epicormic branching of SITKA SPRUCE

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Philip A. Briegleb, Director
Portland, Oregon
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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INTRODUCTION

Epicormic branching is characteristic of Sitka spruce (*Picea sitchensis* (Bong.) Carr.) even when the tree grows in dense stands with a closed crown canopy. When spruce stems are exposed to increased light through thinning or other stand disturbance, the formation and growth of epicormic branches is apparently stimulated (Isaac 1940, Ruth 1958).[1/]

The presence of epicormic branches does not directly affect the utility of spruce saw logs for pulpwood or structural grades of lumber but does lower their value for clear lumber or for veneer. Epicormic branches also increase harvest costs because extra limbing is necessary in the woods and a larger quantity of slash remains after logging. For these several reasons, foresters need better information on the epicormic branching habits of Sitka spruce and may have to give this species special attention when carrying out thinnings or other silvicultural treatments that open up spruce stands.

This study was undertaken to explore (1) effects of light thinning on development of epicormic branches, (2) effects of road right-of-way clearing on the branching of border trees, and (3) the origin and development of epicormic branches.

EFFECTS OF LIGHT THINNING

In 1952, epicormic branches were observed immediately after thinning on 57 selected sample trees in a 100-year-old Sitka spruce-western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) stand on the Cascade Head Experimental Forest near Otis, Oreg. Before thinning, basal area was 450 square feet in 168 stems per acre. Thinning reduced basal area 20 percent to 360 square feet in 130 stems. Sitka spruce made up about one-third of the basal area before and after thinning. Spruce trees were among the largest in the stand although some were smaller than the average stand diameter of 24 inches. Sample trees ranged in d.b.h. from 13 to 44 inches.

Thinning caused no important opening up of crown canopy. Few, if any, truly vigorous trees were cut in the relatively light thinning. Most trees selected for cutting were in the intermediate or suppressed crown classes. This little reduction in crown closure was rapidly replaced by the fast-growing residual trees. In 1962, crown canopy appeared uniformly dense, so dense that photography within the stand was difficult, even with high-speed film. Basal area increased to more than 380 square feet by 1960--a 20-square-foot increase in 8 years following thinning.

[1/] Names and dates in parentheses refer to Literature Cited, p. 9.

Vigor and abundance of epicormic branching on Sitka spruce were classified and recorded in 1952, 1959, and 1962 as defined below:

Vigor of epicormic branching:

Developing.--Many new branches emerging from the tree bole--short (1 to 6 inches) and vigorous in appearance, sometimes in addition to existing epicormic branches and also developing on them.

Stable.--Dominant branches of clusters at least 6 inches long and displaying a fair amount of vigor; bole supporting a scattering of dead branches or dead twig tips as well as a few small, single, new shoots.

Declining.--Live branches rarely exceeding 2 feet in length, and branch clusters dying with just one or two small shoots still living; dead branches, as well as a few small live branches, usually on the bole.

Abundance of epicormic branching:

Light.--Sporadic tiny clusters and individual branches not over 1 foot in length.

Medium.--Clusters and individual branches spaced irregularly on the bole, with a few large clusters having branches up to 2 feet in length.

Heavy.--Full clusters either part way or all around the bole, no more than 6 feet apart on the main portion of the bole above 20 feet.

A designation of "clear" was used for sample trees having no visible epicormic sprouts.

Of 57 trees observed in the unthinned stand, only 9 trees or 16 percent were free or "clear" of epicormic branching in 1952. Six of these trees were still clear of sprouts 10 years later. Epicormic branches on two of the three other trees, originally clear, were rated "stable-light." The third tree had died--cause of mortality not discernible.

On 48 trees with epicormic branches in 1952, the branching tended to become "stable" during the 10-year period after thinning (fig. 1). Chi-square tests of independence were made to determine the changes in sprouting since 1952. While inconclusive because of extreme variability, the analyses showed that some increase in vigor and abundance took place. Many trees classed as having "declining" epicormic sprouts in 1952 tended to be invigorated after light thinning and by 1962 assumed a "stable" status.

