Editor's Note: The following three papers by Christopher George, James Newell, and Jeanette Freyer were Mary Helliar Travel Scholarship Awards for 1993 and are present as a group.

Rhododendron Propagation—Methods and Techniques Carried out in the Pacific Northwest of the U.S.A.

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For me, the missing link in the *Rhododendron* production cycle is propagation. At Osberton Grange, we are growing-on 300,000 rhododendron plants at any one time, but I have never had the opportunity to study the propagation stage.

Therefore, in spring 1993 I used my Mary Helliar Travel Scholarship Award to visit the U.S.A. to fill in this gap in my experience. My first visit soon achieved this goal, as it took me to the source of all the rhododendron plants grown at Osberton Grange.

BRIGGS NURSERY, OLYMPIA, WASHINGTON

Ninety nine percent of Briggs' rhododendrons are produced by tissue culture in their laboratory on the nursery. The present laboratory was completed in 1988 after operating on a small scale for the previous 10 years and researching the subject for 10 more years prior to that.

Bruce Briggs feels that its heavy investment in such facilities has been rewarded by the large number and high quality of plants that leave the nursery each year. To give an idea of the success of the operation, Briggs Nursery produced 6.5 million tissue-cultured plants last year. These were either sold as micropropagules, grown on and sold as liners or grown on at the nursery for its own container production use.

Not without its critics, Briggs Nursery and other tissue culture labs have had to answer to growers who have complained of problems with their micropropagated plants. However, the general feeling I found in the trade is that although problems have occurred, these have certainly been outweighed by the advantages seen with micropropagated material. Tissue culture propagation is still a relatively young technology and can be refined each year if communications between the lab and its customers are good. Such communications help the lab to recognise problems and correct them for the future.

I have no doubt, after seeing the Briggs Nursery micropropagation unit that this is the future in plant propagation. As one nurseryman told me, "Growers must be selective and choose from the most reputable suppliers, and if troubles do occur they are easily approachable. Remember that not all problems are caused at the source—examine your own growing techniques and cultural practices for optimum success."

Briggs Nursery uses eight different media, all variants on the standard Murashige and Skoog medium, with the pH adjusted to suit individual types of plants. One of the most impressive aspects of Briggs' tissue culture operation was the cleanliness of the laboratory. This is very important and helps explain why Briggs can boast

such a high percentage of plantlets growing on in tissue culture successfully. This success is apparant after only 4 weeks. Four weeks later (a total of 8 weeks following initiation), after cytokinins are added, the test tubes are three quarters full and the nutrients in the agar medium exhausted. The cultures are ready for multiplication at this stage. For multiplication the shoots are cut into 25-cm sections every 8 weeks. Then they are moved to the production room and grown on in baby food jars, which in turn are housed in trays and double-stacked as space is at a premium. The trays are regularly swapped around for an equal share of the light. May is the best time of year for initiation as material is more likely to be pathogen free after the plants have put on a new flush of growth.

Plantlets are transferred to another medium for root initiation. After root initiation, the propagules are transferred again.

The propagules leave the sterile lab conditions once roots have been initiated, are potted into 4-in. pots with 25 plantlets per pot, and then transferred to a weaning house.

Apart from the obviously impressive facilities, Briggs also has a research room within the lab for trailing small amounts of new plants. This ensures a constant supply of new cultivars entering the market.

Of the 6.5 million plants which passed through the lab last year, 150,000 plants per week were supplied to the liner unit for potting and subsequent weaning.

VAN VEEN NURSERY, PORTLAND, OREGON

This nursery was a complete contrast to Briggs' Nursery. Van Veen has been growing rhododendrons for over 60 years with a fine tradition attached to the nursery, since one of the pioneers in the field, Theodore Van Veen, established it in 1926.

Little has changed to the propagation system since he was growing here. Modifications have been made over the years but the general principles laid down then still apply today with great success.

The nursery is on two sites—Portland and Woodburn. Portland has 4 acres of glass and growing on areas; Woodburn has 85 acres of field-grown stock.

Over 400 different cultivars are grown with 291,000 rooted cuttings being propagated last year. Of these, 60% went to the field unit at Woodburn, with the remainder staying at the Portland site to be grown on and eventually planted into the field as liners.

Cutting material is obtained mostly from the field-grown plants at Woodburn, with stock plants surrounding the Portland nursery supplying the rest. Cuttings are taken early on in the day when they are turgid and flexible. They are wrapped in burlap, watered, and stored in the shade until transported to Portland where they are stored at 45F until stuck.

