VARIABILITY IN ROOTING AND SURVIVAL OF CUTTINGS FROM WHITE PINE WITCHES' BROOM SEEDLINGS

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INTRODUCTION

I'm sure most of you know what a witches' broom is, but for the benefit of those who are in the dark, I'll first try to describe what witches' brooms are and why they hold such fascination to those of us who are collecting and experimenting with them.

A witches' broom is an abnormal shrub-like growth that occurs only occasionally on various species of woody plants. Most often, it occupies only a small part of the tree while the remainder consists of normal leaves and branches. The broom is considered abnormal because its structure usually differs quite sharply from that of the normal part of the tree. The development of the broom is not the result of a gradual change in structure, but is abrupt, and its point of origin is easily identified (Fig. 1).

I prefer to categorize brooms into two groups; 1) those that are caused by parasitic agents, such as dwarf mistletoe,

Figure 1. A witches' broom on a white pine.

viruses, mites, rusts and fungi, and 2) those that are mutations caused by factors, as yet, not understood. It is the latter group that I am most concerned with because grafts of such brooms usually retain the character of the broom and are not tree-like. The parasite-induced brooms, as one might expect, are often seen in groups, often many on the same tree, while the mutation brooms, which are rare, occur singly and are usually found miles apart.

Although brooms generally are shrub-like, they are not always similar to one another. Very often wide differences in stem and leaf structure occur from broom to broom. Needle length for example, can vary from ¾ inch to over 3 inches. Other interesting features in which brooms differ from one another are color of the needles, density of the branches, and size of the cones. As a consequence, even though the brooms look somewhat similar to the casual observer they are quite different from each other.

Variation that occurs among brooms is fortunate because it increases our chances of finding new and unusual evergreen plants. Brooms are of interest not only because they retain

