 85% are rooted. The method we use in handling the rooted cuttings is different from those used by the majority of growers. Ninety-five to 97% of these plants go directly into the field. This is getting a little beyond our subject of propagation, but I am of the opinion that a successful propagator must see to it that the liners are easily and efficiently put into the field to be grown into finished plants of high quality.

ROOTING MEDIUM

It is our opinion that the material used is of minor importance or rather I should say that some other factors are of greater importance. We use a commercial grade of plaster's sand purchased from a building material company. We have tried several other materials and mixtures but have come back

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ROOTING MEDIUM

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to sand. I do not want to say that everyone should use sand but we have learned how to use it in combination with all the other factors to make for successful results.

We start with this clean sterile sand in early June at which time the benches are all cleaned and sterilized. This procedure is followed once a year. When the coniferous cuttings are stuck in December there is no sterilization or change of sand at this time.

TEMPERATURE

Summer temperatures are allowed to go as high as 100° F. These temperatures are, of course, controlled by the shading on the glass and by ventilation. It is hard to say what is the best balance of these two factors but it is my belief that the amount of light allowed has a direct effect on the vigor, and rooting time, of the resulting plant and also affects the ability of the plant to withstand transplanting. Therefore, we use only as much shading as necessary to control the temperature, using the ventilators for the balance of this temperature control. Here is the point where our automatic humidifiers demonstrate their value. We will discuss this more fully a little later on.

Winter temperatures are carried at 65° F. as a minimum. This may be a little higher than some of you use but it enables us to get the slower rooting varieties in shape to go into the field by late May. The benches have an apron of paper to help build up the sand temperature a few degrees above air temperature.

HORMONES

Rooting stimulants have been used in our work in several forms and on many varieties. I know that there is a great deal of good scientific data to prove their worth and effectiveness. I think that everyone has a different set of conditions under which the work is done. Under our conditions we may find, for instance, that Spirea Anthony Waterer roots without a hormone. This does not mean that root stimulants are valueless to other propagators or on other classes of stock. We use indolebutyric acid in solution. The following uses of hormones have been found most practical under our conditions: We have been using indolebutyric acid on our coniferous cuttings for about 8 years and find that acid used in water solution gives more uniform results than in the powder form. We use alcohol to dissolve the acid so it can be mixed with water.

On Pfitzer's Juniper we use it at the rate of 120 milligrams per quart of water leaving the plants dipped in 1/2 inch of solution for 16 hours. We find that cuttings dipped for 16 hours give more uniform rooting than when used with a stronger but shorter dip.

On Siberian arborvitae, Andorra and Savins juniper we use 80 milligrams acid per quart of water, 16 hour dip. Pyramidal and Globe arborvitae do root well without treatment, but develop a better root system when treated. On these we use 60 milligrams per quart of water for 5 to 10 hours. No treatment is given any of the deciduous items except softwoods of *Prunus* varieties.

HUMIDITY

Here was the one factor which seemed to be the most important and by the way was the hardest to know what we had. Certainly the experienced propagator could go into a house and tell whether the atmosphere is too dry or not. But even he could be off several points or more in his guess as to the relative humidity. And then, too, things might change rather fast when possibly he may not be in that house.

In 1947 we decided to take the guess work out of this very important factor in successful propagation. It was right here in the state of Ohio that I learned of the Binks system of humidity control. It looked so good that we installed it in our two houses. The cost was about $1200 broken down as follows: local plumber, labor and material - $600; electrician - $100; compressor - $500. Present day costs would be 10-20% higher and will be discussed a little later.

Briefly, the Binks system is composed of a stream of air across the end of a tube filled with water. The water is completely atomized and all of it goes into the atmosphere. Drip and wet foliage below the nozzles are completely avoided. The essential parts are:

1. A water tank with a float to maintain water level in the nozzles
2. An air compressor
3. Valves, pressure gauges and an oil extractor
4. Nozzles
5. Humidistat

We use 8 nozzles in the 25 x 100 foot house and 9 nozzles in the 25 x 116 foot house. The compressor is rated at five horsepower.

Now there are many makes of humidifiers and I have studied several of them. The Binks system seems to be well adapted to the use of greenhouse propagation. No doubt there are others just as good with which I am not familiar. But of those I have examined, the Binks system seems to fill our needs. This system may sound complicated but we have found it as near trouble proof as equipment can be. Outside of the compressor there is less machinery than under mist systems. The air compressor is the only major piece of machinery and this is a standard unit which can be purchased and serviced in any town. The entire system is very reliable and free of trouble or failure.

The only changes we have made were about two months ago when we discarded the hair type of humidistat for a new and very accurate Electronic Humidistat. The Sling Psychrometer is used to set the humidistats.

This is a relatively new type of humidistat on the market now which is extremely accurate. It is Electronic Humidistat H 7000 A, manufactured by Minneapolis Honeywell. They guarantee a variation of only 1/2 of one percent either way from the setting and will operate all the way up to 100% with the same accuracy. The cost is about $125 per unit, we have installed this new type in the greenhouse.

The system operates on the principle of the Wheatstone bridge circuit. For humidification, the relay closes the circuit when relative humidity is but a fraction of a percent lower than control point setting. A complete description of the operation can be seen in literature available.

Now that we have our controlled humidity the important question is what amount is best. Here we went to the work of researchers on the subject and adapted their findings to our conditions. At the present time we are using the following: Coniferous cuttings, 80% the first 2 or 3 weeks then reducing to 70% until rooted. Deciduous cuttings, 90% the first 2 or 3 weeks then reducing to 70% until rooted.

We think we are getting good results, at least they are better than when we left the humidity to guess. Records have been kept for many years and here are some actual figures from our 1953 records.

Total Planted	- -	203,192
Total Rooted	- -	180,656
Percent Rooted	- -	89%

The above figures are made up of the following varieties:

Cornus elegantissima
Euonymous alatus
Hydrangea paniculata Grandiflora
Ligustrum Lodense
Philadelphus aurea
Philadelphus lemoinei
Philadelphus virginalis
Physocarpus opulifolius aureus
Physocarpus opulus nàna
Potentilla Gold Drop
Prunus Cistena
Prunus Tomentosa
Prunus Triloba
Ribes Alpinum
Spiraea bumalda Anthony Waterer
Spiraea bumalda Frobel
Spiraea Prunifolia
Spiraea thunbergi
Viburnum opulus
Viburnum opulus sterilis

Many of you who were at our nursery the past year have said that we are getting a high percentage rooted.

The results are due to many factors but one of the most important of the physical items is controlled humidity. Another factor of even greater importance is the human element of making decisions of what practices and procedures to follow. These are generally a composite of the thinking of several people. You will find that true in most establishments. The results that we have had in our activity are due to the composite thinking and management of several people. Clarence Seefert and Donald Nordine, who are here and most of you know, are closest to this phase of our propagation. It takes men like this to help my brother, Gordon, and myself to get results.

The cuttings are all made by hand, that is, we do not use a leaf stripper on softwoods. In 1953 when we kept a record there were 203,192 made in 991 hours or 205 per man hour. In 1949, 658 man hours were spent taking, making and planting 141,862 cuttings or 215 per man hour. I do not know how this compares with production in other organizations but it seems satisfactory to us. The time of taking in relation to maturity is important but this knowledge seems to be gained best by experience. Perhaps they can be taken a little softer with controlled humidity than otherwise and thereby get quicker rooting.

The size of the cutting is controlled in our case by availability of material. We are firmly of the opinion that a large cutting will produce a salable

plant much quicker than a small one. We, therefore, use a large one as far as material will allow. Here, again, the controlled humidity may be a factor in getting as good a stand with large cuttings as we used to with small ones. With our system of planting these rooted cuttings directly into the field the large cutting is quite an advantage. For instance, when a 10 inch cutting is used we can get 30 to 40% of 2/3' finished shrubs after 2 years in the field. Spirea Anthony Waterer gives us over 60% above 12" after 2 years in the field. Thus by using a rather large cutting we get a good quality plant at low cost.

In 1952 we built a lath house for propagation of softwood cuttings to supplement the summer work in the greenhouse. This is built of alumilath and is 50' x 50'. It was purchased from Harry Reynolds, Santa Ana, California and the cost of lath and aluminum joists was $361.97. Other material and labor came to about $350.00 making a total cost of $711.97. In 1953, 73,339 rooted cuttings of shrub were produced in this lath house. We use a Skinner humidifying nozzle with a capacity of 3 gallons of water per house on a domestic water system. It was intended to be a humidifying system but turned out to be more of a mist system. The cuttings are handled essentially the same as in the greenhouse.

As I have said before the rooted coniferous cuttings are planted, without potting, in the fields either in one foot or two foot rows. This is done late in May after danger of frost. We have saved a tremendous amount of labor since years ago we abandoned the procedure of potting. Not only the reduced costs but the quality of the liner is better due to not having been first placed in a pot. The stands obtained by this method result in 80% to 90% finished plants. In the case of the deciduous items the stands are about 90%. I wish to emphasize how easy one can be fooled by guessing at the stand of plants in the nursery row. The above percentages are actual counts.

We are so much sold on controlled humidity that we recently installed the Binks system in two refrigerated coolers, two sorting rooms and a storage cellar. The coolers are set at 98%, sorting rooms at 99% and cellar storage at 96%. The cost of this installation is as follows:

Controls (7 units)	875.00
Plumbing	1080.00
Electrical	100.00

The advantages of controlled humidity in evergreen liner sorting rooms seems to us to be very important. If the roots can in this way be protected from any chance of drying the quality of stock should be improved.

In the coolers we also are hopeful of improved quality and also to some extent eliminating the use of packing material. In the cellar storage for deciduous items we hope to eliminate the use of packing material, however it is purely experimental. This alone would pay for the investment in about three years.

The plant propagator is always alert to ways of improving the stands and improving the quality of the lining-out stock produced. We must also be alert to the economics of the business and give some thought to the cost

of production. I am firmly of the opinion that the expenditure of a few hundred dollars for the installation of "controlled humidity" in propagating houses will help to insure good crops of high quality lining-out stock.

* * * * *

MODERATOR SNYDER: Thank you very much, Mr. Bailey. Now questions for Mr. Bailey.

MR. STEAVENSON: Vince, I was very much impressed with the percentages you got in taking your cuttings directly to the field. Were they in an area served by overhead sprinkling lines?

MR. BAILEY: Yes, they were.

MR: STEAVENSON: Do you grow them for two years before they go to the field?

MR. BAILEY: They are put directly into the field, directly from the greenhouse.

MR. STEAVENSON: Not for finished rooting?

MR. BAILEY: Yes.

MR. STEAVENSON: For example forty spacing?

MR. BAILEY: The rows are closer than that. We use two foot rows for all growing items such as spirea. The spirea is put in two foot rows and spaced about 10 inches apart in the row. At the end of two years, the percentages I have recited here, 60 per cent or about 12 inches, after two years.

MR. STEAVENSON: I was referring particularly to your evergreens.

MR. BAILEY: The conifers are not, of course, put in finished fields; they are put into 12-inch rows, in the case of narrow growth, such as pyramidal. Soft varieties are put in two foot rows and left there for two years and then replanted or transplanted into the balling field and spaced.

MR. STEAVENSON: Do you handle any taxus?

MR. BAILEY: No, we do not.

MR. CHARLES HESS, SR.: (Hess' Nursery, Mt. View, N. J.): Mr. Bailey, when I was at your place last summer you had the aluminum houses. How did these make out?

MR. BAILEY: Well, you refer to this aluminum lath house that I briefly described here and we have the mist system under that lath house. We got about 80 per cent rooted. I forgot the actual percent but I believe around 80 per cent, which we felt was a pretty good percent under those conditions, just a little poorer per cent than in the greenhouse. The cost of the house was less than $600.

MR. LOUIS VANDERBROOK (Vanderbrook Nurseries, Manchester, Conn.): Did I understand you planted the deciduous cuttings in the fall directly to the field?

MR. BAILEY: We plant part of them in the fall directly to the field.

QUESTION: How do you prevent freezing?

MR. BAILEY: In our country we have quite a lot of snow. That helps in that respect. I might add, in finishing the answer to that question, the smaller item such as *Ribes alpinum*, the smaller sizes of those cuttings we put in beds and we do mulch with hay.

MR. MARTIN VAN HOF (Rhode Island Nurseries, Newport, R. I.): I am duly impressed with the percentage of rooting of all your cuttings. What I can't understand is this: you said your shrubs were set right out in the field. Do you get 60 per cent stand, finished product?

MR. BAILEY: Right—60 per cent.

MR. VAN HOF: In the case of *Spirea bumalda Anthony Waterer?*

MR. BAILEY: That is right. Such things as Hydrangea P. G. I suspect we get 75 per cent salable plants. The rest are a little too small and they go back in large liners.

