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LARRY CARVILLE: The "New Plants" portion of our program is always an interesting one where we see new plants which may be introduced into the trade. The moderator for this session will be Al Fordham.

MODERATOR FORDHAM: To begin the program, I will present a short paper along with some slides on how new plants arise.

WHY SOME CONIFERS DEVIATE FROM NORMAL

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When plants are raised from seeds, seedling growth patterns usually duplicate one another with monotonous uniformity. This similarity is brought about through the action of natural growth regulators termed auxins, which are produced in each plant. The following slides illustrate how strictly the growth and development of plants is programmed by hormones and also why some conifers depart from normal when the controls do not function or fail to function properly.

The growth of a typical Scots pine tree (*Pinus sylvestris*) illustrates the normal process of control by hormones. With the advent of spring, the clusters of buds located at the tips of the previous year's growth become active and develop into new shoots. During their elongation period such growths are commonly termed "candles." The time of this activity depends upon location and season. At Boston, Massachusetts, it commences about May 1 and, in a scant 3 weeks, elongation is completed and a new cluster of buds has formed.

Figure 1 (inset) shows a terminal shoot with a cluster of winter buds. When growth takes place the central bud will give rise to a terminal or leading shoot, while those surrounding it will develop into lateral or side shoots. In preparation for the next annual growth cycle, each "candle" will again terminate in a cluster of buds.

Figure 1 (left) illustrates diagrammatically how successive terminal growths of a young pine lead to elongation of its trunk and side branches, while lateral growths have formed branches in

whorls. Thus, each year's growth adds to the framework of the tree, leading to an increase in height, breadth and density. The result of such development is shown in the structure of a roadside pine, (Figure 1, right), It has followed the normal course of events for this kind of pine and its age can be determined simply by counting the branch whorls.

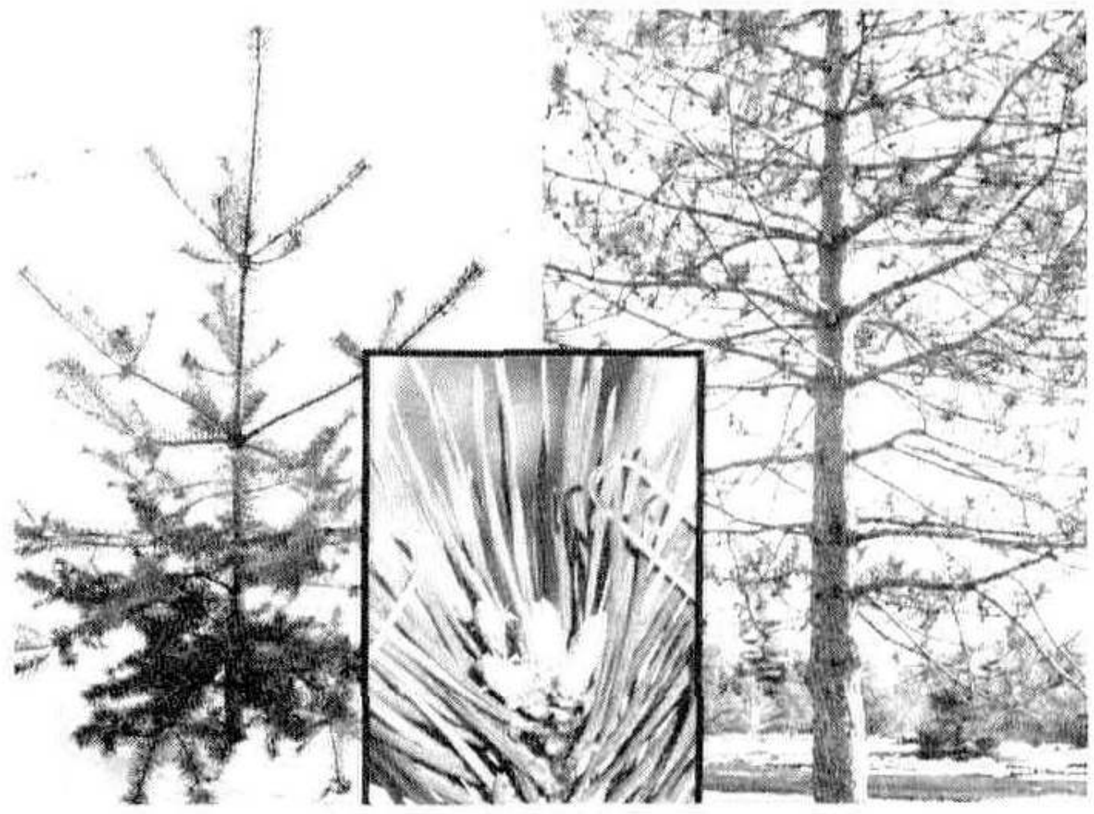

Figure 1. (Inset) Scots pine terminal shoot showing a cluster of winter buds. (Left) Terminal growths of a young Scots pine have led to an elongation of the trunk and side branches while lateral growths have formed branches in whorls. (Right) The result of these developments is shown in the structure of an ailing and partly defoliated roadside pine.

