ably better knowledge of inherent principles. He can fail, find the cause, and do it over.

Improvements in ways of propagating and the ones offered in the compiled proceedings of this Society alone are very great are not an easy thing for all of us to return home and put in force.

They are possibly less easy for the commercial firm to realize quickly on than for others. This is for the reason that improvements can be faulty from the aspects of slowness, tediousness, and not leading to rapid substantial quantity production. They often have a requirement for the working out of additional "know how" as it applies to an individual establishment. To make this clear I am referring to what the automobile industry calls "bugs" in its new models.

We can very easily find differences in attitude regarding nurse systems to carry the newly propagated plant onward. On a trial basis, it is justifiable to carry the new plant through, such as the first over wintering, regardless of all factors needed.

These measures are not so easily justifiable by the propagator who is restricted by end prices and by the division of their facilities among sizeable numbers of runs in large amounts.

Appearances indicate that a broad sector of propagators connected with educational activities do have distinct advantages in communications among people doing similar work. Their policies regarding publication are more disciplined and they seem to be in position to derive greater benefit from correspondence and publication. Their opposite numbers in commerce are simply under a different kind of pressure. Their activities are such that though very willing their time for this type of effort is limited.

Their remains a final question to answer. Are all propagators building a suitable and adequate historic record? It should be one that assures that old practices, some very ancient are not senselessly dropped. We need also measures to cause newer findings to be hastened into more general use.

MODERATOR SHUGERT: Thank you very much, Frank. Our next speaker in the program is Dr. Harold Davidson from Michigan State University, East Lansing who will speak on clonal and sexual differences in the propagation of Taxus.

CLONAL AND SEXUAL DIFFERENCES IN THE PROPAGATION OF TAXUS[1]

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Investigators have found that certain inherent characteristics of plants influence their rootability. Among the character-

[1]Paper number 3524 Michigan Agr Exp Sta, East Lansing, Mich.

istics affecting rooting are inherited clonal variations and sexual differences.

The influence of sex in the propagation of plants by cuttage has received very little attention. Snow (9) reported that cuttings selected from male trees of the Red Maple rooted at a higher percentage than did cuttings selected from female trees. Neal et al (4) found that in *Ilex verticillata* male cuttings taken at certain times of the year rooted better than comparable female cuttings. In a somewhat different morphological situation, O'Rourke (5) reported that vegetative wood of Blueberry rooted better than flowering wood.

Since a number of propagators (7, 8, 10) have made reference to the fact that various clones of Taxus are difficult to root, it was decided to conduct an experiment to determine if there was a difference in the rootability of Taxus clones and to see if the difference might be associated with the sexual character. And since male plants of *Taxus cuspidata expansa* (Japanese Spreading Yew) appeared to be more numerous than female plants in landscape plants, a survey was conducted of some relatively large plantings of this species to determine the ratio of male plants to female plants. Another experiment was also conducted to study the rooting response of cuttings selected from male verus female plants of this variety.

In order to assess the sex ratio of *Taxus cuspidata expansa* twelve samples were taken. Sex determinations were made in the fields of nine nurseries in Michigan. A large block of this species was entered at random and determinations made in a row and when necessary the next adjacent row. Determinations were also made in three relatively large plantings associated with a landscape surrounding a building or in a garden on the campus of Michigan State University. The sex ratio was tested

Table 1. Sex-ratio of *Taxus cuspidata expansa* in selected nursery and landscape plantings in Michigan.

Planting	Classification		Sex Ratio
	Male	Female	
1	82	18	4.56
2	76	24	3.17
3	82	18	4.56
4	75	20	4.00
5	90	10	9.00
6	80	20	4.00
7	49	51	0.96
8	73	27	2.70
9	74	26	2.85
10	20	6	3.33
11	13.5	7.5	1.80
12	13	4	3.25
Mean	60.6	19.6	3.09

for significance by the Chi Square test. Theoretically, a ratio of 1 to 1 should be expected in a population of this species if it had segregated normally for sex.

The results of this survey (Table 2) indicate that there was a difference in the number of male versus female plants. Male plants were found to be present in a ratio of 3 to 1.

In order to evaluate the rootability of cuttings of *Taxus cuspidata expansa* two hundred male and two hundred female cuttings were selected from large vigorous plants growing in the Horticultural Gardens on the campus at Michigan State University. Seven-inch tip cuttings were made, divided into 20-unit samples, and placed in sand media in a completely randomized design using five replications. Hormones were not used on the cuttings. The cuttings were stuck December 9, 1963, lifted and rated according to the Method of Ranks (3, 6) on May 9, 1964.