MR. VAN HOF: Don't you think it would be advisable to take those cuttings and set them out close together, 2 or 3 feet apart on the line and then take them up and line them out next year? They are 100 per cent salable stock then.

MR. BAILEY: Well, we do it with just one or two varieties but we feel it is more economical to put them right in the field where we can give them irrigation generally, not always. We think we are getting a little lower cost of production that way.

MR. SEBIAN: You mentioned that you get considerable snow. How does the aluminum lath hold up under heavy snow?

MR. BAILEY: As you know, the joists this firm send out with their aluminum lath are built so as to put aluminum lath on the top and one on the bottom and we take out the one on the bottom over winter so the snow load does not build up on the roof and we have had little or no trouble with snow breaking it down and wind pulling the lath out.

MR. JACK HILL (D. Hill Nursery Co., Dundee, Ill.): In an attempt to assign an absolute value to your system, would you say its inclusion in your propagating method has made practical the commercial production of plants which before that date you did not consider commercially feasible?

MR. BAILEY: From mist alone, I don't know that I could draw that conclusion because we would probably propagate those plants under some other conditions that were more commonly used several years ago. However, I do think we can make a little better profit and production a little better quality plant this way.

MR. HILL: Then the mist has brought you to a decision that because of the mist we can propagate this, and without the mist it would not be right?

MR. BAILEY: That is a correct conclusion, I would say, yes.

MR. HARVEY GRAY (Long Island Agr. & Mech. Inst., Farmingdale, L. I., N. Y.): Bill, I wonder if this is the place to defend or supplement or prepare the statements relative to the merits and values of the polyethylene tent versus the humidification by misting systems or might we put that off until another time.

MODERATOR SNYDER: I think it would be better to postpone it and consider it as a topic for the question box tonight.

I would like at this time to express appreciation to all the members of the panel this afternoon for their participation in it. I am certain that mist will be one of the subjects at this evening's session.

I will turn the program back to Dr. Chadwick.

PRESIDENT CHADWICK: Thank you, Bill, for conducting a very fine session this afternoon, and I, too, want to thank all of the members who participated in it.

We stand adjourned until 8:00 p.m. this evening.

RECESSED

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Plant Propagation Question Box

FRIDAY EVENING SESSION

December 3, 1954

For the second straight year, the Question Box Session proved to be an interesting and lively meeting. Dr. James R. Kamp, Department of Horticulture, University of Illinois, Urbana, Ill., moderated the session.

There was no record made of this session.

Round Table on Azalea Propagation

SATURDAY MORNING SESSION

December 4, 1954

The session convened at 9:35 o'clock, President Chadwick calling the meeting to order.

PRESIDENT CHADWICK: As I mentioned yesterday, this program has been made up primarily on the basis of returns from surveys that were sent out previously to formulate the program.

One of the main topics requested for discussion this year was azalea propagation.

I think we are fortunate this morning in having Dr. Skinner as the moderator of this panel on azaleas. I think all of you know Dr. Skinner. He has appeared on our programs here previously. Dr. Skinner is director of the National Arboretum at Washington, D. C., and it gives me pleasure to introduce Dr. Skinner this morning.

MODERATOR SKINNER: Thank you, Dr. Chadwick.

Following a customary pattern, the first discussion is intended as a survey of some of the general problems as far as azaleas are concerned. The meeting will then be turned over to the much better speakers who follow, to give you the real details and the real meat of this morning program in azaleas. References cited in the first talk will be found later in the Proceedings.

Dr. Skinner presented his paper, entitled: "Fundamentals of Azalea Propagation." (Applause)

FUNDAMENTALS OF AZALEA PROPAGATION

HENRY T. SKINNER

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A recognition of the principal differences between the classes of azaleas in cultivation here and abroad is prerequisite to a consideration of propagation methods. Morphological and physiological differences between members of these classes are so pronounced as to necessitate quite separate appraisal from the propagation standpoint.

The Kinds of Azaleas

By the system of classification employed by Wilson and Rehder in the *Monograph of Azalea* (29) these plants are of course still botanically maintained as Rhododendrons. Within Rhododendron the azalea subgenus *Anthodendron* is divided in four sections of which the two largest are Number I and IV. The first, *Tsutsutsi,* contains the semi-evergreen "Indian" and "Japanese" types with which we are very familiar. Flowers in this section have stamens variable in number to 10. The fourth section, *Pentanthera,* with stamens in fives, contains the deciduous azaleas including our natives, as well as *R. molle, japonicum, luteum* and the Ghent and Mollis hybrids.

By the English horticultural classification as employed in *The Species of Rhododendron* (12) of the Royal Horticultural Society, and the *Azalea Handbook* of the American Horticultural Society (18), azaleas become the series azalea of the genus *Rhododendron* and this series is broken into six subseries including *Canadense* (*R. canadense, albrechti, vaseyi,* etc.), *Luteum* (including the principal deciduous types), *Nipponicum,* with one species, *Obtusum* (including *R. yedoense, obtusum,* and many other species, the Kurume and Belgian hybrids, etc.), *Schlippenbachii* (including *R. schlippenbachii, quinquefolium, weyrichii,* etc.), and *Tashiroi,* with but one species.

From the cytological standpoint such azaleas as have so far been investigated by Sax (20) or by Ammal et al (1) seem to possess a reasonably uniform diploid chromosome content of 2n=26. The single exception so far discovered is *R. calendulaceum* which may be a tetraploid with a count of 52 chromosomes, implying a measure of possible difficulty to be expected in the employment of *R. calendulaceum* as a parent in hybridizing. Incompatibilities may be evidenced in seed set or in seed germination. Yet we also know that this tetraploid is capable of setting fertile seed when pollinated by certain diploids and can only assume that unreduced gametes in the pollen of related diploid azaleas may be of quite frequent occurrence.

In the present stage of azalea culture in this country the members of four of the subseries just mentioned are cultivated only as species which have undergone very little selection or very minor hybridization. Our mass of garden hybrids fall only into two series, *Obtusum* with its Kurumes, Gables, Glenn Dales, Indian and Forcing azaleas, and *Luteum* with its confusion of Ghent, Mollis, "Kosterianum", "Rustica flora plena", Exbury, Knap Hill and occidentalis hybrids. It is these two subseries which pose the major problems from the propagation standpoint. The nature of these problems may perhaps best be understood by now turning to a consideration of a few requirements for a successful commercial azalea.

Commercial Requirements

To an azalea specialist I suspect that any true species is worthy of cultivation either on its own merits or as a demonstration of his skill in procurement and in rearing it to the flowering stage. In hybrids he realizes that there is available (at a price) a confusing array of the good to mediocre and consequently he wants the best—the best in flower size, color and plant. A suburban home owner is much more easily satisfied so long as there is plenty of color and the bugs are not too bad. He will take pretty much what the trade has to offer—if the price is right.

Nurserymen, by and large, meet quantity demands by offering standard selections which sell, and which can be produced with minimum labor, at a minimum cost. Demand for species such as *R. kaempferi* or *schlippenbachii* can be readily met because they can be raised from seed and seedling production is relatively cheap and rapid. Seed procurement is about the only problem. Most semi-evergreen "Japanese" azaleas of the *Obtusum* subseries will remain with us in quantity because cuttings of the majority root with comparative ease. These rooted cuttings develop rapidly, flower early and produce a plant which approaches the ideal for the roadside trade. The need here has little to do with improvement of propagation techniques. It is concerned with selection of the *best* to propagate from the confusing multitudes of collectors' list-

ings and with additional breeding, still needed, for increased hardiness or adaptability.

We are now left with the deciduous azaleas of subseries *Luteum,* and with these we are confronted with very real propagation problems. To be sure the species of this subsection remain straightforward so long as we can locate reliable seed of *R. alabamense, cumberlandense, prunifolium, speciosum* or *austrinum.* But what of the Ghent, Mollis and related hybrids which do not breed true from seed? Probably all of them can be propagated by cuttings but so far scarcely on a commercially profitable basis. Because they are difficult we find that in Holland they are grafted, in England layered, and in America they are imported. Only one or two nurserymen in this country have done a little with cuttings and there are few, as at Andorra Nurseries, who have seriously attempted layering. Layering seems a little too slow, although I have long been convinced that some enterprising American propagator could make money at it if he really tried.

Among the 200-300 names in Ghent and Mollis hybrids now growing at the National Arboretum are at least a few excellent azaleas worthy of a place in any garden whose owner may welcome a color break from the Kurumes. Some of the good ones have been in this country for 50 years or more. Fortunately they can still be imported but there also exists a real challenge to azalea propagators to work out a reproduction system which will place this class of azaleas more on a par in availability with the Japanese types. The ultimate solution may of course rest with the plant breeder. Certainly some of our native azaleas, such as *R. viscosum* and *arborescens* can be rooted with reasonable success from cuttings, while *R. atlanticum* and perhaps *alabamense* or the stoloniferous *nudiflorum* selections will reproduce from root cuttings or layers. It would seem a logical step to utilize such tendencies in producing improved Ghent hybrids lacking the propagation difficulties of our present stocks. In view of the extreme importance of the propagation factor as a regulator of the dissemination and horticultural use of *any* garden plant it certainly behooves our future breeders to keep more of a weather eye on this problem than many have done in the past. So much for the azalea problem in general. Let us now turn to a review of major accomplishments along propagation lines.

Propagation by Seeds

Seeds provide an easy and relatively rapid means of reproducing azalea species or hybrids where seedling variation is not important. Normal pollination is through the agency of insects and natural cross pollination between adjacent individuals is the rule rather than the exception. While self fertilization is possible on occasion, it has been pointed out by Bowers (2) that self-incompatibility is common. Interbreeding is usually, though not always, possible between members of the same section or subseries but difficult to impossible between sections.

Seed is usually gathered in fall at the time of browning of the capsules following the first frosts. However Creech (5) has found the embryos to be fully developed and capable of germination in seed of several species when gathered, dried at 100 degrees F. for 24 hrs. and sown as early as August 18. The seed is light. That of *R. catawbiense* runs about 5,000,000 seeds to the pound (30). For most azaleas this figure would be even higher. The seed has

no apparent dormancy problems, but loses vitality fairly rapidly in open storage—a loss which may run from 50 to 100% within 12 months. Sealed, cool temperature storage will greatly reduce these losses. When cleaned by removal of dust and debris it may be sown at any time from fall to early spring, many propagators preferring December to January or February in heated greenhouses or mid-April when heat is not provided.

Many germinating media have been recommended: from woodsoil and sand as recommended by Morrison (17) to peat and peatmoss mixtures, sawdust and shredded sphagnum. Advocacy of the last by Stoutemyer et al (11), (24) marked a significant step forward in overcoming usual earlier losses from damping-off fungi. Seed containers may be covered by glass plates or set on open benches in the greenhouse .Morrison et al (18) recommend a night temperature of 55 degrees F. and day temperature of 72 degrees F. for germination. Dr. de Vos has secured excellent results at the National Arboretum this fall by sowing under polyethylene tents or placing seed flats in polyethelene-covered frames on Sept. 9. No further watering was required until the covers were removed during the cotyledon stage. Second and third leaves are now being formed. In unpublished studies at Cornell (1937) Skinner found pure culture germination on agar, using a Knudson's solution containing sucrose, to be a practical method of securing maximum germination from small lots of valued seed. The method has recently been described in detail by Bowers (4). Seedlings are customarily transplanted to prepared soil mixtures for growing on, though the use of sphagnum moss and nutrient solutions has been recommended by Stoutemyer et al (25). Methods of handling both seeds and seedlings were excellently described by Wells (27) in 1949.

Propagation by Layering

While layering is a reasonably effective means of reproducing any azalea or rhododendron, it finds commercial use only for the deciduous hybrid azaleas which do not root readily from cuttings and from which seed would be useless. The physiology of root formation, as in cuttings or layers, was discussed by Mahlstede and Chadwick at last year's meeting. Curtis (7), in 1920, was among the first to prove the effect of ringing in interrupting the downward transport of sugars which gave the clue to the similar effects of wounding or bending, as employed in layering, upon phloem translocation and the formation of root initials. Water and oxygen, as needed for root development, are provided by the moist peat-sand medium in which the layer is embedded.

Layering of azaleas as practiced by the English nurserymen, who use it most, differs from procedures for the evergreen rhododendrons as described by Bowers (2), Wells (27) and others in that with rhododendrons new stock plants are required for each batch of layers, while with azaleas a field of the established stock plants may be maintained in continuous layer production for very many years. Some of the English beds have been used for 50 years or longer. As described by Hanger (9) the system is briefly as follows: Healthy own-rooted azalea plants are set out at 4 x 4 ft. spacing in clean, well prepared peat-sand soil. When well established, these stock plants are cut off at ground level in spring. Vigorous new shoots are layered in a circle about the stock plants the spring following, the shoots being bent upwards, but not notched, and covered with 4 inches of soil, without pegging. With good care,

the layers can be removed the second year, leaving the stock plant again pruned back to the base. This process is repeated indefinitely and continuous annual production can be secured by arranging a rotation so that layers from one-third of the stock plants mature each season. With feeding and good management production increases during successive years. In this country a sizeable shade house provides the most suitable conditions for an operation of this sort.

