The length of time for hardening-off depends on the type of cutting, softwood or hardwood, and also on the species. To give you an idea of the length of time for hardening-off, I will explain the experience we have had with a particular item, *Xylosma senticosa* Orginally, *Xylosma senticosa* was hardened-off for a 10-day period in a well-circulated glasshouse It was then taken out under single lath for 2 weeks before potting After potting, it was placed under double lath. The results were very poor.

For *Xylosmas,* we now lengthen the hardening-off period in the glasshouse to 2 weeks, followed by hardening-off for 2 months under double lath outside

During the hardening-off period, cuttings are fertilized once a week with a weak liquid fertilizer. This fertilizer has all of the major elements plus magnesium, sulfur, and iron. Under this system of hardening-off, the cuttings developed a better root system, and results were 75% better.

Hardening-off Harder Wood Cuttings from the Intermittent Mist

The harder wood cuttings are generally placed directly under double lath outside, and mist is sprayed at a frequency similar to that with the softer cuttings. The cuttings are fertilized once a week with a liquid fertilizer. For example, *Mahonia 'compacta'*, which comes under this heading, was originally kept in a glasshouse 8 to 10 days for hardening-off and then placed outside for 2 weeks under single lath. Survival under this system was very poor We get much better results now by placing Mahonias in a glasshouse with open ventilation — day and night for 2 weeks (essentially outdoor conditions) — and then under single lath for 2 to 3 months. Potting at the beginning of the growing season was the best time for this operation. Cuttings are sprayed and fertilized, as are the softer cuttings.

The two cuttings described above as examples are particularly difficult items for hardening-off. Generally, the period for hardening-off outside is shorter for less difficult subjects

Hardening-off Conifer Cuttings from the Fog Mist

Conifer cuttings taken from the fog mist are placed directly outdoors under double lath and handled as are the harder cuttings above.

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Chairman Tichnor introduced Mr William J. Curtis, Wil-Chris Acres, Sherwood, Oregon.

MIST PROPAGATION WITH EMPHASIS ON HARDENING-OFF

WILLIAM J. CURTIS
Wil-Chris Acres, Sherwood Oregon

Mr. Chairman and Fellow Propagators:

I have been asked to talk to you gentlemen on "Mist Propagation, with Emphasis on Hardening-Off " We in the Northwest who propa-

gate with mist, work under climatic conditions of greater variation than you here in California. However, we must meet certain conditions and factors that are common to both of us. First, a good, clean rooting medium must be used that will afford excellent drainage, second, a supply of good, clean water, third, bottom heat; and fourth, an assist from a rooting hormone.

We have, in the Portland area, good, clean, sharp sand. Several propagators are using PERLITE, a manufactured coarse material that affords excellent drainage yet has the ability to hold a great deal of water in its expanded structure Clean, pure water is no problem; in fact, we sometimes have too much.

The bottom heat we use depends on the crop we are growing. We had several weeks of high, 90-degree weather this past summer. A 3-foot bench, filled with *Clematis armandi* cuttings, without mist, maintained a bottom temperature of 65 degrees, which seemed to be the right temperature for the best results When the weather cooled off, the heating cable was turned on.

We also have a climate that offers a great variation in light intensity Normally, a few warm days are followed by cloudy, dark days. If you use a time clock for your misting intervals and do not change it, you might apply too much water during such dark days.

An intermittent type of mist system, like "Mist-O-Matic," does a satisfactory job for me Many time clock controlled mist systems are used in the Pacific Northwest, and all seem to be giving good results. At this early stage in mist propagation, perhaps no one can justly say which system is best for applying mist to a bench of cuttings. In July, we start with our deciduous ornamentals. The first are *Magnolia stellata* and *M soulangana* We use a standard flat of coarse, sharp sand, firmly tamped. In four to six weeks, they are ready to pot We then take them from the mist, and hand-water them for a week to ten days, depending on how busy we are at the time. If the weather is hot, we cover them with newspapers for a few days from 10:00 a.m to 5:00 p.m. A semi-hard wood cutting is used, we snap or cut out the soft tip. The cuttings of *M. stellata* run 100 to a flat, while we only get around 70 of *M. soulangana* to the flat. A 78 to 85 degree bottom temperature seems to be the best. The re-strikes are set back in flats, though not under mist. These are not potted until spring, for deciduous cuttings must have time to grow a little and develop a good root system before going dormant. When the re-strikes show signs of growth the following spring, we pot them. They will catch up to those potted the summer before, and may even outgrow them. We do not delay all potting until spring, because most of the magnolias are sold as fall liners out of 2½" rose pots.

Philadelphus virginalis, Philadelphus 'Mulkeyi,' and *Viburnum plicatum* are handled similarly to the magnolias.

Camellia cuttings are taken early in August. A ¾ inch cutting is used for most varieties; the Kumasaki roots well and grows excellently with a single-leaf two-node cuttings. If short of cutting wood, a single-leaf cutting will bring good results. By the time they are rooted, the weather has cooled off and we have been hand-watering for several

weeks We do let the sand dry out a little, for one loses fewer if the rooting medium is a little on the dry side.