The results (Table 2) indicate that cuttings from male plants of *Taxus cuspidata expansa* rooted better in the five month period, than did the cuttings from female plants. The ratio was in the order of 2 to 1.

Table 2 Rooting Index for Male versus Female Cuttings of *Taxus cuspidata expansa*.

	Sex of Cuttings		
	Male	Female	Ratio
	75	32	2.25
	61	54	1.13
	66	24	2.75
	63	21	3.00
	80	42	1.90
	78	38	2.05
	70	33	2.12
	77	18	4.28
	32	27	1.19
	54	25	2.16
Mean	65.3*	31.4	2.08

*Means are different by odds of 99-1

In order to determine whether or not there was a difference in the rootability of several clones of Taxus an experiment was made using seven clones (Table 3) in a replicated, randomized design similar to that of the first experiment. The differences for clones were established by use of Duncan's Multiple Range Test (2). The difference between sexes was tested by an orthogonal comparison with one degree of freedom.

The results of this experiment indicated that there was a difference between the rootability of the seven clones of Taxus. Of the seven clones, 'Hatfield' rooted the best or with the great-

est ease and *Taxus cuspidata* 'Nana' was the most difficult of the group to root. The comparison between male and female was significantly different by odds of 19 to 1. But in this experiment the difference was in favor of the female cuttings.

Table 3. Rootability index for Seven Clones of Taxus.

Clone	Sex	Index
Hatfield	Male	64 a
Halloran	Female	42 b
Wardi	Female	36 b
Densiformis	Male	21 c
Browni	Male	20 c
Hicksi	Female	17 c
Nana	Male	4 d

DISCUSSION

The results of these investigations indicate that some mechanism is operative that caused populations of *Taxus cuspidata expansa* plants to segregate in a ratio to 3 to 1 in favor of the male plants, rather than an expected ratio of 1 to 1. This segregation might be explained by the fact that male cuttings of this species rooted more readily than did female cuttings and as a result propagators might inadvertenly be selecting for male plants. If this selection was carried through many populations it could end in much higher ratios as was found in one nursery where the ratio was 9 to 1.

The exact cause as to why the cuttings from male plants of *Taxus cuspidata expansa* rooted better than did the cuttings from the female plants and why in the study on the rootability of Taxus clones, the results were in favor of the female group is yet to be determined. This data will indicate that it is not associated with a male gene as might be expected if all male clones rooted better than female clones.

Edgerton (1) and Neal et al (4) have suggested that the difference in the rooting of the sexes was related to carbohydrate content of the cuttings. They suggest that the cuttings from female plants might have a smaller carbohydrate supply because it was used in fruit production. But if it were strictly a carbohydrate relationship, all male clones would be expected to root better than the female. But it is to be noted from Table 3 that *Taxus cuspidata 'Nana'*, a male clone, had the poorest rooting index and the clones 'Halloran' and 'Wardi', both female clones, had relatively good rooting indicles. This would suggest that perhaps another factor other than carbohydrate content is operative in controlling the rootability of Taxus clones. Studies are now underway to determine the cause of this difference.

It should be pointed out that many of the cuttings that were slow to root would eventually develop a good root system and

that treatment with root accelerating compounds would undoubtedly be of value. It is also highly possible that if these same clones were tested another year or under a different environment that they might respond somewhat differently. Nevertheless, the conclusion is clear, namely: there was a real difference in the rootability of Taxus clones and that cuttings from male plants of *Taxus cuspidata expansa* rooted more readily than did the cuttings from female plants.

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MODERATOR SHUGERT: Thank you very much, Dr. Davidson for that very fine paper. Gentlemen we have 10 minutes for questions.

MARTIN VAN HOF: What I want to ask the last speaker is how do we distinguish male Taxus from a female?

DR. DAVIDSON: We can distinguish the female from the male Taxus very rapidly, of course, when it is in fruit. Only the female will have fruit. You can distinguish the male from the female at almost any other time of the year by the shape of the flowering buds. The flower buds of the male forms are quite round or ball shaped. The flowering buds of the female are quite elliptical. They are very different. Also the male usually has tremendous numbers of buds.

ROLAND DEWILDE: Did you say that the Hicks was a male form?