Air layering with use of polyethylene film, as described by Wyman (31), Creech (6) and others works very well with azaleas. But while it may be a convenient method for use of the amateur its commercial advantage over the older system awaits demonstration.

Propagation by Grafting

Grafting is sometimes used for two classes of azaleas: (1) for "Indian" or Belgian forcing azaleas which are suitably displayed on short standards and (2) for Ghent and Mollis hybrids, particularly as they are propagated in Holland.

In group 1 a tip graft involving young wood is usually employed, as described by Mallinson (15), Bowers (2) and others, the understock being *R. mucronatum* (*ledifolia alba*) or the clone 'Concinna' of *R. phoeniceum.*

Group 2, the Ghent and Mollis hybrids, are handled by the usual veneer grafting of potted understocks of the Pontic azalea, *R. luteum.* It is this class of grafted azaleas, particularly the Mollis hybrids, that have been chiefly criticized as exhibiting poorer performance in this country than own-root plants. Bowers (3) in particular noted pathological conditions which he classified as a probable graft effect. Unfortunately this is a field in which detailed information is lacking. *R. luteum* certainly needs checking as a desirable understock. Regardless of its compatibility with all clons of Ghent and Mollis hybrids, it is certainly a very variable species from different seed sources; some individuals succeed well in our eastern states while others remain indefinitely stunted. Until one is sure of uniformly desirable understocks, grafting may be expected to remain subject to recurring criticism of this sort.

Propagation by Cuttings

For a review of the physiological principles applying to propagation by softwood cuttings, including those of azaleas, I refer you to Dr. Mahlstede's paper delivered before this society last year. I need only enlarge upon a few additional points of particular application as they apply to the two classes of semi-evergreen and deciduous azaleas.

1. *Semi-evergreen Azaleas.*

Procedures in the handling of semi-evergreen azalea cuttings have been reviewed by Mallinson (16), Bowers (2) and others. While cuttings are usually made of half-ripened wood in summer, Hitchcock (10) found that many clons could be successfully propagated in any month of the year. Preston and his co-workers (19) have recently shown that succulent cuttings root best from stock plants on a low nitrogen diet while well ripened wood is quite successful from nitrogen-fed parents. More cuttings were produced by plants on the higher nitrogen diet. As to sequence of cutting availability Morrison et al (18) have observed that the first to provide suitable cutting wood are the soft or thin-leaved azaleas such as *R. yedoense*, next the hairy-leaved types

including *R. mucronatum* and *kaempferi,* next the Kurumes and finally those with the relatively hard leaves of *R. indicum.*

As to rooting mixtures, Hitchcock (10) was among the first to advocate a mixture of sand and peat over sand itself, although some of his best rooting was in pure peatmoss at pH 3.7. Several other media have since been used including Styrofoam (8), Vermiculite (23) and mixtures of these with peatmoss and sand. Each propagator tends to have his own preference depending upon his facilities and techniques.

With introduction of the rooting hormones Watkins (26) was among the first to show the improved percentage rooting of three Kurume azaleas by the use of a water solution of indolebutyric acid at 60 mgs./1. Skinner (21) noted similar effects with a fairly wide range of clons and species but the greatest stimulation was usually secured with those which naturally rooted the most easily. As an aid chiefly in increasing the rate of rooting various hormones, usually at intermediate strength and in powder form, are now used by many azalea propagators. Supplemental bottom heat is not essential to rooting but when hormones are used a temperature in the vicinity of plus 70 degrees F. will hasten the rooting process.

Cuttings of semi-evergreen azaleas have been very successfully propagated at the National Arboretum in cold frames under constant mist as has been described by Wells (28) and others. They have also been rooted with a minimum of effort in polyethylene-covered greenhouse benches.

2. *Deciduous Azaleas*

The deciduous azaleas are distinct from the foregoing in being generally described as difficult to root from cuttings, with the few exceptions among our native species noted earlier in this paper. In contrast with the semi-evergreen types, the young shoot growth matures fairly rapidly, becoming quite hard, and deciduous azaleas are somewhat lacking in the ability of Kurume types to produce successive growths without pronounced rest. Ghent and Mollis-type hybrids were seldom produced commercially from cuttings before the advent of growth hormones. At least one nursery in this country is so propagating them at present.

In the first major tests of growth substances with these particular plants Skinner (21), (22) was able to secure reasonably good rooting with all but one of 19 Ghent hybrids, with all but one of 6 Mollis hybrids and with all of 4 deciduous species tested. With few exceptions (*R. roseum* among them) all of these were rooted without hormone treatment but with a hormone in the form of indolebutyric acid in water solution, percentage rooting was generally increased (to 100% in many cases), the quality of root system was improved and the time required for rooting was markedly shortened. An effective acid treatment was usually a soaking of about 10 hrs. in a 90 mgs./L. solution. Best rooting occurred in closed frames in a sand-peat mixture at 70 degrees F. bottom heat in cuttings set the third week in June. Rooted cuttings were potted and gradually hardened to have dormancy broken by normal winter in cool greenhouse. The turn-off of usuable plants was surprisingly good, as were results from a similar experiment at the Morris Arboretum in which rooting was done in subirrigated vermiculite. Knight (13) has observed that while certain of these azaleas can be induced to root they are too hard to overwinter without severe losses. Kraus (14) recently reported on

the highly successful rooting of 3 Mollis hybrids, *R. nudiflorum* and *R. occidentale* taken as cuttings on May 25, treated with Hormodin No. 2 and inserted in a peat-sand mixture in outdoor frames without bottom heat. All cuttings were potted by August 28, developed short shoot growths and overwintered well. Cuttings taken on July 5 rooted poorly; many developed terminal flower buds in the propagating frame and of those rooted only 1% finally grew the second year. Morrison et al (18) have noted that *R. schlippenbachii* roots freely when juvenile cuttings are taken as shoots from the base of old plants. Future work with this class of azalea might well utilize this observation, take cognizance of the important relationship between time of rooting and successful overwintering, and give passing attention to recent advances with constant mist or polyethylene film. Through improvement of cutting or layering techniques the production of own-root deciduous azaleas may yet become a venture of commercial significance in this country.

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MODERATOR SKINNER: I think it is the usual custom to delay questions after the first talk particularly since we started a little bit late.

If this is agreeable, I would like to introduce the next speaker, whose background is found in a family nursery rignt near by, in Willoughby. He was a graduate in landscape architecture at Ohio State and after graduation was active in various phases of landscape contracting. Since 1946, he has

been busy in expanding activities at the home nursery, where azaleas are grown among other plants and where many of these azaleas are grown from seeds.

It gives me great pleasure to introduce Mr. Zophar P. Warner, Warner Nursery, Willoughby, Ohio, who will talk to us on azaleas from seed.

MR. WARNER: Thank you, Dr. Skinner. I am very grateful that you covered a phase of my talk of which I know very little, and I have completely left that part of it out of my talk.

Mr. Warner presented his paper, entitled: "Azaleas from Seed" (Applause).

AZALEAS FROM SEED

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There are other propagators, several of whom are here, that use essentially the same method of growing azaleas from seed that we use. However, we have had continued success and will offer our procedure in the hope it will be of some value.

In addition to the azaleas that are desirable to grow from seed, the following procedure for the most part can be followed in growing *Pieris, Rhododendrons, Leucothoe, Kalmia*, and similar plants.

Our time of sowing the seed is based on the fact that we want to make use of the winter months and that we want a plant large enough to bed out by the last week of May. That is considered to be the frost date around here. Also we have limited greenhouse space and we do not want too large a plant.

January 15 is about the right time for azaleas. *Rhododendrons* and *Kalmia* should be sown in early December or before. All our flats are 20 x 14" and 2-3/4" deep. Only the depth is important. Less depth will cause drying. More depth is unnecessary and makes flats cumbersome to handle.

Only moist peat should be used in the preparation. It should be neither dry nor soggy. First, about an inch of coarse peat should be placed in the bottom of the flat. From here on, we recommend using only the lighter brown, coarse ground Michigan type peat, pH 4.5-5, such as comes from the vicinity of Sandusky, Michigan. The flat should be filled and firmed to within about half an inch of the top with unscreened peat. The last half inch should be filled and firmed with screened peat.

Now, if I seem to be going a little bit too much into detail, the people who know how to do this aren't going to change their method anyhow and I am sure the people who don't know can have success by using this method. I believe one of the main features in using Michigan peat is that you don't have to know what you are doing to have success.

Actually, the plants will do better in the unscreened peat but it is easier to separate the plants at dibbling time if screened peat is used. Clean seed is then sprinkled over the prepared flat. If the seed is good, it is easy to get them too thick. After seeding, sift on just enough ground sphagnum moss to barely cover the seed. Place the flat in a water pan until it is completely soaked

to the top. We then set the flat in the greenhouse in full light. Temperature from 70 to 80 degrees F. are desirable, 60 degrees F. will slow things down a little. Water lightly from the top just as soon as the sphagnum shows dry.

We grow our seedlings in an old tumbledown greenhouee that has a lot of air circulation in it, consequently, there is little trouble with fungus. When necessary we use Natriphene. A good house for rooting cuttings is definitely not good for seedlings unless it is properly ventilated.

The seedlings are ready for dibbling as soon as the first two seed leaves appear. Very little root system has formed, consequently, the plant is retarded very little, and it is most easily removed from the seed flat.

The transplanting flat should be about 3/4" deep, filled and firmed with moist, coarse ground, lighter brown, Michigan-type peat mentioned before. No fine screened peat should be used as it prevents aeration and encourages the growth of moss, which is undesirable. The plants are lifted with a steel writing pen, prepared by heating the point and spreading. We favor making a little hole, pencil size, in the peat, so that the stem of the plant will not have a kink or twist. The kink formed if the plant is pressed into the peat with the pen alone may break during heaving the first winter. We once had about a half bed of Carolina rhododendrons break out and I couldn't figure out what bug was active in freezing weather. I discovered there had been a little curl put in the stem. Since they were brittle, they were forced out by heaving.

We plant 350 plants in a 14 x 20" flat. We don't use a template to mark the holes. I don't know if it would work in the coarse peat. A person should soon be able to do a flat of 350 in an hour. It helps to sprinkle the flats lightly the day before dibbling. That will hasten speed of operation because the loose peat won't cling to the tools. After each flat is finished, it should be completely soaked by setting in a flat pan of water.

The flats are then placed in full light and watered from the top as soon as the peat shows drying. It is usually not necessary to water for a couple of weeks but as the days lengthen and the greenhouse becomes hotter, two waterings a day may become necessary.

We set the thermostat at about 60 degrees F. but do not worry about ventilating until it is over 80 degrees F.

We have used Fermate weekly as a preventive fungicide, but I don't think it has been necessary to use it during the last year or two.

We make two applications of Rapid-Gro about three weeks apart, the first coming after growth is well started. I don't think it is desirable to use even liquid fertilizer when the plants have just been disturbed. It might work but I have always been afraid to try it. It is probably not desirable to use acid type fertilizer when pure Michigan peat is used.

By the middle of May or probable frost free date, the plants should be three or four inches tall. The flats can be carried outside in full sun, and cut back with the hedge shears. The greenhouse has been completely unshaded during this time. If you are in a warmer section, you will have an earlier frost free date and can get them out sooner. You do have to ventilate quite extensively, and consequently, water extensively. It is not desirable to cut back the plants and plant immediately afterwards. Buds should be well started first.

Another application of liquid fertilizer about a week before planting is helpful in breaking buds.

In preparing field beds, I will assume we are starting with good soil, usually old bed areas with a high percentage of old peat. We use no boards or concrete structures to make frames.

First, we make a heavy application of cow manure if we can get it. The whole area is then disked or rototilled. The beds are laid out 80" center to center with 24" paths. This allows two row trailers and tractors to run over the beds with the wheels in the paths. Three or four inches of soil are shoveled from the paths and spread on the beds which are raked level. This should probably be done mechanically. When I have just another mile or two of beds I will figure out doing it that way. An application of commercial fertilizer is then made and about four inches of Michigan peat are spread evenly on the bed. DDT is applied on top of the peat. to keep out white grubs and Japanese beetle larvae.

An irrigation system that applies water at a low rate is the best. This prevents puddling and also allows longer applications of water during the heat of the day. We use nozzles of No. 1 or No. 2 size which can be turned on as planting progresses. You don't have to hold up planting operations while you water. There should be no delay in watering on hot days. Areas planted at 12:00 o'clock and not watered until 1.00 will suffer severe losses.