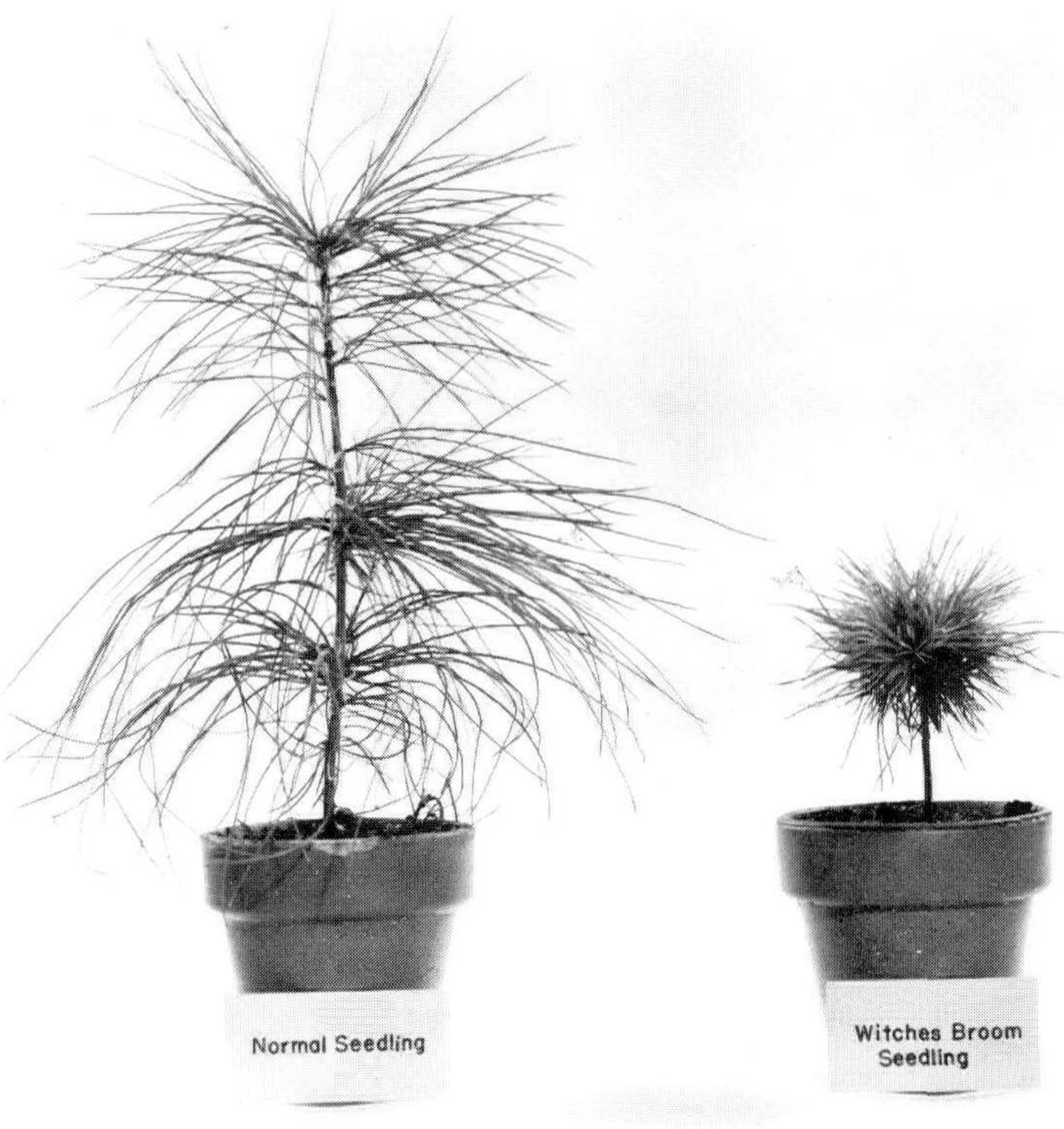

Figure 2. A normal and a witches' broom seedling of white pine.

their dwarf form when vegetatively propagated, but because the germination of seed obtained from brooms results in many unusual forms of shrubs. The fact that these abnormalities are carried over in the seed supports the concept that brooms are the result of mutations (Fig. 2).

To this date only female conelets have been found on brooms. Seed production can occur only by cross pollination from the normal part of the tree or adjacent trees having male catkins. Usually 50 percent of the seedling offspring are abnormal and 50 percent are normal. Of a seedling population from one broom, having a total of 741 plants, 368 were normal while 373 were dwarfed. In another progeny, 98 were normal and 104 were dwarfed. Similar witches' broom progenies have been previously reported by Fordham (3) and by Johnson, *et al.* (6). Both reported 1:1 ratios for normal and abnormal offspring.

In one group of white pine seedlings that are now five years old, considerable although subtle variation was found to occur (Fig. 3).

Figure 3. Examples of variability in form and texture among a group of seedlings obtained from a white pine witches' broom. All plants are 5 years old.

The vegetative propagation of witches' brooms is limited to grafting (7). Attempts to root cuttings of brooms have been unsuccessful except for one pitch pine cutting which rooted out of 25 taken. Grafting has been generally successful for most brooms except for one broom whose scions were found to grow very slowly. After four years these stunted grafts are still living, but seem to be suited more for a bonsai dish than for the field. For the majority of the brooms tried, grafting has proven successful.

In view of the fact that cuttings from brooms rarely root and because the odds in finding interesting forms among seedlings of brooms are much greater than from among the brooms themselves, an experiment was initiated to determine: 1) if cuttings taken from white pine witches' broom seedlings could be rooted; 2) if rooting varied among seedlings; and 3) if rooting varied according to the age of the plant. It is well known that white pine is not an easy-to-root species, but it has been reported that cuttings have rooted especially when taken from young plants (4).