DR. DAVIDSON: To the best of my knowledge there are two forms, male form and a female form.

DR. CHADWICK: I'll take a guess at this. That the male forms of Hicks are costage.

JOHN VERMEULEN: When the taxus Hicks was brought into the trade, there were two different "species" of plants given to us at Hick's Nursery. I dont know exactly where they came from, but they were distinctly different and they are both called Hicks. When we started to make cuttings and distribute them, both types were distributed under the same name. Later we called them Hick's number one and Hick's number two. Number two is the male and number one is the female. The number one grows a little straighter and number two has a tendency of bending over slightly on the top.

DR. PRIDHAM: I have been down to Mr. Hicks at various times and he has pointed out the plants which he considers are Hick's Yew. I would like to ask Mr. Vermeulen just where the female tree was located that Mr. Hick's showed him.

JOHN VERMEULEN: It isn't there anymore. But it was by the greenhouses, and near the fence.

DR. PRIDHAM: That's the right one.

MR. BORK: I want to ask Professor McDaniel how he controls witches'-broom in Hackberry.

PROFESSOR MCDANIEL: Some of our people at Urbana have controlled witches'-broom by spraying. Witches'-broom is the result of the combined action of powdery mildew and a mite. You can control either one or the other and not have the witches'-broom. However, I have not studied the pathology of it myself.

VOICE: We have a bug coming from Hackberry the latter part of September. If the tree is near the house, the insects penetrate the house, covering the screens, coming under the screens, and everything. There are just millions of them.

PROFESSOR MCDANIEL: I have heard of this problem, but I cannot give the control.

HARRY HOPPERTON: Has anyone had any luck budding Hackberries?

PROFESSOR MCDANIEL: We have had about 50% but with limited quantities. We use the chip bud and have used the bark graft on some of them also. It is a little difficult to bud by the "T" bud method. I prefer to use the chip bud where the wood is left on the bud. The bark is rather fragile and tends to splinter.

MR. PLUMER: We have had good luck budding Hackberries with a heel bud. But the thing is you've got to have big, vigorous understock and good budwood. We get sixty to seventy percent, sometimes higher, but never below sixty.

DR. STADTHERR: I would like to ask Dr. McDaniel, if all of the Hackberries are so heavy fruiting, will this not detract from their use as street trees?

PROFESSOR MCDANIEL: Grey's manual calls them scant fruiting although he may have got there late in the season. The

fruit is attractive to the birds, and they work on it. I have been looking for non-fruiting trees but so far I have not found one that would qualify.

MODERATOR SHUGERT: We will now go into the third quarter with a paper entitled, "The Diffusion of Root Promoting Substances from *Hedera helix Stems*." The paper written by Ronald Girouard and Dr. C. E. Hess. Mr. Girouard is going to present the paper for us at this time.

THE DIFFUSION OF ROOT PROMOTING SUBSTANCES FROM STEMS OF Hedera helix

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1. Introduction

The vegetative propagation of plants by cuttings has attracted the attention of commercial propagators and research workers for many years. As a method of reproduction it has varying degrees of success depending upon the species, cultivar, clone, or growth phase of the plant used (1, 6). Internal and external factors and interactions of these influence the initiation of roots on cuttings (6, 7, 8). The root promoting substances or cofactors extracted and characterized by Hess (4, 5) are examples of internal factors. Recently the movement of these substances in a downward direction as influenced by the presence or absence of leaves on stem cuttings of juvenile English ivy, was studied. It is this work which we would like to review at this time.

2. Materials and Methods

To determine the activity of substances with root promoting properties, mung bean (*Phaseolus aureus*) seedlings were grown in a controlled environment chamber. At the end of ten days the seedlings were cut 3cm below the cotyledonary node. To each bioassay vial containing four ml. of indoleacetic acid solution, ten bean cuttings were added; several of these vials were kept as controls (3).

In one set of experiments, juvenile *Hedera helix* shoots eight inches in length were cut, stripped of only a few basal leaves and added base down in increasing numbers to vials with bean cuttings. At the end of four to six hours glass distilled water was used to restore the level of the liquid in the vials and thus prevent dessication of the cuttings.

In a second series of experiments one major change was made: the ivy cuttings were completely defoliated before being placed in the vials.

Diffusates, or substances slowly released from the base of ivy cuttings in liquids, were collected over a period of two days in a small volume of glass distilled water, evaporated almost to