The beds should be thoroughly watered the day before planting, or even longer ahead than that, and the flats of azaleas should be thoroughly soaked before being separated for planting. This keeps root damage to a minimum and starts the plants off in a turgid condition. It helps in handling if the roots, with peat adhering, are squeezed into a compact ball. By this time, the flats are completely root-bound and there wouldn't be any loose peat left in the flats after you separate it.

Spacing should be gauged so that plants will be crowded but not damaged by crowding at the end of the first growing season. Less space is required and better growth is obtained if the plants are not too far apart, three or four inches apart is about right. We place 16 to 18 plants across a bed that is 54 or 56 inches wide. Shading is not used at any time.

Wiltpruf cuts down drying-out but it will also substantially delay starting of growth. If watering is watched closely, it is not necessary to use it. Watering twice a day may be necessary at first. Later, once a day and finally every other day will do. If peat shows drying in the early morning, the beds are too dry.

In about a week after new growth is evident, we make a light application of Vigoro and water it in. When we are far enough along to apply the first fertilizer in June, another application is made not later than July 15.

We spray periodically with a mixture of Captan, Malathion and liquid fertilizer. It should be repeated every two weeks. Normally, no fertilizing of any kind is done in September. Irrigation is also tapered off in September.

By fall, plants have a large peat ball and little winter heaving occurs. When cold weather comes, we mulch with shavings or sawdust. In the spring, plants are ready for sale as liners or for replanting.

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MODERATOR SKINNER: Thank you Mr. Warner for your excellent discussion. I think we have time now for some questions before a little break, and before the last half of the program.

MR. JOHN D. NORTHRUP (Northrup's Nursery, Conneaut, Ohio): I have two questions. The first one has to do with the hardiness of the Knap Hill hybrids and the second one is, I would like a formula to make up an inexpensive liquid fertilizer for azaleas.

MODERATOR SKINNER: Suppose I try the first question on the Knap Hill hybrids. To my knowledge, the Knap Hills have not been sufficiently tested to be able to tell very much about their hardiness. They, of course, are improvements of the older Ghent forms of azalea. They are coming into this country and we suspect they will be fairly hardy.

There is the fact that both the Knap Hills and the Exburys have supposedly more blood of our western azalea than some of the old Ghents, and we know *Azalea occidentalis* is a poor grower in the East. It stands our winters but becomes chlorotic in the summer. For this reason, we have our fingers crossed a little. We believe many forms of the Knap Hills will be hardy. Has anybody had any experience with them?

MR. ROLAND deWILDE (deWilde's Rhodo-Lake Nurseries, Shiloh, N. J.): While I haven't had any great deal of experience, we made some experiments with Knap Hills and after the first year, when they were spotted in flats in the greenhouse, just as Mr. Warner has explained, we put them out in an open frame or without any shade whatsoever the following winter and we saw no appreciable difference between that and the ordinary *A. mollis*. They stood -4 degrees F. without any injury, so I would say they must be fairly hardy.

While I am on my feet, about *A. occidentalis*, I sowed seed in '52. That is now in the open field and went through one winter, last winter, without any protection and there was no dieback. They grew fairly well this summer, although they did have a good bit of shade, especially in the afternoon from the woods. That may be part of the answer. I would say they need a little more shade than the average man would give. How they will do this next year, I don't know. You can come and look.

MODERATOR SKINNER: There was a second part to this question —the formula for an inexpensive liquid fertilizer.

MR. JOHN D. NORTHRUP: Agrico has been recommended and I have used it, but I don't consider it particularly inexpensive. The price I paid was $110 a ton. If we can buy lower-priced forms of nitrogen and fertilizer and if we knew the proper ingredients, I believe we could build up a much lower-priced fertilizer.

MODERATOR SKINNER: Does anybody else have any information to offer?

MR. HARVEY GRAY (Long Island Agri. & Tech. Inst., Farmingdale, L. I., N. Y.): In answer to that question, I think I can throw a little light on it. I suggest you pay no attention to your phosphorous and potash in your fertilizer. You put that in your soil and then as far as your nitrate is con-

cerned, do that with urea in the liquid form. The rate of application was discussed last year. Urea, 45 per cent nitrogen, is quite inexpensive when you figure on the cost of nitrogen.

DuPont's Nu Green, which is a trade name, can be made up inexpensively by making an application through your irrigation, using two pounds of urea to each 1,000 square feet of area that you are covering, and there are techniques and devices on how to get this urea in your irrigation line. If anyone is interested, I would be glad to show them a little diagram as to how the thing could be set up.

MODERATOR SKINNER: Thank you, Mr. Gary. Is there another question?

MR. JAMES S. WELLS (D. Hill Nursery Co., Dundee, Ill.): Mine isn't a question; it is a comment on foliar feeding. I don't like foliar feeding. Jack Hill refers to my attitude as a "monastery gardener". I am a monastery gardener. I admit it without any quibble.

That people are using foliar feeding is obvious. That they are getting quite good results is obvious, but I think the whole thing is dangerous if we come to rely too much on this type of culture.

I prefer to prepare the ground well and to top dress my azaleas with tankage as an organic and slowly available form of nitrogen, which is reasonable in price—$65 to $70 a ton, and you don't need a battery of white-coated scientists to determine just what to put on.

MR. GRAY: Henry, I want to answer Jim, if his interpretation of my explanation made last night was foliar feeding. Did you get that idea?

MR. WELLS: No, I didn't.

MR. GRAY: No, it is irrigation rather than foliar feeding.

MODERATOR SKINNER: I think there is very good sense to foliar feeding. We know that it was developed as a quick shot in the arm for fruit trees without a carry-over effect. The importance of a soil application for prolonged growth is very well taken.

MR. CASE HOOGENDOORN (Hoogendoorn Nursery, Newport, R. I.): You mentioned raising azaleas from cuttings. A few years ago we rooted some *Azalea lutea*. After they were rooted and potted, they were rerooted. We carried them over to the sash house at 40 or 45 degrees F. and I don't think five per cent of them ever broke again in the spring. Will you give me the reason why?

MODERATOR SKINNER: I think it hinges on a point stressed at the end of my paper. Dr. Kraus pointed out that earliness of rooting is probably the secret of carrying over. I have rooted cuttings early in the season from plants in the greenhouse and there you have a cutting which can be established early. You may get some growth on it the first year, and I don't think you have trouble with over-wintering. I believe your trouble comes from taking cuttings too late in June or July and not getting any bud activity. They just won't carry over. If your cuttings are taken in May, I believe they will come through.

MR. ROGER COGGESHALL (Arnold Arboretum, Jamaica Plain, Mass.): We tried several years to root *Azalea calendulacea.* We found we could root them and not over-winter them. Last year for the first time, we succeeded in getting a fairly good percentage to live through the winter. I think it is primarily due to what you say; since the cuttings were made the last week in May in comparison with the last week in July. The July cuttings died almost completely, whereas, every single one rooted that were taken in May. That is the first time we have been able to do it.

MR. CARL WILSON (Cleveland, Ohio): When I was out to Mr. Warner's place I noticed he used sawdust quite extensively. Do you use it for replanting with azaleas or with such things as *Juniperus virginiana* or Pfitzer's juniper?

MR. WARNER: We generally make sure we have a higher nitrogen fertilizer, where we mulch the beds over and where they stay for another year we like to make an application of ammonium sulphate and some other nitrogen fertilizer.

I do think it is better to use shavings, chips, corncobs or peanut shells or anything that is larger and more porous and less solid and decomposes more slowly because sawdust, if it is several years old, even in a large pile will drop the nitrogen.

Could I ask a question while standing up? I was wondering if anybody has had any experience in this. In speaking of foliar feeding, I am not just thinking in terms of inducing growth. What about using liquid phosphorous as a means of slowing down growth in September when you are afraid you are going to have frost in two weeks. Has anybody had any experience with that?

MR. DE WILDE: I didn't use phosphorus but I used potash on the basis of some research. On tomato plants you can reduce phosphorus by the use of potash. A few years ago I fed these azaleas pretty hard and along about the first of September it looked as though I was going to have trouble, so I inquired around and the consensus of opinion seemed to be that the best thing to do was to use both nitrogen and potash, since if the nitrogen happened to be low, potash wouldn't be absorbed properly. But I don't think this is to be recommended. I think it is better to cut down feeding through your irrigation system sooner, even at the risk of getting plants a little underfed toward the end of the season, because you would have less bud trouble.

MR. JOHN VERMEULEN (John Vermeulen and Son, Neshanic Station, N. J.): I would like to make a comment rather than ask a question. I think in general we are putting too much emphasis on growing big and tall plants. We were taught to grow a sturdy plant and the size of seed didn't make any difference. We ship our plants all over the states and by growing too fast a plant in one season we take a certain amount of strength out and all people can't take care of it. I think if you get too much fertilizer you get it too big.

MODERATOR SKINNER: The next speaker on the program comes of a family that has been known for many years in nursery circles. As owner of Rhodo-Lake Nurseries at Shiloh, New Jersey, he has been active in the New

Jersey Nurserymen's Association and knows a great deal about azaleas, rhododendrons and their propagation.

It is my pleasure to introduce Mr. Roland de Wilde, who will talk to us about azaleas from cuttings.

Mr. Roland de Wilde presented his paper, entitled: "Azaleas from Cuttings". (Applause).

AZALEAS FROM CUTTINGS

ROLAND DE WILDE

de Wilde's Rhodo-Lake Nurseries, Shiloh, New Jersey

I am not going to spend too much time on the propagation of the Kurumes and that type of azalea because of the fact that a great many people know how to do it. As a matter of fact, in our part of the country every cross-road farmer has a batch of azaleas and they are as common as weeds, and I am afraid they will be pretty nearly as cheap as that before too many years. However, we like to do things just a little different from the common practices, so I will just briefly explain our method.

First with Kurume cuttings and *Rhododendron kaempferi*—the standard practice is to make the cuttings from wood that has nearly finished growing. It is not important to do that.

We stick the cuttings in sand and peat in a cold frame. The cold frame is constructed out of a 4-inch wide concrete box two blocks high and filled up with a medium of half sand and half peat. We try to be a little heavy on the sand, especially if we use the peat dry and the peat swells when it gets wet and increases in volume.

After the cuttings are stuck, we put the sash on tight. We make the frame air-tight with the aid of some burlap around under the sides of the sash and in between the sash we weatherstrip. We whitewash the glass and put a shade on it. In addition to that, we have what you might call a lath house, for built over the frame is an iron plate with wire-bound shade. That is about six feet or more over the top of the frame. The only reason we do it is that it helps keep things a little cooler when you have the frame up, to stick the cuttings. The boys like it and it is not a lot of work.

When the cuttings are set, we stick them well down, practically flood them, put the sash on and leave it on for the next six or eight weeks. If it is dry, like this summer, we open it up and give them a drink.

Normally, we get a stand that varies between 80 and 100 per cent. Sometimes it is a little less. Occasionally, you may get a few rotten cuttings. There is practically no work to it and that is the way we do it.

The plants are left in the frame all winter long. We put a mat on top to help prevent freezing. Back in the early thirties we used to have winters when the weather man reported it might go to zero, so we had that to keep the things from freezing.

They stay in that frame until after we finish shipping, which may be the first of June. By that time, they usually have made some growth. We

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promote that by the use of a dose of liquid fertilizer, usually do it with a watering can, because we usually don't have too many. About a tablespoon of I. P. Thomas 3713 to a gallon of water gives them enough of a boost to grow from 2 to 4 inches, depending on the variety. When we get ready to plant them we put them in field beds without sides, but with overhead shade. They are planted 4 x 4 inches on an average. When the cuttings are taken out of the frame we take as many as we can hold in our hand and chop the tops off to get them to break better.

In October we try to break them up by replanting at 12 x 12 inches field beds. The reason for doing that is because we find that moving them inhibits the chance of bark splitting, especially varieties of *A. ledifolia*. That is always a problem. You can be pretty sure that if you get them out in time you are going to have very little trouble.

We leave them for a full year, and usually we find that the following year we have to dig most of them because they need transplanting. We sell a lot of them at that stage. The ones that are too small to sell or are not shaped well enough are replanted in the field. The rest are held under shade with the idea of having them handy to ship.

It is quite a bit of work. But if you have to get 3,000 or 4,000 azaleas out, it is easy to dig them out of this bank, and load them on a truck. It is not like having to go out and label them in the field.

As to fertilization, we used to use a mixed fertilizer. At present we use castor pomace which is a cheap organic fertilizer. It usually has five to seven per cent nitrogen, depending upon how it is made. It is fairly slow and is safe for practically anything. We put it on when we plant in the fall or spring. I like it better in the fall because it gives more time for it to break down. We use it at about 1,000 pounds to the acre, although a little more won't hurt. I have never burned anything with it yet.

Then, we used to have a mixed fertilizer which amounted to a 3-10-10, with which we top-dressed in the spring. Lately we have had such hot dry summers, that this year we used just fertilizer through the irrigation system, which is a very simple proposition.