HORMONAL CONTROL OF DEVELOPING PINE SHOOTS

Hormonal control causes developing pine shoots to grow vertically. (Figure 2 - left). Any deviation from vertical is quickly corrected by auxin which gravitates to the lower side and causes that part to grow more rapidly, thus bending the shoot upward. Figure

Figure 2. Hormonal control causes developing pine shoots to grow vertically. Center - Partially developed cluster of shoots fastened in horizontal position. Right - Shoots have exceeded the amount of adjustment needed to become perpendicular and have formed hooks.

2 - center shows a partially developed cluster of shoots that was fastened in a horizontal position at noon. By 8 a.m. the following morning they had far exceeded the amount of adjustment needed to become perpendicular and had formed hooks (Figure 2 - right). When returned to their original position the shoots, in the course of 1 day, responded by forming lesser hooks on the opposite side. In 4 days they had resumed a vertical position.

APICAL DOMINANCE

The symmetrical form of trees develops through organization by hormones. Auxin produced in the uppermost growing tip migrates downward through the tree and prevents the lateral branches from growing upward; this control is called apical dominance.

On the outskirts of Boston, Massachusetts a landscape planting of Colorado spruce (*Picea pungens*) trees was made at a traffic interchange. They are now about 15 ft tall. Each year, for many years, the top of one has been stolen at Christmas time. Consequently, apical control no longer asserts its influence, and in time a few of the topmost branches curve upward and assume symmetrical shapes similar to those of normal spruce trees. Usually one leader takes control and dominates; if not plants may become trees with double or multiple trunks.

When traveling about the New England countryside, one sees many white pine trees (*Pinus strobus*) which lack apical leading shoots and terminate in clumpy masses of growth. Such abnormal developments arise through the absence of hormonal control when

Figure 3. Five-year-old white pine seedling placed on its side. The trunk gradually bent to a vertical position.

the apical shoots are destroyed by white pine weevils and the nearby branches, no longer suppressed, bend upward.

Hormonal control can also influence older plants whose trunks have lignified. When five-year-old white pine seedlings were placed on their sides, the trunks gradually curved upward until the stems had moved from a horizontal to a vertical position with a 90° bend at the soil line (Figure 3).

What appeared to be a grove of Norway spruce trees (*Picea abies*) Figure 4 (left) is actually all one clone which originated through natural layering. The lower branches of the original free-standing specimen rooted upon reaching the ground. A number of these natural propagants now approach the height of the parent plant. Figure 4 (right) shows the hockey stick-shaped trunks that came about when hormonal control took over and each rooted layer assumed a vertical posture.

Figure 4. What appeared to be a grove of Norway spruce trees is actually all one clone. Note the hockey-stick shaped trunks that came about when hormonal control took over and the layers assumed vertical postures.

ESCAPE FROM APICAL CONTROL

The lower branches of large, free-standing spruce, hemlock, fir, and perhaps other trees can be too distantly removed from the influence of apical control and therefore, its effect is lost. Some excellent examples of this are provided by a free-standing Norway spruce tree located at the Case Estates of the Arnold Arboretum (Figure 5). Some of the lower branches escaped the restraint of apical control, turned upward, and have now assumed the shapes of individual trees. Note that where the branches join the trees,

massive points of attachment capable of supporting the heavy tree-like structures have developed.

Figure 5. Free standing Norway spruce tree. Influence of apical control has been lost and the lower branches have turned upward.