To maintain hygiene, all clippers, gloves, bench tops, knives, etc. are sterilised with Physan at 1 : 10 (v/v). Cutting material is washed using Shield at 1 oz/4 gal, with Syphonex at 1 : 16 added—the plant material is well-drained prior to use.

Cuttings are wounded deep enough to expose the cambium layer. Hormones used are Hormodin #3 for most subjects but for dwarfs and lepidotes 1 : 10 IBA in alcohol is used. For harder to root types, Hormodin #3 plus boron and 1.6% IBA is used.

Cuttings are inserted at 5 cm square spacing using a medium of 1 peat and 1 pumice (v/v). Pumice is preferred over perlite as it is heavier, available locally (being a volcanic substance), and cheap.

Cuttings are watered-in and treated with Vapourguard to help control water loss. As they are only 5 cm long they would tend to dry out quickly without this treatment.

For the first 6 weeks to 2 months, cuttings are watered each morning and mist is applied from 11 a.m. to 7 p.m. depending on weather conditions. Mist application is regulated by an automatic leaf. Heating between 72 to 78F is by means of electric bench cable. Ventilation in the roof is manually operated with a higher humidity preferred for best results. Callusing is expected to occur in 1 to 2 weeks and rooting by 2 to 4 months.

MONROVIA NURSERY, DAYTON, OREGON

Propagation at Monrovia takes up an area of 20 acres with 140 people employed, including the liner team, so it was particularly interesting to see how rhododendrons fitted into the propagation schedule.

Of the 15 million plants grown at Monrovia last year, 500,000 were rhododendrons. Thirty rhododendron cultivars are propagated from October to November. Traditionally rhododendrons were produced in flats but currently they are direct-stuck into a liner pot. This is because the cutting would be too woody by the time it had been potted on into a liner pot. Now, with the direct sticking method, the liners go into a 1-gal (5-litre) pot as a younger plant and this ensures better lower branching.

The material is prepared in the propagation shed and then goes to the mist unit where the pots are stacked up and filled with media consisting of 3 peat moss : 2 perlite (v/v). Prior to insertion the cuttings are disinfected with Consan at 200 ppm and then washed in chlorinated water (15 ppm chlorine).

Depending on the culitvar, the hormone used is Hormodin #2 or #3. The cuttings—7.5 cm to 10 cm long and pencil thickness—are inserted into the pots and placed onto the bed in the mist unit.

The propagation house is filled with concrete beds which slope down both sides from the centre to collect water in a gulley for recycling. Bottom heat is kept at 64 to 65F and supplied by 25-mm copper tubing below the surface. Four boilers maintain the temperature with the water needing to be kept at 100F to achieve the desired basal heat in the bed. Intermittent mist is used, coming on one hour after sunrise and off one hour before sunset. The cuttings are misted for 2 sec every 10 min.

Monrovia boasts an average 90% take on its rhododendrons, depending on the quality of the wood used. For example, *R.* 'P.J.M.' was giving 85% in 1992 but was down to 70% in 1993 because the cutting material was too woody.

Cutting material is removed from 5-litre and 10-litre container plants in the nursery. In the propagation room, there is enough space for 50 cutters to operate. They cut and prepare their own material and are encouraged to take 3000 cuttings per day. If an individual does not achieve this number, their technique is analysed so that any problems can be ironed out. A table is pinned to the wall showing each cutter's performance. Top of the list was a lady who made 4700 cuttings on the previous day. This was achieved by a superior technique with both hands being active all the time, and good concentration on the job.

A SANDY RHODODENDRON, SAND, OREGON

A very young nursery, started only four years ago, but one which produces many

excellent, quality, rooted cuttings and liners. Around 60,000 have been grown over the past year for sale to the trade, with over 450 species and hybrids on the list.

Propagation is by conventional cuttings which Chris Hoffman, the proprietor, believes to be the most natural way for the plant to thrive. "As long as the best possible conditions are employed, there is no reason why 100% rooting should not occur," he says. The nursery currently achieves an average of 95%.

The cuttings are propagated from May onwards, depending on the subject. The majority are propagated in July and will root from September onwards, again depending on the subject in question. Cuttings are given two wounds, one longer than the other, not too heavy and not too deep. As much leaf area as possible is retained, with only the longer leaved subjects being reduced for space conservation.

Cuttings are inserted into a medium consisting of 2 perlite : 2 moss peat : 1 fine grade hemlock bark (by volume). The bottom of the propagation bed is also lined with bark to encourage the roots to spread out and take advantage of the microbial activity there. After sticking, cuttings are sprayed with Wiltproof to reduce transpiration and protect against fungal spores.