In a steel barrel, cut in half to be easily filled with water, we place a 25-pound drum of liquid fertilizer and stir it in. From the pump at the suction line we bring about a quarter-inch gas-line with a small gate valve. This line is primed before the pumps are started. Once running, we usually leave our irrigation on for an hour as a minimum and we have found by past experience that if you open the valve wide you can suck up about 25 gallons in 25 minutes, so about 25 minutes before we get ready to shut it off, we open this valve, and it sucks the tank practically dry, leaving about a pint in the bottom for a primer. We then move the line and go on to the next location. In that way, we can get approximately 250 pounds of the liquid fertilizer, in dry form, to an acre of azaleas, which we find is an ample dose. The treatment is repeated two or three times depending upon how well they are growing.

The only caution with the liquid feeding is that it should not be used too late. We find that latest possible date in our climate is the 15th of August. I think it takes at least two weeks to use up each dose and you want to be sure there is not too much nitrogen in the ground when the first frost comes, because you will lose your buds.

We like liquid fertilizer. It is not foliar feeding. It is actually fertilizing through the irrigation system. The fertilizer goes to the roots with very little on the foliage.

Some people grow Kurumes in the wintertime in the greenhouse and get a little bigger plant than we do in the same length of time, but we have always found it expensive to keep them in a heated greenhouse all winter and so we use this system.

As to the question of rooting deciduous azaleas, I don't profess to have the whole answer. Frankly, I haven't done it that long, but we have tried for about three years now. The first year was strictly a failure. We rooted a few but didn't keep any over the winter. The second year we did a little better. That year we used two different strength hormones, Hormodin No. 2 and No. 3 and we found very little difference in results, if anything, we got better with No. 3. We also wounded them, which is a trick I think Jim Wells has popularized. It helped.

The main trick with rooting deciduous azaleas is to get them as early as possible. That is quite a job with most of us because we are busy as a rule trying to get our stuff shipped out. That means with us that we have to stick them around the 1st to 15th of May.

We like heel cuttings and just strip off the crowns of the plants before they have had a chance to get even remotely hard. All you need to do is to get them fairly stiff around the base, so you can get them in the sand. We cut the leaves back to half their length but we don't take any off. They seem to root best in a sand-peat mixture.

Rooting is not such a problem. The question seems to be what to do with them after you get them rooted. The first year those that rooted I stuck in a cool greenhouse with low heat. That turned out to be a total failure. I don't think any one of them lived. *A. calendulacea* and all the more common varieties were there.

The second year we got them quite a bit earlier and they rooted earlier, and then I didn't pot them at all, but took them out like seedlings of rhododendrons and azaleas into prepared cold frames with plenty of peat, planted under a shade. Most of them came through fairly well. We don't yet have the complete answer because, I have done it on a comparatively small scale.

I think that about covers the essentials of my topic. If there are any questions I will try to answer them to the best of my knowledge.

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MODERATOR SKINNER: Mr. de Wilde, while you are here on the platform, first, we want to thank you for the talk, it was excellent. Secondly, I think we will have a few questions. You made a nice, concise job of getting it done.

MR. HOOGENDOORN: What was the percentage rooting on those azaleas?

MR. deWILDE: It varied a little from variety to variety. I didn't keep an accurate account. The husky ones like 'Aida' rooted practically 100 per cent. The straight mollis—like 'Dr. Moerlands' rooted fairly well, too. Off-hand, the only one I could think we had a little trouble with was *A. occi-*

dentalis. I don't think it ran over 60 per cent. The year before it was practically 100 per cent. I can't account for the difference unless the cuttings were a little too hard. I would rather have taken them two weeks sooner but the greenhouse was jammed full.

MR. ART VUYK (Musser Forests, Inc., Indiana, Pa.): Were the cuttings from forced plants?

MR. deWILDE: No. The only difference probably from your situation and mine would be that our stock plants are planted in the woods, and the reason for that is not only the fact that they grow a little better, I find the cuttings I take out of a fairly densely shaded woodland, and that applies to the rhododendron as well as the azaleas, root slightly better. I think Jim Wells will agree with me on rhododendron after looking at the list. I have some results he hasn't got yet, I think mainly due to the fact in a fairly dense shade they don't get woody.

MR. VUYK: I happened to be at the Experiment Station in Boskoop about three years ago and they were making azaleas in big numbers from the deciduous Ghent and mollis varieties. They all made those cuttings from plants brought into the greenhouse the first week in April. They forced them and the shoots were long enough to make cuttings. They inserted them in the greenhouse right away. In their checks in the sweat box—they rooted very rapidly and they claim that azalea cuttings taken from forced plants root more rapidly, and the second point, as soon as they were rooted they took them out and planted them in a cold frame, covered with a sash where they broke dormancy. They made very little new shoot growth. None of them died during the winter, and they popped out very nicely next spring.

MR. deWILDE: I think it is essentially the same idea. You get your cuttings soft enough. That is the beginning of the secret.

MR. CHARLES HESS, SR. (Hess' Nursery, Mountain View, N. J.): What I want to bring out, if I may, about losing azaleas in a heated house. If you keep them in a cold frame and expose them to the cold you will carry them through. If you carry them in a heated house you will lose them. With dogwood cuttings, if you get them rooted and keep them in a heated house over winter they die from the top down or from the roots up. If you expose them to a light frost you carry them through. That is the secret. You try it and prove it to yourself.

Another thing I wanted to mention. Nobody has mentioned cotton-seed meal as one of the best fertilizers for azaleas.

MR. deWILDE: We used to use it before they charged $120.

MODERATOR SKINNER: Just one comment on the fertilizer. I think Mr. deWilde will find if he likes the Ghent and mollis types, that they respond to more fertilizer than the Kurumes.

MR. deWILDE: We use it on seedling stock. A thing I forgot to mention is that the only way of getting the deciduous azaleas from cutting is to use a mist system. I happened to use constant mist. I suppose intermittent would do.

MR. WELLS: This isn't a question. It is just a little bit of additional information. I entirely concur with Roland and other people on the importance of taking the cuttings early, and I think in general most of us are afraid to take the cuttings as early as we should with misting.

In the one small series of test which we ran before I left Koster Nursery, we got a steady picture of increased rooting on all of these deciduous azaleas by using this new Geige chemical No. 416, and that was consistent over about nine named varieties, including mollis, occidentalis and others. I haven't a chance to do that again, but I can let anyone have some of the powder if they are interested.

MR. A. M. SHAMMARELLO (South Euclid, Ohio): I understand after you insert the cuttings you don't syringe them; you just water them heavily.

MR. de WILDE: In the cold frames we don't even look at them.

MR. SHAMMARELLO: Are they shaded heavily?

MR. deWILDE: We leave them alone and you could possibly get little better stands if you watched them in the greenhouse the way a lot of people do. We figure that if we lose 20 per cent, what is the difference? It is easy to make another couple of thousand cuttings. It is a question of economics. There are probably better ways of doing it, but it happens to be economically very handy for us.

MR. SHAMMARELLO: I am surprised they root at all under heavy shading. That is what caused me most of my trouble.

MR. deWILDE: If you left bare glass, it would get too hot in summer. That is the reason why all the deciduous azaleas have to have shade. We wouldn't have any leaves on them the first of June.

MODERATOR SKINNER: Thank you very much, Mr. de Wilde. I am sure there are a lot more questions. We may have a little time at the end for extra questions on general subjects.

Our last topic is to be discussed by another very well qualified New Jerseyite, who has a background of many years service with Bobbink Nurseries, the wholesale division of Bobbink & Atkins of East Rutherford of which division he is an officer and director, as well as being noted for his activities in numerous nursery and florist organizations. It is my pleasure to introduce Mr. Everett L. Conklin to speak on azaleas from grafts.

Mr. Everett L. Conklin presented his paper, entitled: "Azaleas from Grafts. (Applause).

AZALEAS FROM GRAFTS

EVERETT L. CONKLIN
Bobbink Nurseries, East Rutherford, N. J.

In this modern age of propagation of azaleas there are very few left which must, or rather, can be grown from grafting. The field is limited primarily to the florist-forcing varieties, of two groups, — the *A. rutherfordiana* and the *indica* varieties. These varieties are hardy in practically all of the State of California, that is, the coastal part of California, the immediate Gulf counties and a part of Florida. However, beyond those areas, they are not comparatively hardy anywhere else in the country. There are a few isolated instances where we will find some growing in Washington, I know, that have been there for some years, but we would prefer to say they are not dependably hardy in such areas.

Briefly, the history of the grafting of *Azalea indica* goes back to the early 1800's, reaching a rather large scale in Belgium around 1870, and in this country since quarantine 37 prohibited their importation about 1920.

Last night, in making my notes, knowing the growers throughout the United States as I do, I added up the quantity of *A. indica* and *rutherfordiana* being grafted at the present time, and I was surprised when I added it up and came to one and a quarter million per year. I am sure that is a conservative number. It could run to one and a half million per year, so it is a rather big industry.

They are grafted primarily on the east coast, in the New Jersey area, and on the west coast in California and the State of Washington.

Why graft all of these *A. indica* and *rutherfordiana* varieties? The reason they are grafted is that in later years the own root plant, for one thing, does not have the eye appeal. It is a low squatty plant, and secondly, which is perhaps most important, it does not develop as well. The inside of it tends to open. It tends to lose its foliage on the inside and, generally speaking, the root system never is strong enough to match its rapid growing top.

Many growers in this country, during the past 20 years, have grown *indicas* quite extensively on their own roots, but I think all of them have now gone back to grafting, that is, in large quantity production.

The understock which is used is *A. phoenicea* 'concinna' erroneously classed by everyone as 'coccinea'. Cuttings of 'concinna' are rooted from about the 20th of May on. Since it is not hardy, we have stock plants growing in the greenhouses which serve as a source of supply of cuttings. Also, the cuttings are available from the one and two-year old grafts, that is, they are allowed to grow as shoots on the side of the understock.

The cuttings root very easily. We do not treat them in any way, mostly because it is not necessary to treat them with any root-promoting agent, and in about six to seven weeks they are ready to be removed from the sand. They are then potted in a mixture of two parts leaf mold, that is, acid oak leaf mold, two parts of imported peat moss, and one-half part sand.

We then let them grow, depending of course very much on the time of the year, until they reach the stage ready for grafting. This is approximately

eight weeks after the time it has been potted. After it reaches that size, which is roughly 3/32 to 1/8 inch diameter and rooted through the pot, it is ready for grafting.

Now the next step, of course, is the actual grafting and the grafting is begun about October 20th, as soon as it is cool enough, and carried on until it is too warm to graft, which in our part of the country is about the 15th of May.

As to the exact, actual grafting process, perhaps I can demonstrate that by enlarging the motions through which the grafter goes.

To begin with, this is a softwood graft as opposed to a hardwood graft, as is usual in practically all other nursery practice. The scion is in a vegetative state and the understock is also. The graft is a cleft-wedge graft. Taking the understock first, the top is cut off, the top three inches, and then a long cut is placed in the side of the understock. At the point where the cut is to be made the leaves are plucked off. They are not pulled down because of the danger of ripping the bark. Then one straight vertical incision is made. The scion is then cut with two cuts in a wedge shape and it is inserted into the understock, held there with the thumb and tied in place with mercerized crochet thread No. 60, wound with the top down, and the two ends pulled together and twisted. It is not tied because tying would take too long.

As to the actual grafting operation, a good man can turn out about 800 in an eight-hour day. He has to be a fairly good grafter to turn out that many.

No wax or other protective coating is used after the graft is made. We have found that is not necessary and every possible motion we can remove we have removed in this rather large operation.

The removal of the thread later on, incidentally, is quite a chore. It takes up a lot of time. We, along with Dr. Davidson of Rutgers, are now working on a self-disintegrating thread which would last approximately six weeks and pull apart. If we can find one it would save a great deal of time.

After the graft is made, beginning in October, carrying on through the winter months, it is placed in a standard grafting case, which is run at 70 to 75° F. Opaque paper (ordinary wrapping paper) is rolled over the case to keep it dark during the brightest weather. There are times, as at this time of year, when there is a great deal of cloudy weather and the sun is not too strong. Then it is not necessary to use the paper. Incidentally, the grafting cases are in a greenhouse which in itself is light and very lightly shaded.

The grafts are lightly syringed just before placing in the grafting case and it is very seldom necessary to water them at any time after that until they are united. After 26 days the cases are aired very slightly, with a crack of not more than one inch, perhaps from a half to one inch for one-half hour a day. After 38 days we extend the period to one hour per day.

The complete union takes place in from 42 to 48 days. At that time, the thread is removed, the sashes are removed and the heat is kept up in the greenhouse to about 70 or 75° F., then gradually lowered to harden them off. They are left for about two months in the pots during the winter months, but later on not that long. They are removed from the pots and transplanted in the greenhouse benches in sash houses. They are left in the sash houses for

one year and then transferred into beds where they are grown under larger sashes.