METHODS AND MATERIALS

Seedlings obtained from a white pine witches' broom were grown in a greenhouse for 16 months under long photoperiods to hasten their rate of growth and were then lined out in the field and grown under natural conditions. After 4 years each plant was large enough to provide a limited number of cuttings. On March 28, 1968, 240 cuttings, four cuttings from each of 60 dwarf seedlings were taken, treated with Hormodin #3 and Captan 10:1 and then placed in coarse sand under mist. The following year, on April 18, 1969, the experiment was repeated using the same 60 plants except that five cuttings were taken per plant, providing a total of 300 cuttings. The frequency of the mist intervals was controlled by a light-operated interval switch (8) that responds to the intensity of the prevailing sunlight. The mist controller was adjusted to provide a minimum amount of water while maintaining a constant film of moisture over the foliage.

The small number of cuttings used per seedling was far from ideal, but in this instance the size of the dwarf seedlings, four and five years old, precluded the taking of a greater number of cuttings.

RESULTS

Of the 60 witches' broom seedlings used as stock plants in 1968, 61 percent had cuttings that rooted (Table 1, Fig. 4).

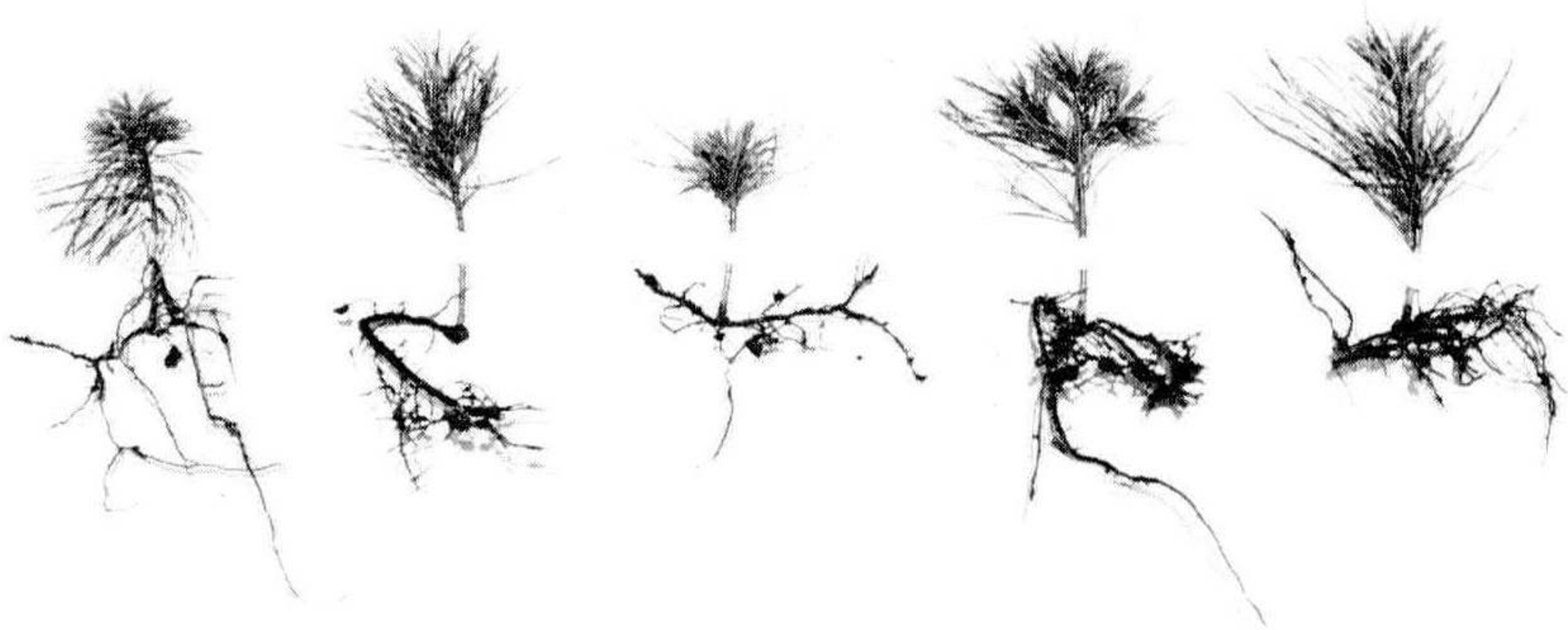

Figure 4. Examples of rooting of cuttings obtained from five white pine witches' broom seedlings.