The mist unit consists of beds running the length of the propagation house, with Mypex on the ground and the beds built on top. The atmosphere is kept as humid as possible, preferably 100% RH, with the vents closed and a summer temperature of 120F. Reducing the air flow means a reduced chance of disease spores getting into the house.

The aim here with misting is not to have the medium too wet around the base of the cutting to avoid rotting, especially around the critical months of June, July, and August.

Once rooting has occurred, in the autumn, the cuttings are transferred to another house to grow on in an unheated bed. The medium here consists of bark, mixed with a strange cocktail of nutrients given at intervals: kelp and fish, vinegar, household ammonia, rock sulphate, glacial dust, and molasses.

In May the young plants are moved outside into a bed containing the same medium described above. They will grow on here until two flushes of growth have been achieved by the autumn.

I was very impressed with the quality of the plants, which Chris Hoffman puts down, at least partly, to his use of natural fertilisers. The kelp (African seaweed) contains 56 trace elements and 13 vitamins. The fish emulsion results in better break-down of the rest of the mixture for the plants to obtain nutrients more readily. The kelp is sprayed once per week, the fish emulsion once every 3 weeks.

Apart from foliar feeding, the kelp together with the vinegar is used as a natural rooting hormone for harder to root subjects. Coupled with Hormodin #3 this results in the cuttings producing large, pure white callus after 3 days. The vinegar, incidentally, helps the uptake of the kelp ingredients by the plant.

These feeds help Chris Hoffman produce good, compact plants with better branching, less leggy growth, shiny, healthy looking foliage, and a super indumentum.

Pests and diseases are very infrequent as the natural defence of such strong, vigorous plants are high. Sap sucking insects have seldom been seen on the nursery over the last couple of years. Chris believes that when chemicals such as Subdue are used, then natural microbial populations are reduced and the plant becomes

more prone to attack without this benign microbial activity which keeps it strong.

OREGON STATE UNIVERSITY, AURORA, OREGON

Of the many experiments taking place here, I picked up on one of the 'pet' subjects of Bob Ticknor, Professor of Horticulture. This was the capillary sandbed system, which is highly recommended to American nurserymen by Professor Ticknor and his team. They are trying to prove its undoubted benefits.

At Osberton Grange, we grow all our rhododendrons on such a bed—based on the beds designed and developed at Efford Experimental Horticulture Station. We are very happy with the benefits of the beds, which include: water conservation, reduction of nutrient leaching, automatic watering thus reducing labour requirements, reduced weed problems, and better drainage leading to better aeration of the container compost.

Experiments at Oregon State University have also proven these advantages. However, one argument against such a system is echoed frequently, the inability of growers to achieve the absolutely level piece of ground the bed requires for success. In this area of Oregon, the rolling landscape does not lend itself to level beds, so an experiment is under way to counter the problem. A capillary bed of 70-ft long is being operated with a 1-ft gradient down its length, with capillary piping running down the surface of the bed. A series of dams is positioned at intervals in the bed so the water does not run straight to the bottom but is evenly distributed.

Another experiment concerns the breeding of *Phytophthora* resistant rhododendron cultivars. This is done with some reluctance, as finding such a plant gives the public the idea that rhododendrons are generally susceptible which may 'back-fire' on the trade. A popular plant being used in breeding is *R. calendulaceum* [syn. *R.bakeri*] but others subjected to the disease have shown no ill effects so far during the trials.

Other work concerns 'late bloomers' which Professor Ticknor is trying to hybridise. This is because many visitors to the area come too late in the rhododendron flowering season and miss the main show of colour. As the last weekend of May (Memorial Weekend) signals the start of the holiday season, such plants could extend the flowering season into June and give visitors that extra viewing time.

Acknowledgement. I would like to thank all of my hosts during the study tour who were only too willing to share with me invaluable information on all aspects of the production cycle of rhododendrons. I learned a lot and made some good friends.

Editor's Note: Space does not permit inclusion of details of the following nurseries which Chris George visited but the author, and GB&I Region, would like to extend thanks to them, as well as to the nurseries described in this paper, *for their help with this study tour. A full account can be found in the Mary Helliar* Travel Scholarship Report, which is available to any I.P.P.S. Member who sponsors the Scholarship.

Other Nurseries Studied: Woodburn Ornamentals, Woodburn, Oregon; J&L Nursery, Silverton, Oregon; Kraemer Nursery Inc, Mt Angel, Oregon; Sorums Nursery, Sherwood, Oregon; Clarke Nursery, Long Beach, Washington; Berryhill Nursery, Sherwood, Oregon; Klupenger Nursery, Aurora, Oregon; Honsuchachac Rhododendron Garden, Salem, Oregon; Wrights Nursery, Canby, Oregon.