The general take in grafting runs somewhere between 85 to 94 per cent. I say 94 per cent because in my 16 years with Bobbink and Atkins that is the very highest we ever had. That is a 6 per cent loss. Most of the time it runs around 85 to 90 per cent. We would like very much to increase that, but don't know just quite how to do it.

Now this procedure, as I have outlined to you, is old. It is old-fashioned. There is absolutely nothing new about it. It has been used for 20, 30 or 40 years. However, we are continually experimenting and I thought perhaps some of our experiments might be of interest to you because only by experimenting can we find something that is really worth while and use it.

First of all, we know that light is a factor. During this time of year when it is not necessary to shade the grafting case with opaque paper we get a relatively quicker union. When it is necessary to use this paper or to shade them, the time is prolonged and it seems to be almost in direct ratio to the length of time that the paper is on or off.

The time saved is perhaps only 3 or 4 days, but nevertheless, it proves to our way of thinking that light is a factor.

Secondly, we are trying a little foliar feeding. Now, I hasten to add right here that we do not believe in foliar feeding in the greenhouses or in the fields. We don't like it. We don't think there is any need to use it, but we do feel that a little foliar feeding just before the time of grafting adds sufficient food which is necessary to complete a better and quicker union. During the time it is in the grafting case, of course this is impossible because the foliage is covered with moisture all or most of the time.

We would like very much to graft 12 months of the year. We could very easily prepare the understocks. We can easily obtain the scions, but during the hot months of June, July, August and September the mortality is too great to warrant doing it at that time of year. We think there is a possibility in the use of misting, either constant or intermittent misting in an enlarged grafting case. By that I mean perhaps a polyethylene tent for lack of a better name, which is 6 to 8 feet high above the bench in which there is constant or intermittent misting. With nozzles, it would reduce the temperature and we might get the results we like to get during the summer months. Next summer, we shall experiment a great deal more with this method.

There are many times of the year when scions are obtainable, but the understocks aren't ready. So we have experimented a little bit with cold storage of scions and we have found that these scions stored at 33 to 34° F., in a polyethylene wrapped envelope with the tops exposed, and with peat moss, sphagnum moss or any other moisture-containing substance about their bottoms will keep in good condition for about four weeks. After that, they looked all right but the losses were great.

In the use of Wiltpruf or other antitranspirants, for spraying the grafts immediately after the grafting process, we noticed no difference between treated cuttings and grafts and those that were untreated.

I think that pretty well covers the field of *Rutherfordians* and *indicas*.

Now I shall touch very, very briefly on the grafting of the *mollis*, *pontica* and *rustica* varieties. To begin with, we are probably one of the two

or three concerns in this country that still graft. We graft a very, very limited amount, primarily because, as Dr. Skinner said earlier, we can import them a lot better and a lot cheaper than we can graft them ourselves.

We do feel, along with Roland deWilde, that a new strain, a new and better strain, based primarily on our native varieties of *A. calendulacea* and so forth, would certainly be welcome in this country. There is too much *A. pontica* in our opinion in the varieties that are available in the European countries at the present time. I think we would all like to see some hybridizing work done along these lines.

Now, the actual graft. This is a hard graft done in January and February. It is a heel graft done very much in the same way as you graft your evergreens and other things. The understock that is used is - *Azalea pontica,* or in better terms, *Rhododendron luteum.* It is unsatisfactory as Dr. Skinner pointed out. It is never quite the same. You are never, quite sure what you are going to get. I have seen rather large quantities of them go into small leaves and yellow leaves, mildewed and in such bad shape we wouldn't use them as a stock. Other times they will come through with hard, shiny, good foliage.

I think I have fairly well covered the field. This grafting or reproduction of azaleas, as is true of all things, you have got to give it some thought. First, you have to think. You know there is an old saying we are all equipped with to ends—one to think with and one to sit on. It is up to you to choose. Heads you win and tails you lose. Thank you.

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MODERATOR SKINNER: Thank you, Mr. Conklin for a very nice talk on grafting. Let's have just a few questions preferably on the last topic. Then we can throw it open.

MR. HOOGENDOORN: Mr. Conklin, one of the reasons I graft these Belgian Azaleas is to have a better plant but also to secure uniform blooming. I have seen plants where half the plant is over and the other half coming into bloom, because it was cutting grown.

MR. CONKLIN: There is a great deal of truth in that. However, that is especiaily true of the early flowering plants. Lately we pre-cool during the month of October for a 30-day period, which results in uniform flowering at Christmas time.

MR. HOOGENDOORN: You mean you put those in storage?

MR. CONKLIN: Yes, that is right. We do it on a limited scale because storage space is expensive and it must be done at an exact temperature. That is a big field. I could go into it but I won't take the time.

MR. HOOGENDOORN: One more question. You say you graft your *Azalea japonica* in the winter, dormant. What is your percentage?

MR. CONKLIN: Yes we do, but it is not good. It is less than 50, however I don't know exactly.

MR. HOOGENDOORN: We tried over 30 years ago grafting in the summer, just as we did it in Holland. The only trouble we found with the

A. japonicas, you thought you had a good scion and you put it in the bench, three days later it would be hard as a brick and it would never callus. They turn hard very quickly.

MR. WELLS: I would like to ask Mr. Conklin, do you bury the point of union when you put the grafts under the case?

MR. CONKLIN: No, the level of the peat moss or cinders, is never above the lip of the pot.

MR. WELLS: Would it be harmful in your opinion if the point of union were buried?

MR. CONKLIN: I am not sure. I don't recall ever having tried it.

MR. WELLS: The purpose of the question is that if you try grafting in an open bench without double glass but with the point of union buried you could add intermittent misting. On the work we have done, not on your plants, all indications are that higher percentages are achieved in that way.

MR. CONKLIN: That is a good thought. We shall try it.

MR. LESLIE HANCOCK (Woodland Nurseries, Cooksville, Ont.): You mentioned *Azalea 'concinna'* as a stock. Is this a clone?

MR. CONKLIN: Yes, I would say so. It does not set seed.

MODERATOR SKINNER: Mr. Conklin, I think to stick to schedule we will stop now. Thank you very much for your talk.

I will now turn the meeting back to Dr. Chadwick.

PRESIDENT CHADWICK: Thank you, Dr. Skinner, for conducting a very interesting session this morning on propagation of azaleas, and I also want to thank all of those who participated in the meeting this morning.

The session recessed at 12:00 noon.

has been in print since the early 1800's on the vegetative propagation of beech and of linden.

Dr. Creech presented his paper entitled: "A Review of Vegetative Propagation of Beech and Linden." (Applause).

A REVIEW OF VEGETATIVE PROPAGATION OF BEECH AND LINDEN

JOHN L. CREECH
U. S. Plant Introduction Garden, Glenn Dale, Md.

Beech and linden are among the deciduous shade trees that generally are propagated from seed. At least in the case of beech, vegetative propagation is very difficult while linden falls into that category of plants for which layering, a practice only occasionally used in this country, can be substituted for seedage. A review of some of the literature pertaining to the vegetative propagation of these two trees has been suggested as an appropriate subject to present to the 4th Annual Meeting of the Plant Propagators Society. Most of the observations were made by European nurserymen and we find that discussions of beech propagation appeared frequently in such periodicals as the Garden's Chronicle of England, and Moller's Deutche Gartner-Zeitung, a German publication. Because some of our earlier colleagues were aware of techniques that may not have been passed down, a discussion of observations made by horticulturists during the past century is worth our consideration.

Beech — In 1889, the Wiener Illustrierte Garten-Zeitung (4) listed 55 varieties of the European beech. Eleven years later, Bean (6) described only 21 distinct varieties which he classified on the basis of (1) tree habit, (2) leaf form, and (3) leaf color. Wyman (22), regarded as our current authority on recommended varieties of ornamental plants, lists only 8 clones of the European beech worthy of cultivation.

While the main reason for this reduction in the number of clones is due to the discarding of duplicate and inferior varieties, some of the disappearances undoubtedly were brought about by the difficulty encountered in vegetative propagation. This problem is emphasized by the fact that in the trade papers of the past 100 years only rarely are methods other than grafting encountered. Rooting of beech cuttings has not been practical although Doran (10) stated that when summer cuttings were treated with indoleacetic acid (200 mg./1., 24 hrs.) 50% rooted in 37 days, in a sand-peat medium.

Only two instances of beech layering were noted. Temple (20) observed that natural layering of the low branches of *Fagus sylvatica* occurred in Kew and Eckstein (11) reported that young beech trees could be saved following mice-girdling by mounding leaf-mold over the damaged area.

The preponderance of literature on beech propagation relates to grafting. As early as 1844, the Gardener's Chronicle (1) answered a correspondent by advising that one-year scion wood generally failed but that two-year scions would unite with certainty. In an 1857 visit to the French nursery of M. Cochet, M. Pepin (17) was impressed with the results secured by

approach-grafting. At this establishment, grafting by other than this method was never employed due to the difficulties encountered.

Here in United States, the Gardener's Monthly (2) reported on beech propagation in 1869. At the nursery of Dingee and Conard, West Grove, Pennsylvania, great success was obtained with the blood-leaved beech by whip-grafting in the greenhouse in winter, setting the grafted plants out the following spring. Parsons (16), writing in the Rural New Yorker in 1881, stated that budding of beech was entirely out of the question but that bark-grafting was entirely successful in the open in April, provided that the scions were made of one-year wood, attached to a portion of two-year wood.

Approach-grafting was used in German nurseries around 1890 and Friedlander (12) described his method. Seedlings were planted around the mother plant in the early fall, with grafting carried on the following March or April. In the same issue of Moller's, Demuth (8) also reported on approach-grafting. He used potted seedlings which were plunged around the variety in early spring and grafted in May. Using a technique familiar to many of us today, he nicked the scion branch below the union one month after grafting and in two more months cut the scion branch entirely free. In order to align the varietal branch properly, it was staked to the ground and then bent up parallel to the seedling stock.

In 1895, Alfred Rehder (18) and two colleagues presented a discussion on beech propagation. Grafting under glass was the most successful method and more stress was placed on the selection of grafting-wood than on the kind of graft. Two-year wood made the best scions but in some instances, one-year wood with short internodes was suitable. Thin one-year wood with long internodes invariably failed. Whip-grafting and bark-grafting were the preferred techniques. Grafting was on potted stocks, as soon as they became active. It was essential that the grafts be placed in a warm, humid location and syringed daily. The following May, the successful grafts were set out in the cold-frame.

The Gardener's Chronicle of 1896 (3) suggested a method that was certain to succeed. Grafting was done in the field in early spring, using whip-grafts. These were made as close to the ground as possible and two-year scion wood was used. Immediately after the grafts were tied, the soil was mounded up over the union to prevent drying out of the graft.

Winter-grafting was again suggested in 1898 by Trobchen (21). Stocks were potted in the fall and brought into the greenhouse about 3 weeks before leafing out. As soon as the old leaves adhering to the seedlings fell at the slightest touch was regarded as the proper time to graft. Whip-grafting and cleft-grafting were used, depending on the size of the scion wood. Again we find that two-year scions with short, one-year side twigs were selected. The grafts were kept in the greenhouse until they had hardened off in late summer.

In the same issue of Moller's, Muller (15) described a similar method but recommended that the stocks stand in pots an entire summer before they were adequate for grafting. Greenhouse grafting gave the best results and although outdoor grafting was difficult, it succeeded if done at the proper time. Stocks should be 5 cm. in circumference and solidly rooted in the nursery, having been set out the previous spring. Scions were cut in Febru-

ary and stored until late March or early April, at which time bark-grafting, was used. Scions should be made of two-year wood with short internodes and should have three or four buds.

Kache (13), in 1929, recommended quite similar methods as did his predecessors. He used the greenhouse method on slightly active, potted stocks and applied whip-grafting and cleft-grafting. Two-year shoots made the best scions, cut just prior to the time that they were needed. While earlier writers were usually optimistic over their results, Kache reported that success varied from 20 to 50% depending on the variety.

Sheat (19), author of our best modern propagation manual, recommends approach grafting on stocks planted around the varietal tree 18 months in advance. Grafting is carried on in the spring just before the leaves unfold. Waxing the union is advised and staking is essential to secure maximum rigidity. The scion is cut free the following autumn. Grafting under glass is also decribed. Potted tocks are used similarly to what has already been described. However, for scion wood, Sheat recommends clean-growing terminal shoots, 8-14 inches long. The grafts are placed on their sides in a heated propagating case and syringed occasionally. Union is completed in five weeks at which time the case is gradually aired. Undoubtedly the close control over environmental conditions has permitted the use of 1-year scions in place of the custmary 2-year wood. For spring grafting in the nursery, the scions are of 2-year wood, grafted close to the ground as possible to avoid the ugly union that results from top-working.

