satisfactory as you will learn this morning from our panel of successful propagators.

Actually, in our propagation techniques with cuttings, we are attempting to establish environmental conditions which are optimum or as near optimum as we can get them for the rooting processes. Paramount among the environmental factors are the control of light, temperature and humidity. Of course temperature would include both air temperature and medium temperatures, water relations would include that of the atmosphere as well as the medium.

We are going to divide the discussion this morning into two phases. The first aspect will be a discussion of the methods that are actually employed by these various nurseries and individuals Following that, there will be a discussion period, which will give you a chance to ask questions specifically concerning the details of the methods We will then take our break and come back and give the members of the panel an opportunity to brag about their results and about their methods.

I am prepared, if necessary, to ask a few baited questions for some of these people. I hope we can get an argument started. However, I doubt seriously if it is necessary for the panel moderator to precipitate any discussion or questions. We are going to try to make this as informal as we can by having the panel all up here at the same time.

I would like the following panel members to come forward: Bill Flemer, Roger Coggeshall, Leslie Hancock, Merton Congdon, and Henry Weller.

These gentlemen will take some five to seven minutes first to discuss the methods of propagation which they are following and then we will have a question and answer discussion We will call first on William Flemer of Princeton Nurseries, Princeton, New Jersey, to discuss their methods of propagation by cuttings in the greenhouse. Mr. Flemer. (Applause)

MR. WILLIAM FLEMER: Thank you, Dr. Snyder.

We use greenhouses with bottom heat in the winter and without it in the summertime for our softwood and firmwood cutting propagation at the Princeton Nurseries. We think that this is an economical method to use because the maintenance costs are so little.

Our houses, for those of you who have not seen them, are the old-fashioned kind of Dutch greenhouse They are low double span houses, joined side by side. They are 100 feet long and 16 feet wide, I believe. We have two, 3½ foot benches on either side of a 2½ foot central walk. The glass begins at the rear of the bench, at a point about 15 inches above the bench and then goes up to a gable overhead. By this you can see that the glass is rather close to the bench, which is great aid in maintaining uniformity of temperature and moisture.

We have eight of these houses, four on each side. Beyond these, we have eight sash houses which are wider. They have six foot beds and they are covered with sash which can be taken out during the summertime. When we are pressed for propagation room we can put two or more of those sash houses into use, either in the winter or summer,

because three of them have bottom heat. We use these to help us over the hump during the rush seasons.

Our system of greenhouse cooling is a rather unusual one which you don't often see in the nursery business. We run pipes down the ridge poles of each house and they have Skinner fine spray nozzles alternately placed two feet apart down these pipes spraying out in opposite directions. During the hot periods in the summer we turn the lines on. They are full of cold well water, which is sprayed out on the glass. This cools the glass which in turn cools the air inside the houses. It is a very effective and inexpensive method of greenhouse cooling. You have to have cold well water to do it with, since warm pond water is ineffective. This water runs down to the gutters and away to a little pond which we use for irrigation

We work these greenhouses very hard We take four and a half crops of cuttings per year out of each house. The reason I say four and a half is that it depends on the speed of rooting. In some houses we take five crops and in other only four, so it averages out at four and a half crops of cuttings. I will run through the cycle just briefly with you.

Starting in mid-May, which is the only time that these houses ever become empty, just after we plant out the last of our potting stock, we have a little breathing spell. At this time we check over the houses, do any painting that might need attention, replace cracked glass and tidy them up in preparation for the next year's crops.

At that time we take out all the sand and replace it with fresh sand. We are sterilizing with steam and electricity. We are convinced that after you have grown a few crops of cuttings in the same medium you get a build up of fungi, bits of roots, bits of leaves, even though you sterilize the sand. There will soon be reinfection from aerial-borne spores and a medium full of organic matter like that is just a breeding place for fungi of all kinds.

During this May period we replace with sand completely. We take the old sand out and stockpile that and use it for covering seeds in the seed beds. After replacing the sand and touching up the greenhouses, we are ready for our first crop of softwood cuttings These are usually those varieties which start growth early and harden, like lilac, followed by *Spiraea bumalda A. W., Prunus spp., Berberis thunbergi,* and *Deutzia gracilis.* These are the first crops we put in. These root very quickly at the end of two weeks or two and a half weeks, depending on the plot.

We pot those off in jiffy pots and put them directly in cold frames where they are not taken out again until they are ready for planting in the spring.

We get the second crop of softwood things ripening in the middle of the summer which includes: *Weigela, Hydrangea P. G.* and *A. G.*, *Viburnum tomentosum,* and as we go further into the summer *Viburnum tomentosum plicatum* and various other varieties which we grow from cuttings.

Those houses which have had two early crops of softwoods are empty in time to take what we call firmwood cuttings, which would in-

clude the evergreen barberry, hollies of various kinds, and other broadleaf evergreens. Those greenhouses which have a second crop of rather late cuttings, like the viburnums, are not available for that broadleaf crop but are emptied out in time to be available for the first of the conifer cuttings. Eventually all of the houses are filled with conifer cuttings.

We start with arborvitae. We follow those with yews and we end up last of all with junipers. Our experience has been, within reason, the later you take your junipers the more quickly and the more abundantly they root.

Since we propagate in the greenhouse the material does not get below 48 or 50 degrees in even the coldest weather. We therefore like our yews and all our conifers, in fact, to go through some cold weather before we take them. Experiments in taking conifer cuttings early in the season in August or September have been uniformly disappointing. They callus but they don't root properly and those that do root don't break bud dormancy properly.

After the first of the conifer cuttings which were stuck have rooted and have been potted up, those houses are made available and used for grafting. We practice both open bench and some case grafting, depending upon the case of the subject. Those houses which are not used for grafting are used for a very early spring crop of small hardwood cuttings of the type Louis Vanderbrook described to you in detail several years ago.

After the grafts have set up and the hardwood cuttings potted off, open spaces in the benches are filled with conifers which have been potted up in the Jiffy pots We then go into the spring season, in late April or early May, with all the greenhouses full of pot plants of cuttings which were made last winter. All the sash houses are full of potted plants and all our cold frames are full of potted plants. From that time on we are planting. We then clean out the greenhouses and repeat this cycle which I have described to you.

Costs sound bad to begin with, but when you consider the small amount of upkeep that you have to do on a well-built greenhouse versus the continual upkeep that you have on a polyethylene plastic house, you can amortize this initial cost over a number of years and it will compare very favorably with the plastic house.

Costs in New Jersey run about 50 cents per square foot of inside area for constructing a decent plastic house compared to $1.50 a foot for constructing this Dutch type of greenhouse. This is just for the house, and does not include the heating. Heating will add another dollar a square foot to the cost When you consider that those houses were built 40 years ago, and have never had major repairs of any sort, then that $2.50 a foot initial cost figures out to be a pretty low yearly cost.

I think that is all I have to say for the present. I will be glad to answer any questions which occur.

MODERATOR SNYDER: Thank you very much, Bill . We will go on now to the Use of the Polyethylene Enclosure, the procedure originally described by Harvey Templeton a number of years ago and