Combining both years' results, 80% of the seedlings provided rooted cuttings. Considerable variability in rooting occurred among the seedlings. Twenty percent of the seedlings provided cuttings that did not root in 1968, nor in 1969, while 26 percent provided cuttings, all of which rooted. When considering only those seedlings whose cuttings rooted in 1968 and comparing the percent rooting with those rooted a year later, it was found that there was a highly significant decrease in rooting of cuttings taken in 1969 (Table 1). In other words, the percent rooting was significantly greater on cuttings from four-year-old (60.4%) than from five-year-old trees (29.4%).

Another example of a decrease in rooting with the increase in age of the tree was observed when cuttings were taken from a 10-year-old dwarf white pine that was found growing in the wild and which may have been of witches' broom origin (Table 2).

Table 1. Rooting of cuttings obtained from white pine witches' broom seedlings.

Seedling No.	Percent rooted 1968	1969	Seedling No.	Percent rooted 1968	1969
1.	0	0	31.	0	20
2.	0	0	32.	100	100
3.	0	40	33.	50	0
4.	0	100	34.	50	60
5.	25	40	35.	75	60
6.	0	80	36.	100	60
7.	0	60	37.	25	80
8.	50	60	38.	100	20
9.	0	0	39.	100	20
10.	0	100	40.	100	0
11.	25	0	41.	25	0
12.	25	40	42.	100	0
13.	50	20	43.	25	0
14.	0	0	44.	100	20
15.	50	20	45.	100	0
16.	0	0	46.	0	20
17.	25	80	47.	25	40
18.	25	20	48.	0	0
19.	0	80	49.	25	20
20.	0	0	50.	0	100
21.	0	100	51.	25	80
22.	25	20	52.	0	0
23.	50	40	53.	75	20
24.	100	60	54.	50	40
25.	100	20	55.	50	40
26.	0	0	56.	25	0
27.	0	0	57.	100	20
28.	0	0	58.	0	0
29.	0	40	59.	75	0
30.	50	0	60.	100	0

Table 2. Effect of age of stock plant on rooting of cuttings of dwarf white pine.

Date	Age (Yrs)	Rooting %	Date	Age (Yrs)	Rooting %
Apr. 1959	10	100	Apr. 1963	4	60
Apr. 1968	19	4	Apr. 1968	9	30

The percentage rooting was 100% in 1959 and only 4% in 1968, when the plant was 19 years old. The cuttings which had rooted in 1959 were grown on and in 1963 were used as an additional source of cuttings. At this time 60% of the cuttings rooted. Five years later, in 1968, the percentage rooted decreased to 30%.

DISCUSSION

Witches' brooms as well as seedlings from witches' brooms brooms are excellent sources of new and interesting dwarf evergreens (2, 3, 7, 9). There is enough variation in form, texture and rate of growth to justify the selection and propagation of choice clones. Propagation by cuttings can best be accomplished by selecting clones which are easy to root. Not all clones root equally well, however, and some were impossible to root.

Deuber (1) reported, in 1940, much variability in the rooting of cuttings taken from white pine clones even though all were of the same age.

The age of the pine seedling has considerable influence over its rooting potential. In these experiments one year's difference in age resulted in a significant decrease in rooting. The decline in rooting in only one year is not unusual. Gardner (4), in 1929, reported similar responses of one, two and three-year-old white pine seedlings whose cuttings rooted 98% from one-year-old seedlings, 51% from two-year-old seedlings and 12% from three-year-old seedlings.