Linden - Lindens are generally raised from seed even though germination is slow and uneven. Vegetative propagation is used mostly in European nurseries and both layering and grafting have been tried.

Loudon (14) says that the linden is seldom propagated other than by layering, putting down the branches in the autumn and removing the rooted plants after one year. Mound blocks are started by cutting off an old tree in the nursery close to the ground, and a quantity of vigorous shoots are soon sent up. Among these, the nurseryman throws a quantity of peat soil in which rooting takes place. In 1902, the Gardener's Chronicle (5) reported that the D. Thomas Nursery, of Wimbleton, layered about 3500 lindens every year by this method.

Summer grafting of linden was described by Muller (15). Three, and 4-year seedlings of finger-size were grafted in August as soon as the varietal wood had ceased to grow. The seedlings were worked about 10-15 cm. above the ground by bark-grafting, using scions 12-18 cm. long. The leaf blades were removed at once, leaving a piece of each petiole. As ties, strips of paper smeared with wax were used. Rarely did a bud break during that same year and after the shoots developed the following spring, they were staked. Stocks were not cut back until later in the season. *Tilia platyphyllos*, secured from French nurseries, was the best stock.

Budding was preferred by Trobchen (21), who also worked the various species onto *T. platphyllos* in August. He observed that when *T. ulmifolia* (*T. cordata*) was used, the scion often overgrew the stock. We find that Kache (13) also commented on this point, stating that nurserymen first used *T. platyphyllos* for stock, switched to *T. cordata*, and then reverted to *T. platyphyllos*. Sheat (19), however, recommends that *T. vulgaris* (*T. cur-*

opaea) be used and that the stocks should be produced by layering. As far as he is concerned, grafting should be used only to supplement layering. It is interesting to note that in 1874, a Belgian nurseryman, Burvenich (7) found that grafting *T. argentea* (*T. tomentosa*) onto common linden (*T. vulgaris*) was unsatisfactory in that the scion overgrew the stock to form a disagreeable "bourrelet" (ridge).

Two supplemental notes on budding of linden are those by Parsons (16), in the Rural New Yorker, and Desportes (9), a Frenchman. There is agreement to the effct that the proper time for budding lindens and similar difficult shade trees is when one can no longer lift the bark without tearing it. This is because of the fact that at the height of the growing season, the buds are likely to be "drowned out". By delaying budding until the bark has tightened up, one is most likely to succeed.

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MODERATOR CREECH: I think what we should do next is to hear from Mr. Crawford of the Willis Nursery Company, Ottawa, Kansas, on his method of propagating the Buisman elm and, after that, I would like to discuss my own observations on root cuttings and on air layering Mr. Crawford.

MR. HAROLD CRAWFORD (Willis Nursery Company, Ottawa, Kansas) presented his paper, entitled: "The Propagation of the Buisman Elm." (Applause).

THE PROPAGATION OF THE BUISMAN ELM

HAROLD CRAWFORD
Willis Nursery Co., Ottawa, Kansas

Members of the Propagators Society and visitors: I don't have a lot of scientific information to give you this afternoon in regard to percentages and data of that kind. What I can give here this afternoon is merely our own personal experience in the propagation of this tree.

As you know, the Buisman elm, and I am referring to the same thing sometimes called the Boisman elm, was introduced from Europe, I think in the early twenties. It was used there as a tree resistant to the Dutch elm and they later discovered it is also resistant to phloem necrosis.

The only way that we can propagate this tree and maintain the resistant qualities is, of course, vegetatively. There are several ways that have been tried with more or less success, such as budding, grafting, top cuttings, hardwood cuttings, and root cuttings. Our own experience has been confined principally to that of root cuttings and softwood cuttings in the greenhouse.

We have been very unsuccessful in taking the wood cuttings from plants in the field, and therefore, we have had to resort primarily to the use of root stocks.

After we get our root cuttings established, we have been quite successful in propagating from softwood shoots developing from these roots.

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Of course, the limiting factor on the propagation of this tree is your stock plants. It is a little slow in building up a stock. You have to dig the trees and chop up the roots, and therefore you eliminate that tree. It took several years to produce that tree in the first place. I think we were one of the first nurseries to receive stock from the U.S.D.A. and it has taken us all this time to build up a stock suitable for quantity production.

We prefer a two-year tree as a source of roots. We have used older trees and we have used roots from one year trees. The difficulty of using a one-year tree is that you get so few roots of suitable size, whereas, with a two-year tree you get roots of the size that we like to use, and that is about a lead pencil size. Some of the earlier papers recommended using roots of three-quarter to an inch in diameter. We do not like to use a root that large, not that it will not root readily, but it leaves rather a rough plant and requires a larger pot after it is established, but we have used a lot of roots as small as one-half the size of a lead pencil. They are slower and do not give as nice a plant.

We prefer to use a section approximately an inch and a half to two inches in length. Here again, some of the early information conflicts. I think they recommended using lengths as long as 2 to 4 inches, but that is not necessary.

We dig the trees to get the roots in November in our area, which is very close to Kansas City. By that time, the tree is completely dormant but the root system is still pliable and in good condition. We have never tried taking root pieces from the tree and leave the tree established. We dig the tree in its entirety so that we get the maximum number of roots.

Don't throw away roots that are injured by spades or forks when you are digging. We find that a piece of root can be quite badly mangled and will still develop adventitious buds and produce a suitable plant. After all, this little piece of root we are using actually becomes a very small portion of the finished plant so that you do not have to be careful about how it looks or the condition it is in.

I was talking with one of your members here last night about the propagation of the Buisman Elm and he said he had some difficulty in storing the roots. We never attempt to store the roots. I don't mean to say they cannot be stored successfully and then used later, but we try to cut up the roots and put them in the rooting media the same day.

Really, it is quite a simple thing to root this tree from piece roots. I think the most important factor to keep in mind is that the portion of the root nearest the parent tree must be set upright. If you get them upside down you are going to have a very spurious cutting and they will develop buds at the bottom which very seldom reach the top. A callus develops on the top which amounts to nothing. We do that occasionally and after we discover our error and turn them over.

I think there has been some work done on this with layering the roots horizontally and Dr. Creech was telling me today he had rooted some in that manner. I don't know that it makes too much difference which method you use as long as you get the end result. We pot our plants, so obviously, the horizontal root would not be desirable.

I think an important factor in the propagation is light. We like to use practically full sunlight on our roots. You see, we are trying to do two things with this little piece of root. We are trying to grow roots on the bottom of it and new shoots from the top. With our softwood cuttings we already have our tops established and only have to establish roots. With this little piece of root, we have to grow feeder roots and tops and to get the quickest action from the callus for the development of tops you need light.

I think it makes very little difference the type of media you put them in. We use perlite almost exclusively in our propagation. The roots, after placed in the media, callus very quickly — within 10 days or two weeks. This callus very quickly starts turning green around the cambium layer of the root, and from this green callus develops shoots which make the top of the plant. Now we get this action ordinarily sooner than we get the root action. Judging from the tops you will think it is ready to pot up, yet you may have practically no root action.

We got the idea why not go ahead and pot them up if we had the tops developed. We didn't get too good results from that practice, so now we leave the plants in the media until we have both tops and roots. There is no difficulty in transplanting from the media to the pots. We just take the cuttings out of the propagating house, pot them up and put them into a finishing house.

After becoming established in pots and placed in a cool house the plants grow quite rapidly up to 6 to 8 inches. Now you will have a whole ring of shoots coming from this piece root. Obviously, we only need one stem for a tree, so we remove these tops, down to two leaders. We leave the extra one there in case one gets broken off. Then we take the top cuttings, put them back in the media and root them. We attempted to propagate from softwood cuttings from plants in the field, and so far we have had 100 per cent failure from that method, and yet, we got almost 100 per cent strike on top cutings from plants grown in the greenhouse. Of course, that is true in a good many other plants also.

We like the plants developed from the top softwood cuttings better than those from the root cutting. We have a little smoother, nicer-looking plant. It is obvious they are propagated a month to six weeks after the root cuttings are put in, but by the time we take them from the greenhouse in the spring they have caught up.

We carry our plants in pots until time to go to the field. If we have the time, we try to take them out from the greenhouse and harden them off in cold frames outdoors. Here in this part of the country and farther east, I know you are able to take stock directly from the greenhouse to the fields. Our growing conditions are at times quite rugged and at planting time we have warm winds; quite often it is dry. For that reason we pot most of our stock and also try to harden it off rather than take it directly from the greenhouse.

I was a bit amused last night at some of the explanations that were made of temperatures of 109, which you enjoyed in Illinois last summer. We experienced temperatures of 118 degrees last summer with a wind of 20 to 30 miles an hour, along with relative humidity of about 25 per cent. Those are rugged growing conditions.

Incidentally, the Buisman elm planted from pots in the field without water survived and did very well. We didn't get an enormous growth but we did get growth and high survival, which is an interesting sidelight on the use of the tree.

I failed to mention or discuss in any detail the other methods of propagation. I think the Cole Nursery has had some experience on budding. With us, that is not too satisfactory. They are budded on *Ulmus parvifolia* or *U. pumila*. We get too much over-growing of the bud and not too high a stem. I think Mr. Cole told me they were not satisfied with their budding method, either.

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MR. CRAWFORD: If there are any questions, I will be glad to answer them.

MR. RALPH M. FISHER (Manchester, Conn.): Do you find you get dwarf trees from the juvenile growth? They dwarfed on me.

MR. CRAWFORD: I think the oldest tree we have is about seven years old. We left a few alone just to see what they would do.

MR. FISHER: The trees I dig up are four inches through and dig the whole tree. Some have long roots and I usually cut them about two foot long from the tree, a ball about two foot and plant them back in.

MR. CRAWFORD: You dig the tree?

MR. FISHER: I dig the whole tree by the root and follow them on. You get an enormous number of root cuttings, as you say, all sizes. If you do it every year, they are more or less uniform and about pencil size when grown in a good moist soil.

MR. CRAWFORD: What we would like to do is get our stock plants built up to the point where we can use our regular digger and still get enough roots from it. Spade digging is expensive.

MR. JACK SIEBENTHALER (The Siebenthaler Co., Dayton, Ohio): Have you ever had occasion to observe any results that might have occurred if you just dug the trees and left a few of the roots? Incidentally, phlox propagation was mentioned yesterday. Would that give you any change of reproduction?

MR. CRAWFORD: We have not. We have been so greedy to get all the roots for propagation that we haven't knowingly left anything. I do know with *Zelkova* that you will get sucker shoots that way. On the Buisman elm, I don't know.

MR. C. MAHLSTEDE (South Euclid, Ohio): Do you cover the root cuttings or leave the tops exposed?

MR. CRAWFORD: If the entire root is covered, you will get rotting of the root. We leave them exposed a quarter to a half inch. They will rot if you cover them with material even as light as perlite.

MR. WILLIAM COLE (Cole Nursery Co., Painesville, Ohio): We have two things a little different in the way of handling. In the first place,

bringing those plants in early and sticking them gave us a little more growth, and we gave a heavy mulch with manure and put ours directly into pots, the cuttings root about the same as yours do, but we saved that one operation. Again, we left the top of the cuttings sticking out. We found it was easy to rub the suckers off if they were just barely at the surface. We didn't think of saving them for cuttings.

MR. CRAWFORD: The only reason for leaving the tops is for additional propagation. You might as well rub them off if you have an ample supply.

MR. ROSCOE A. FILLMORE (Centreville, Nova Scotia): What is the medium?

MR. CRAWFORD: Perlite. That is an expanded aluminum, I believe it is, that they use for light-weight plastic. It is pure white.

MR. FILLMORE: Would that be better than vermiculite?

MR. CRAWFORD: With us it was the one available and we knew how to handle it. We get better results from using perlite than vermiculite or a combination of vermiculite and sand. You may not agree with me on this, but again, we get better results and we use it exclusively even on softwood cuttings.

MR. CASE HOOGENDOORN (Hoogendoorn Nurseries, Newport, R. I.): Do you use glass over your propagating bed when you insert those roots or use an open bench?

MR. CRAWFORD: Open bench. Our propagating greenhouses are the small, two-bench style house, 10 feet wide and seven feet high.

MR. STUART H. NELSON (Central Experiment Farms, Ottawa, Canada): Have you ever tried leaf-bud cuttings?

MR. CRAWFORD: No.

MR. NELSON: The Oulette L'Assumption Experimental Farm has been working on the Dutch elm disease and has had considerable success with leaf-bud cuttings on the species. I don't remember the report in full but leaf-bud cuttings were used in the greenhouse, with some shading.

MR. CRAWFORD: Ray Keen has told me of that work. I want to try it next year on some of the hybrid elms but on the Buisman elm I see no reason going to that work because the other way is so simple.

MR. MAHLSTEDE: By budding or grafting a Buisman elm, would it still be immune to Dutch elm disease?

