we carry on our work at Neshanic Station we will be most willing and happy to exchange information with anyone who is interested in doing likewise.

1 Hancock, Leslie, 1953 "Shrubs from Softwood Cuttings". Proceeding PPS — 3 151-164 1955 "The Burlap Cloud Method of Rooting Softwood Cuttings". PPS — 5 56-58
2 Templeton, Harvey M, 1953 "The 'Phytotector' Method of Rooting Cuttings' PPS — 3 51-52
3 Hess, C W M, Sr, 1955. "Rooting Cuttings in Containers under Mist" PPS — 5.135
4 Hill, Jack D, 1957 "Propagating Plants Directly in Containers". PPS — 7:75-78
5 Reisch, Dr Keneth W, 1957 'Propagating Plants Directly in Containers by Means of Hardwood Cuttings" PPS — 7.78-79
6 Vermeulen, J Peter, 1959 "Propagation of Woody Ornamentals Under Mist in Peatmoss Pots" PPS — 9 207-210
7 Baker, Kenneth F, 1957 "The U C System for Producing Healthy Container-Grown Plants" Calif Agri Exp Sta, Berkeley 4, Calif
8 Rose-Dutton, Patricia, 1959 "Mist Propagation of Cuttings" Commonwealth Bureau of Horticulture & Plantation Crops, East Malling, Maidstone, Kent, England
9 Camp, Dr Wendell H, 1956 "Micro-Organisms in Soils and Their Action on Plants" PPS — 6 107-121
10 O'Rourke, F L (Steve), 1955 "The Bolivar Pit Method of Rooting Cuttings". PPS — 5 54-56

MR. ART LANCASTER: Thank you very much, Pete. The final paper for the first section of this afternoon's session is by J. Paul Wilms, Gwenn-Gary Nursery, Inc., Columbiana, Ohio.

PROBLEMS AND PROPAGATION PROCEDURES OF A SMALL TO MEDIUM SIZE OPERATION

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Back in 1937, when the J. P. Wilms Nursery began, budding of roses and fruit trees was the only propagation work done. At the end of the next three years, after the name had been changed to Gwenn-Gary Nursery, rooting of evergreen cuttings was begun. The nursery of 10 acres supplied most of the cutting wood which was set in either cold frames or in rented space in nearby greenhouses.

In using rented greenhouse space, several problems occurred. (1) The cuttings had to be made in advance in large quantities, and some drying out occurred before the cuttings could be set. (2) Alternating temperatures, such as when the cuttings were brought in from the cold, made up in a room at moderate temperature, and out in the cold again to be transported to the greenhouse before being set in a controlled temperature environment. (3) However, the most critical problem was the inability to oversee watering and care after the cuttings were

set. At best, using rented space was inconvenient, but much better than nothing at all.

Lining out stock was purchased to compensate for losses and to obtain items that were "unrootable" or required special techniques and operations, such as grafting or growing seedlings. The preceding operation was continued for about 10 years and the nursery acreage was increased to 25.

In 1950, an extensive building program was inaugurated. The principal building was for storage, office facilities, potting and garage areas, but also included two attached, adjoining greenhouses. It was a four-level, two-story building designed by Mr. David Metzger of Terrace Gardens, Inc. of Youngstown, Ohio, with revisions made by Dr. L. C. Chadwick of Ohio State University and some of his students.

An oil-fired boiler supplies hot water heat for the building, and underbench heating in the greenhouses.

The two greenhouses (14½ feet by 52 feet) each hold three benches. The outside and end benches measure 30 inches wide and 6 inches deep; the center one, 57″ by 6″ and are constructed of redwood. Four two-inch pipes extend under the outside benches, and six under the center bench. Two pipes also run along the outside walls of the two houses to provide ample heat.

In the fall of 1950 cuttings of *Taxus, Thuja, Juniperus,* and *Ilex* varieties, in respective order, were made, prepared and set in the houses. Washed sand was the media used, Hormo-Root "B" and "C" were the growth regulators tried, and hand watering methods were employed.