A shift in abundance of epicormic branching from "light" and "medium" to "heavy" took place during the 10 years following thinning (fig. 2). Six percent

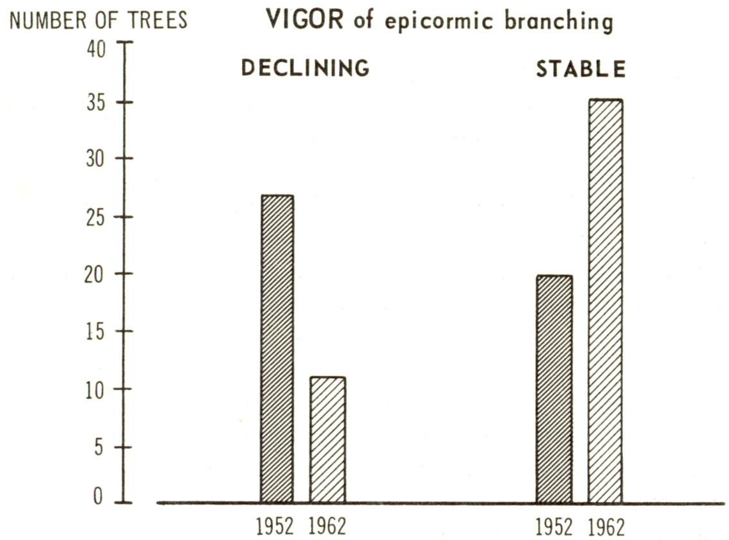


Figure 1.--Ten-year change in vigor of epicormic branching on Sitka spruce.

Note: Two trees died between 1952 and 1962.

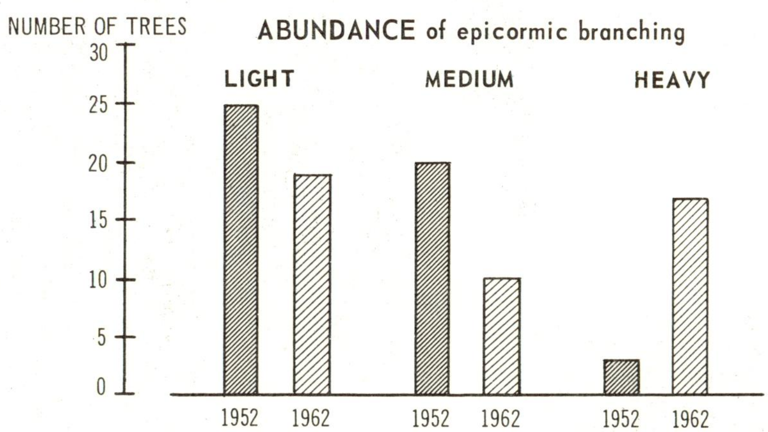


Figure 2.--Ten-year change in abundance of epicormic branching on Sitka spruce.