Rhododendron cuttings are placed in 2½" spruce veneer bands in a mixture of 45% coarse, sharp sand and 55% coarse peat. This mixture is dampened enough to enable one to fill the bands on the potting bench before setting them in the greenhouse under mist. If a Rhododendron has small leaves, a 2" band can be used. A heavy wound 1" long is made on one side of 3-inch-long cuttings. The cuttings are dipped in Hormodin #3. The excess is tapped off against the side of the can A very good percentage is the rule. Mid-August can be hot and dry in Oregon, so Rhododendron cuttings must be under mist. However, one can put many varieties in the bench in October or November and get good results without mist Once again, we have cuttings rooted in the early winter when the mist has been shut off for several weeks If you have some varieties that root easily and are ready when the days are still sunny and warm, you can take them from under the mist and harden them off by hand-watering and covering with newspapers during the part of the day when the sun is most intense.

We have found *Viburnum burkwoodii* roots better in the open bench with hand-watering rather than under mist.

Daphne odora cuttings taken in August and placed under mist root well and are ready to pot prior to Thanksgiving. We use a 3" cutting placed in sharp sand with no rooting hormone. Hardening-off is no problem, for we have had the mist shut off for several weeks. Pyracantha cuttings are taken when the side branches of the gallon-can plants have grown six or eight inches long. This gives a 4-6 inch cutting, with some longer We use sharp, coarse sand in flats. In 4-6 weeks, they are ready to pot. We take the flats from under the mist and hand-water, allowing the flat to dry out some, to make digging easier. If we have hot days, which we sometimes do in early October, we cover these with newspapers until they stop flagging.

I have found that Hormodin #3 gives the best results on all cuttings placed under mist. The only exception is *Daphne odora*, which roots excellently without a rooting assistant.

We use St. Julian plum for understock for semi-dwarf peaches, plums, and prunes. Our source of supply of understock notified us in July that they had had a 95% crop failure I immediately put 1,000 under mist and another 1,000 in the open bench, treating all with Hormodin #3. Results· complete failure. Thinking that perhaps the sand was not coarse enough, I used a great deal coarser sand, using Hormodin #3 — Hormodin #2 and several flats without a Hormodin powder. They, too, were a total loss What did we do wrong? Why a total loss? I will try another batch of cuttings when they go dormant.

In summarizing, there are several factors we must consider:

First A clean, sharp rooting medium that affords excellent drainage is a MUST.

Second A supply of pure water.

Third Stiff bottom heat is most important.

Fourth The use of Hormodin powder provides more roots faster than if you do not use it.

Fifth I have not said much about hardening-off, for it is not a great problem with us. By the time the majority of our cuttings are ready to pot, the weather has cooled off and we have shut off the mist and have been hand-watering.

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Chairman Tichnor introduced Mr James S. Wells, James S Wells Nursery, Inc, Red Bank, New Jersey

MIST PROPAGATION — HARDENING-OFF TECHNIQUES

JAMES S. WELLS
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Mist propagation has become such an integral part of almost any propagating nursery that it is interesting to recall that the first recorded instance of its use in plant propagation was in 1936, at Trinidad, British West Indies. By 1940, it was being tested in this country, and an excellent article in the *American Nurseryman,* May 1, 1941, by a nurseryman, Edward Gardner in Wisconsin, gave a long list of plants successfully propagated under mist. Then the war intervened, and most people lost sight of the method, although it was still in use at many of the state experiment stations. It was not until 1946-7 that practical work began once more. Mist, then, is a horticultural development of the first magnitude that has come into general use within the last 10 years.

As an essential preliminary to our discussion, we should first consider briefly some of the wider aspects of the misting techniques. I like to think of misting as being a better method of controlling water loss from cuttings, grafts, or transplanted seedlings. Most of the techniques the skilled plant propagator has used since his work began, have been directly toward the control of water loss from the plant materials with which he is working. A piece of a plant is arbitrarily removed from its natural water supply when it is taken as a cutting, and it is, therefore, in a precarious position It has no well-defined source of water, yet it has an undiminished ability to lose water through its leaves. Such a piece of plant material has to have quite careful attention day by day, even hour by hour, if it is not to die. It requires a special place — a greenhouse — plus the attention of the skilled propagator, and all these efforts are directed to the control of water loss. The syringing of greenhouse walls, the use of double glass or a polyethylene tent, the waxing of a graft union, or the use of mist are all part and parcel of the same thing, control of water loss. In this respect, misting has three distinct aspects. First is maintenance of an extremely high level of relative humidity inside the greenhouse. That is where fogging comes in. The standard humidifier is in this category, and for many cuttings this use of water is entirely adequate. Maintenance of humidity at 95 to 98% is sufficient to prevent undue water loss, particularly on cuttings that do