In the next three or four years the immediate problem was the every-day care required to maintain a good crop. One man with the right touch was the key to successful rooting of cuttings. (Rooting percentages in these first years were similar to those of the usual beginner's luck.) Another problem was created when the building and the greenhouses were built. The building shaded the southern portion of the greenhouses about 5 feet. Overwatering and subsequent losses occurred until the "touch" was acquired to prevent overwatering. The third problem to arise at this time was the uneven heating which occurred in the houses. The above-bench locating of the thermostat was the cause, and also the reason for detrimental, early bud breakage, as bench temperature was often less than that of the house temperature. To alleviate these problems, the thermostat was placed beneath the benches and the benches skirted with muslin to retain the heat under the benches. Increased rooting percentages and lower heating costs were the result. Also, at this time, I became a charter member of the Plant Propagators' Society.

Each fall the greenhouses were thoroughly cleaned out and new sand was brought in to replace that from the previous year. The benches were repainted with "Cuprinol" or copper napthanate solution every two years. We tried silica sand for a media,

but rooting percentages did not improve enough to merit the extra cost and, was dropped after two years of use.

In a statement made by Mr. Case Hoogendoorn at one of these meeting, he said that the selection of cuttings taken from the base, or near the base of *Juniper excelsa stricta* had bubbles on them and rooted very readily. This information was incorporated into our program at home, and although it was necessary to stand on your head to get the cuttings, the percentage of rooting increased about six-fold — from 15% to 90%.

The rooted cuttings of all varieties we grew were transplanted into the open field in rows 18 inches apart and 5 inches in a row. All varieties came through wth the exception of *Taxus* species. Through inquiry and information obtained from this organization, we discovered the need of *Taxus* to receive some protection in the first few years after rooting. Thus, we constructed a bed area where all our *Taxus* have been grown for the first two years after rooting. These beds are covered with shades, allowing 50 percent light to pass through.

After these first two years, the *Taxus* are transplanted into the field in rows 4 feet apart and 8 to 12 inches in the row for two more years.

The yews are then transplanted again into field rows 4 feet apart and 26 inches apart in the row, and from here are balled and burlapped. The other varieties go directly to the field from the greenhouse for two years in the liner area, and then into the field row of 4 feet and 26 inches in the row.

In 1958, three nights of constant watch over a balky oil furnace, with 85,000 cuttings in the greenhouses and the temperature near zero, was sufficient reason for us to purchase an auxiliary furnace to avoid a possible recurrence of this emergency.

During the years of 1958 and 1959, while my son, Gary, was attending Michigan State University, Steve O'Rourke guided him in several experiments. One of these was the rooting response of cuttings in various types of media. A mixture of styrofoam and peat moss repeatedly showed good results with a mature root system that did not break easily when handled.

In 1960, one greenhouse was used to experiment with different media to see if it would improve our rooting, and produce a more easily handled root system than was produced in sand. The expense of styrofoam, and the cost to break it up, resulted in our substituting perlite for the styrofoam in our mixture. One bench in the greenhouse was filled with a mixture of sand, perlite and peat moss in equal portions by volume; another bench with peat moss and perlite in the same proportions; and the other bench filled with sand.

The cuttings rooted in the peat moss-perlite mixture were the best developed, and easiest to handle, that we had ever worked with. We are still using this mixture today, but with a greater percentage of perlite (roughly 60%) than we started with.

A new idea was developed in this year, too, to improve the

water drainage and heat penetration into the media. The center boards in the benches were removed and replaced with ¼-inch wire mesh and covered with a thin layer of peat moss to prevent the loss of the media through the screen.

Also, the greenhouses, with the exception of the vents, were lined on the inside with plastic to cut off drafts which had developed with age in the house. (Separation of glass and ribbing, and little pieces of broken glass and at joints of overlapping glass. Other advantages soon were apparent with the installation of the plastic. It was easier to maintain humidity, and the water drawn from the media condensed when it touched the plastic and dropped back to the media. Less watering was thus needed. The area between the glass and the plastic provided 2 inches of air space insulation, and the heating costs were reduced somewhat.

The water-retentive qualities of the peat-perlite mixture made it necessary to adjust the "touch" in watering to prevent excessive moisture detrimental to obtaining healthy-rooted cuttings. One problem of this media that we have had was redampening this media when it dries out. Water applied to the dry mixture would saturate a layer on the top, but flow through the lower portions more or less in channels, and drain out, leaving only a small portion of the media with moisture.

With background information received at several Plant Propagators' Society meetings, I began grafting scions of upright Junipers on unrooted "bubble," cuttings of *Juniper excelsa stricta* in the fall of 1960. There were 25 to 30 grafts in each of four different varieties. Twenty out of 27 *Juniper scopulorum 'Blue Haven,'* 27 out of 29 *Juniper keteleeri,* 23 out of 27 *Juniper 'Hill's Pyramidal,'* and 20 out of 25 *Juniper virginiana cupressifolia* were successful.