LACK OF APICAL DOMINANCE IN SOME WITCHES'-BROOM SEEDLINGS

Figure 6 shows a selected sampling of white pine (*Pinus strobus*) witches'-broom seedlings. Photographs were taken of the

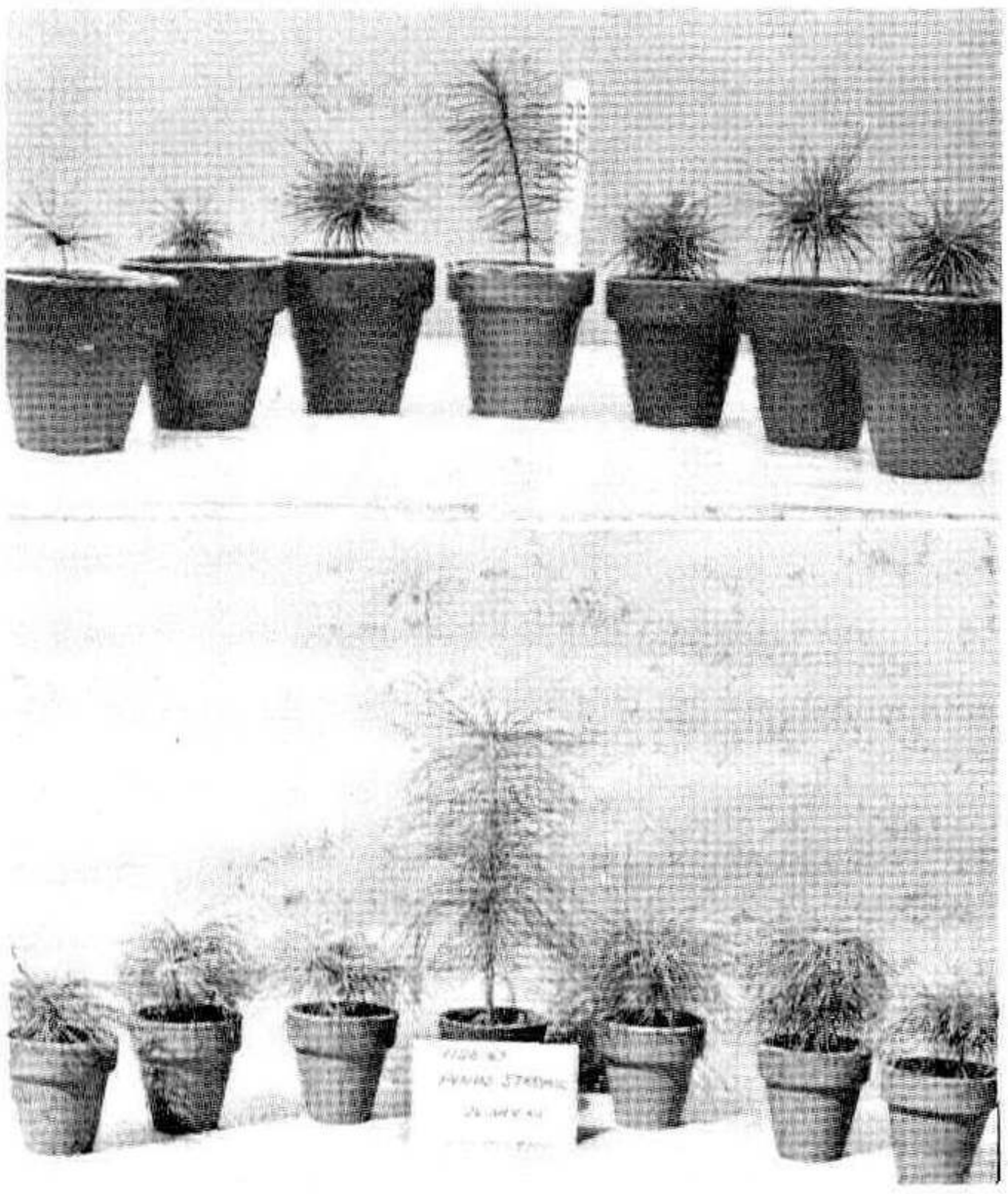

Figure 6. Selected sampling of white pine seedlings. Photographs taken of the same plants at six (upper) and eighteen months (lower).

same plants at age 6 (upper) and 18 months (lower). Differences in the seedlings became readily apparent as soon as they had passed the cotyledon stage. The seedling in the middle has a central stem, shows apical dominance and is normal in character. It went on to become a typical white pine tree. Other seedlings in the group developed lateral branches in the cotyledon area, and lacked apical dominance. They have grown into multibranched globe-shaped plants.

LACK OF HORMONAL CONTROL IN PROSTRATE PINES

New shoots of prostrate pines are under hormonal control and develop in a normal vertical manner. However, when growth is completed they lack the ability to remain erect and lie down. Such growth behavior leads to flat, congested plants which increase in diameter rather than in height. In natural habitats they would be in constant danger of being overgrown and shaded out by plants of normal growth.

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MODERATOR FORDHAM: The next paper will be presented by Dr. Gary Long and is entitled, "Plant Breeding with a Purpose."