The physiological changes that occur within plants from the juvenile to the mature stage and their concurrent decrease in rooting potential which was described by Hess (5) might serve to explain the decreased rooting of the witches' broom cuttings taken in 1969.

CONCLUSIONS

Seedlings obtained from witches' brooms offer a wide selection of unusual forms of slow growing evergreens. The rooting potential among the different clones varies quite markedly.

Propagation by grafting presents no problem, but cutting propagation may be limited to the easily rooted clones. With the increase in age of the seedling there may be a decline in the ease of root initiation.

The practice of taking cuttings from rooted cuttings of a particular clone may extend the period during which it could be rooted.

LITERATURE CITED

1. Deuber, C. G. 1940. Vegetative propagation of conifers. *Tran. Conn. Acad. Arts & Sci.* 34: 1-83.
2. Fordham, A. J. 1963. An unusual witches'-broom on *Prunus strobus*. *Proc. Int. Plant Prop. Soc.* 13: 117-119.
3. Fordham, A. J. 1967. Dwarf conifers from witches'-brooms. *Arnoldia* 27: 4-5, 29-50.
4. Gardner, F. E. 1929. The relationship between tree age and the rooting of cuttings. *Proc. Amer. Soc. for Hort. Sci.* 26: 101-104.
5. Hess, C. E. 1960. Research in root initiation. *Proc. Int. Plant Prop. Soc.* 10: 118-123.
6. Johnson, A. C., S. S. Pauley and W. H. Cromell. 1965. Dwarf seedlings from witches' broom in jack pine. *Minn. For. Notes.* No. 158.
7. Nordine, R. M. 1961. Propagation of witches' brooms. *Proc. Int. Plant Prop. Soc.* 11: 113-114.
8. Waxman, S. 1960. A light operated interval switch for the operation of a mist system. *Storrs Agr. Expt. Sta. Prog. Rep.* 40, 5 pp.
9. Waxman, S. 1966. New plant varieties from witches' brooms. *Milestones.* 10-11.

MODERATOR FLEMER: Thank you, Sid for an interesting talk about an interesting group of plants. Any question?

ED MEZITT: Do you have any trouble with woolly aphids on these dwarf white pines?

SID WAXMAN: Not too much; we do have them out in the nursery on a few of the dwarfs.

JOE CESARINI: In separating the seeds from the cones have you ever tried to save the seeds from the lower, middle, and upper part of the cone separately and plant them this way?

SID WAXMAN: I know this is supposed to have some bearing on their potential growth but I have not tried it.

AL FORDHAM: We have separated the small seeds from the large seeds from witches' brooms cones and we got a higher percentage of dwarfism from the smaller seeds.

ROBERT FARMER: Have you checked the ploidy on these?

SID WAXMAN: No, I have not but I believe Arnold Arboretum has done this; am I right, Al?

AL FORDHAM: Yes, the chromosomes have been counted and they were found to be normal.

JOHN RODNEY: How can you tell a witches' broom is a gene mutation and not caused by a pathogen when they're up in the air?

SID WAXMAN: If you see only one broom in an area it's a pretty good indication that its a mutation. Also with white pine we know that it is not usually caused by a parasite.

JOE CESARINI: We find that some sections of these witches' brooms graft very easily and others are very hard to graft. Also, if we take our scions from the grafts our precentage of takes keeps increasing.

SID WAXMAN: So it works the same with grafts as with cuttings; cuttings root better from cuttings.

JOE CESARINI: I have also noticed that sometimes I have 15 or 20 grafts of a single broom, then all of a sudden the brooms will start to go bad, turning yellow and dying. If I happen to pass by the place from which the original broom was taken I notice it is dead too.

MODERATOR FLEMER: Thank you again, Sid, for an interesting talk. Our next speaker, Al Fordham, is going to discuss the propagation of one of the most interesting and valuable of the small size maples, the paper bark maple, *Acer griseum*.