MR. CRAWFORD: Yes, if you have a root system you are sure is immune. The American elm root would be out. We don't like the root system of the Chinese elm. In our part of the country it makes too shallow a root system. You can't grow anything under the trees and they tend to blow over badly in moist areas.

MR. WM. FLEMER III (Princeton Nurseries, Princeton, N. J.): What shape do you think the Buisman elm would ultimately make: similar to the Chinese or to the American?

MR. CRAWFORD: A broad pyramidal type, more on the order of the Chinese than the American elm. In the East it will probably not be as tall and quite a bit smaller. I think it will not be as archy a tree as the eastern elm. When you compare it with the American elm you should know what section of the country a person is from. They vary from New England with high branches, to central Kansas where we have some elm trees that grow almost flat, spreading out 30 to 50 feet and not over 20 or 25 feet tall.

MR. WILLIAM COLE: Ed Scanlon grew some of these on chinensis roots. I would like to know what results he got. Did you plant some out?

MR. ED SCANLON (Olmsted Falls, Ohio): Yes, when we got those trees started we wanted to get some kind of fast. I fugured I hadn't much time left, so we tried to graft them on four different understocks to determine the compatibility, since nobody knew anything about it. We worked on *Zelkova,* Chinese, Scotch, and English, and we got the best results from the Scotch, because they became reestablished better, faster and with a higher percentage..

Of course, the Chinese has such a clumsy root system that we had quite a bit of loss on those, so I think the first batch of them we planted here were on Scotch. They didn't come along so good. As a matter of fact, they all kind of stood still. I think it was for two or three years, and then all of a sudden they got going.

On another batch we put on Chinese, we planted deep, with the idea they would establish their own roots and, of course, somebody brought up the question of whether on Scotch or English you have the understock susceptible to Dutch elm disease. Of course, the top is resistant. Of course, if it gets down that far you haven't any tree anyway, so it might as well kill it. There is no danger of infection that low because we know an infection in Dutch elm starts at the top as I believe it does in phloem necrosis also.

Another thing, we had quite a bit of success in budding on Chinese, but because of the poor quality of the Chinese stock, I am going to put it on Scotch hereafter.

Now the *Zelkova* understock didn't work too good because it was a little too slow for the top. They were not compatible but we got some beautiful trees out of it, and I think we have about three or four streets of them here. Some of them have been in as long as three or four years, I believe, and they are doing quite well.

Another thing I would like to suggest with regard to the form of the tree, now on the basis of the fact that this is a variety or a selection of *Ulmus carpinifolia,* we have a beautiful specimen. That is a broad-leaf pyramidal tree with a central leader and in no way resembles the American elm from an arching standpoint at all. As a matter of fact, I would say it is rather a buxom heatley elm, a little larger at the base. I think it is a very beautiful tree and from the standpoint of the form I like it for a street tree. It has a much more practical form from a maintenance standpoint and also lacks a heavy overhead or top, which of course we found out in the last three months definitely is not a very desirable thing for most street trees.

MR. CRAWFORD: I think there is a difference of opinion on the ultimate shape of the tree, based on different localities. The same variety of

tree grown in Kansas would take a different shape than one growing in the New England states.

MODERATOR CREECH: Thank you, Mr. Crawford.

I want to talk on root cuttings just a little further, some of the basic facts we know about them.

Dr. Creech read from the article entitled "Root Cuttings" by John L. Creech, *The National Horticultural Magazine*, 33:21-24, 1954. (Applause).

PROPAGATING PLANTS BY ROOT CUTTINGS

JOHN L. CREECH
U. S. Plant Introduction Station, Glenn Dale, Md.

Cuttings can be made from the roots of a number of species that are difficult to root from stem cuttings. This method is quite frequently applied to the woody legumes but to a lesser extent in other plant groups. According to Priestly and Swingle (4), root cuttings tend to produce adventive shoots more readily than adventive roots just as stem cuttings are prone to regenerate roots, seemingly as if each were trying to replace that portion of the plant which was missing. In addition, the adventive shoots formed on root cuttings are more likely to be found at the upper (proximal) end of the cuttings than at the lower (distal). Thus, the most successful root cuttings will be those obtained as close as possible to the base of the plant. This proximity to the base of the parent plant might also be expressed in terms of the diameter of the root cuttings. Kvarazkhelia (3) reported in a study of the vegetative propagation of the tea plant that when he separated the root cuttings into thick (over 2 cm.), medium (1 cm.), and thin (less than 1 cm.) pieces, the thick cuttings gave the best results and the thin ones the poorest, namely 52-73%, 37-45%, and 9.5-18% respectively. This has also been observed at the Glenn Dale Plant Introduction Garden with *Cyrilla racemiflora* when cutting were separated into two groups, one-half inch or over and less than one-half inch. In addition to a higher percentage of rooting, the thick cuttings also produced more vigorous shoots than the small roots.

As a supplement to growing the plants derived from root cuttings, it may be desirable to use some of the newly developed shoots as softwood cuttings. This may seem a roundabout means of obtaining softwood cuttings but results show that these cuttings will often root better than similar cuttings taken from stems. Toole (5) took softwood cuttings of *Albizzia julibrissin* both from root pieces and stem pieces. Those shoots originating from roots rooted 100% in twenty days while the ones obtained from stems failed completely.

Root cuttings should be made either in the fall or during the winter months. Hoblyn and Palmer (2) reported that root cuttings of plum grew much better when planted in December through February than if set in April. In the propagation of the Beach Plum (*Prunus maritima*), Graves (1) used roots of lead- pencil size collected in the fall. These were cut into lengths of 3-4 inches and buried outdoors at a depth of 2-3 inches with the cuttings laid

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horizontally. By this method, a 50% stand of plants may be obtained. Roots can also be dug from around the parent plant and propagated in the greenhouse. The roots are cut into 3-4 inch lengths and placed in a flat of moist sphagnum moss. Cuttings may be laid horizontally or placed on end with the thicker (proximal) end uppermost and covered with an inch of moss. One text suggests that by reversing this latter position, better results will be obtained but in view of the relatively greater adventive shoot development at the upper end, there is little basis, theoretical or experimental, for this suggestion. Cuttings will produce new shoots and roots promptly and may be transplanted after three or four months, but in some instances, shoots will appear and immediately wilt due to the failure of adventive root formation. This lagging of root develpment is perhaps the main cause for failure of root cuttings to succeed.

Plants in the following genera have been described as developing successfully from root cuttings: *Albizzia, Chaenomeles, Clethra, Cyrilla, Daphne, Ilex, Koelreuteria, Lagerstroemia, Maackia, Prunus* (Beach Plum), *Rhododendron* (Azaleas), *Syringa, Wisteria* and *Xanthoceras*. No conifers have been described as rooting from piece-roots and root cuttings could not be used to propagate grafted plants unless the grafts had been planted deeply enough to permit scion-rooting.

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1. Graves, G. 1944. The beach plum, its written record. *Nat. Hort.* 23:75-97.
2. Hoblyn, T. N. and R. C. Palmer. 1934. A complex experiment in the propagation of plum rootstocks from root cuttings. *Jour. Pomol. and Hort. Sci.* 12(1):36-56.
3. Kvarazkhelia, T. K. 1934. Vegetative propagation of the tea plant. *Trop. Agri.* (Ceylon). 83:261-266.
4. Priestley, J. H. and C. F. Swingle 1929. Vegetative propagation from the standpoint of plant anatomy. *U. S. Dept. Agri. Tech. Bul.* 115. 98 pp.
5. Toole, E. R. 1948. Rootability of cuttings. *American Nurseryman.* 88 (2):72.

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Dr. Creech added: Those pieces of root which are closest to the base of the tree, in other words, the largest root cuttings generally give you the best results. Furthermore, you get much better results when the root cuttings have the proximal end, the end from which the adventitious shoots are going to develop, exposed above the medium. Theoretically, the cuttings should be stood on end. However, you can put them at an angle and get many more on. We use sphagnum moss for our medium, but it is immaterial what you use.

We have little time left and I want to show you some of the things we have learned about air-layering. I like to think that the technique has a potential use as an indicator of the success that can be obtained from stem cuttings.

To develop this point further, I have observed a correlation between the rooting of air-layers and cuttings. We have four selections of *Prunus mahaleb* at Glenn Dale, all with desirable habit and quite vigorous. When we air-layered the four clones last spring, two rooted 100%, one 50% and one failed

to root at all. When I took cuttings of these clones, the results were quite similar and the selection which would not air-layer would not root from cuttings. Thus in a relatively simple manner, it was possible to separate easily rooting clones from the difficult one.

We have had some interesting results with air-layering the oriental flowering cherries. Although most of the varieties of *Prunus serrulata* were quick to root, the Japanese weeping cherry, *Prunus subhirtella pendula* did not commence to root until late in October while the upright form, *P subhirtella* variety Jugatsu-Zakura rooted in ten weeks. In both instances layers were applied in June.

I brought two air-layers of cherry with me to show the extent of the root development. These were layered in May. One plant (that with the active root system) was removed from the tree in mid-September and plunged in a cold greenhouse. This is a really successful manner to handle air-layers—removing them in the fall after they are dormant and plunging them in peat in a cold greenhouse where the temperature is low enough to prevent top activity but where the roots will remain active during the winter. The other layer was just cut from the plant prior to this trip and you can observe the extent of the root system. It is possible to leave a layer like this on the tree through the winter and remove it during the next year. Although the sphagnum will freeze solid and many of the roots die, there will be rapid root formation in the spring.

Perhaps we can now have some questions both on vegetative propagation of beech and linden and on the other subjects discussed.

MR. HOOGENDOORN: You mentioned in a reference on grafting that you cut the scions in February and grafted them just previous to leafing out. Does that give you any percentage?

DR. CREECH: Percentages were not stated but what they did was to cut the scions in February and store them until late March or April. I don't know how successful that method is with beech but I know it is very successful with the simpler things we bud and graft. We do it with all of the *Prunus spp.* at Glenn Dale. I like it for those. On beech I can quote only the citations from the literature.

MR. HOOGENDOORN: I have done it once and I cut my wood probably the last week in April. This was just before they started to leaf out and we had 98 per cent.

MR. FILLMORE: *Is it practical to air layer the copper beech?*

DR. CREECH: You recall when I gave the literature summary there were only two references to layering of beech at all. One of them was an observation where the branches were layered to the ground. I doubt if it would be very successful.

MR. FILLMORE: I am interested because I tried air layering on a very fine specimen. I figured if it would be successful I could do several hundred. I didn't get any results at all.

DR. CREECH: That would be entirely dependent on technique and we often fail because the sphagnum was too wet to begin with. That may be your difficulty.

MR. LESLIE HANCOCK (Woodland Nurseries, Cooksville, Ontario): I have two questions. Why do you put the air-layers so far down, Doesn't it take a long time to get balance between root and top when you have the air-layering so far down the stem?

DR. CREECH: One of the things I have found in the literature, and have observed myself, is that the balance is very quickly overcome. For example, on some of the American hollies that I air-layered and removed in August with shoots almost 18" - 24" long, the root system had become proportionate to the top within a mouth.

MR. HANCOCK: The other question is how much experience anyone has had growing the native beech from seed?

MR. CHARLES HESS, SR. (Hess' Nurseries, Mountain View, N. J.): We have grown them from seed. Actually, we have no trouble at all. The main thing with any beech is that you must sow it practically as soon as you pick it. If you store it and sow it in the spring you are going to have poor germination.

MR. MARTIN VAN HOF (Rhode Island Nurseries, Newport, R. I.): In 1919 I planted 3,000 beeches for Mr. Horvath Sr. in Mentor. We grafted them and waxed them. There wasn't enough room to set them out singly, so we sat one pot on top of the other, three high. They came out perfectly.

MR. JOHN VERMEULEN (John Vermeulen and Son, Neshanic Station, N. J.): I wonder why you haven't mentioned any bottle grafts. All the nurseymen must remember the type of bottle grafts. We used a very little bottle and skinned the branches and tied them together.

MODERATOR CREECH: If there are no further questions, I will turn the meeting back to the President.

PRESIDENT CHADWICK: Thank you for the discussions, Harold Crawford and Dr. Creech.

The next session on the program is the Annual Business meeting. While the voting lies in the hands of the members, we would be glad to have the junior members and the guests attend this meeting.

The scientific sessions adjourned at 3:10 o'clock.

The report of the Business session will be found on pages —— these proceedings.

Fourth Annual Banquet

Following the banquet, President L. C. Chadwick called the meeting to order and introduced the speaker of the evening, Dr. Freeman S. Howlett, Chairman, Department of Horticulture, Ohio State University, Columbus, Ohio.

Dr. Howlett's discussion was entitled, "Some Aspects of Horticultural Research of Importance to Plant Propagators and Nurserymen."

At the conclusion of this discussion, the Furth Annual Meeting of the Plant Propagators Society adjourned *sine die* at 9:30 p. m.