With this encouragement, 1500 grafts were made in 1961. Half of these were grafted on *Juniper chinensis hetzi* "bubble" cuttings, and the remainder on *Juniper excelsa stricta.* The same relative percentage of take occurred with those grafted on *Juniper excelsa stricta* as in the year before, but only 20 to 25% were successful on *Juniper chinensis hetzi.*

In 1962 (last year) 3500 grafts were made on *Juniper excelsa stricta* "bubble" unrooted cuttings. Initial progress was good, with substantial callous formation and union beginning to take place. However, while on vacation last winter, it is my opinion that excessive watering caused the rotting of a majority of these grafts and the mortality rate was quite high this past spring.

In this year, also, we added further insurance to growing a successful crop of cuttings by purchasing a tractor-driven power generator which will supply enough power to maintain the building, greenhouses, and near by house in case of extended power failure.

In this subject I have covered some of the procedures, techniques, and problems encountered in the small to medium-sized

operation that we have at Gwenn-Gary Nursery, Inc. However, the most important thing of all to give particular attention to is the care of cuttings after they are set in the bench. A good illustration of what I mean is clearly pointed out with the loss of our grafts last winter. The "after-care," as I call it, requires a man with what can best be described as a "touch," seasoned with experience, guided with the help which comes from above, and with perseverance to toil day after weary day to meet the challenge of Mother Nature, and the constantly changing picture in the greenhouse with success. This requires work, sacrifice, and persistence to make good, but the reward is great in seeing a crop of well-rooted cuttings being planted out in the ground, or sold to a happy, satisfied customer.

MR. ART LANCASTER: Thank you very much, Paul. We will now entertain questions for the four papers you have just heard.

MR. LESLIE HANCOCK: Has any work been done with the application of nutrients during the rooting of cuttings?

DR. HESS: Dr. Harold Tukey from Cornell reported on experiments with mist fertilization last year, and I'll turn this question over to him.

DR. HAROLD TUKEY, JR.: Our experience with feeding nutrients, primarily nitrogen and phosphorous, through a mist system, is that it does not speed up the rooting process, but the plants grown from the rooted cuttings are vastly superior.

MR. JACK HILL: I would appreciate some more detailed information about *Ginkgo biloba* cuttings.

MR. PETE VERMEULEN: The cuttings were taken from the tops of large male trees. The cuttings were 6-8 inches long, they were taken in July, just after the wood had matured. The cuttings were treated with number three Hormodin or with the Germain formulation. We used intermittant mist with a medium of sand, peat, and perlite, ⅓ of each.

MR. JACK HILL: How soft are the cuttings?

MR. PETE VERMEULEN: It's rather hard to describe, but the cuttings will crack if you bend them.

MR. ARIE RADDER: What time do you take the blue spruce cuttings?

MR. PAUL WILMS: We took the cuttings after the first of August. We used Koster cuttings, placed them in peat and perlite, in a greenhouse with intermittant mist. The cuttings were pretty hard, but we had about 65% rooting.

MR. RADDER: Did you use current seasons wood and did you wound the cuttings?

MR. WILMS: Yes, we used current seasons wood. We did not wound the cuttings.

MR. RADDER: What hormone powder did you use?

MR. WILMS: We did not use any.

VOICE: Why are you using cutting-grafts?

MR. WILMS: We have been using potted grafts for years and with good success. But there is one problem. The roots in the pot follow the pot and form a knot. And even on larger Junipers, when you dig them up, you still find the knot with a few large roots going out. We have trouble in transplanting. With the cutting-grafts, we never put them in a pot. They go right from the rooting medium out to the field just like a cutting.

VOICE: You tried both *Juniper stricta* and *Juniper Hetz.* Didn't you find that *Hetz* gave the better root system?

MR. WILMS: This we will have to find out. We haven't had them long enough.

MR. HARRY HOPPERTON: The understock will also regulate the height of the plant later on.

MR. WILMS: Yes, when upright junipers are grafted on *Hetzi,* the plants will not grow as fast, but they make nicer, fuller plants with less trimming.

MR. HOPPERTON: In addition, the final height of the plant is reduced.