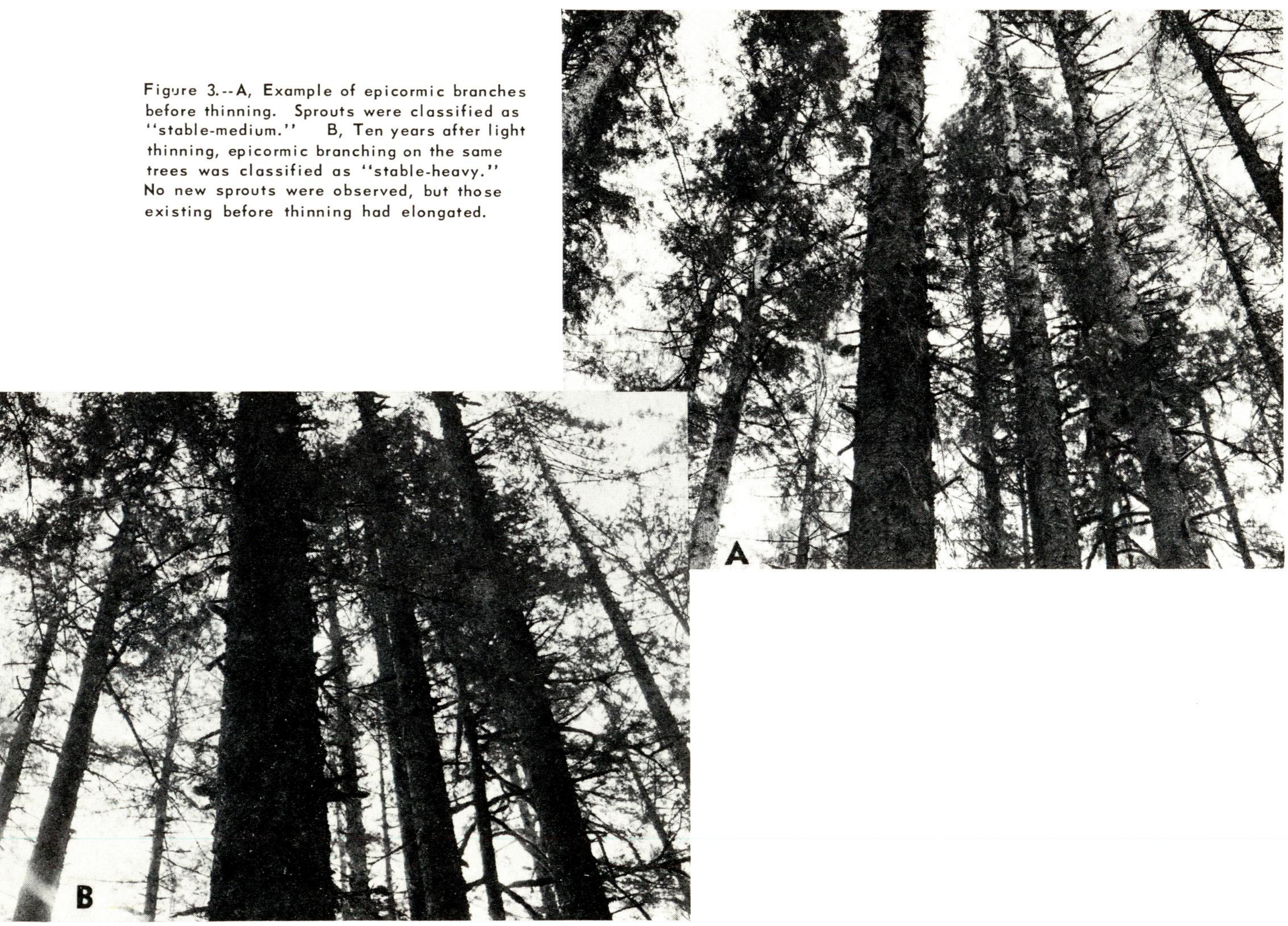
Note: Two trees died between 1952 and 1962.

of the 48 trees in 1952 were classified as having "heavy" epicormic branching. More than 35 percent had "heavy" branching in 1962.

Although many trees in the "declining" vigor category in 1952 assumed a "stable" sprout-vigor status in 1962, no trees had "developing" sprouts in 1962. No observational data are available for the years soon after thinning; therefore, no description of developing sprouts can be given. However, one study tree, intermediate in the crown canopy in 1959, was observed to have "developing-medium" (in 1952, rated "stable-light") epicormic sprouts. Three years later, the tree was dead. Sprouting has been observed on other obviously dying spruce trees unable to compete for crown space because of crowded stand conditions. Perhaps physiological imbalance, brought about by imminent death of these individuals, set up processes conducive to sprouting (Wahlenberg 1950, Kramer and Kozlowski 1960).

Actually, only limited sprout growth took place during the 10-year observational period--most of this in the form of invigoration and continued slow elongation of epicormic branches present in 1952. Some new sprouts developed on trees still living in 1962. Repeat photographs of some of the study trees support these observations (figs. 3a and 3b).

Figure 3.--A, Example of epicormic branches before thinning. Sprouts were classified as "stable-medium." B, Ten years after light thinning, epicormic branching on the same trees was classified as "stable-heavy." No new sprouts were observed, but those existing before thinning had elongated.



EFFECTS OF ROAD RIGHT-OF-WAY CUTTING

Internodal growth of epicormic branches of Sitka spruce was investigated in 1963 on trees along a logging road right-of-way established 7 years earlier. Trees bordering the right-of-way were profusely covered with epicormic sprouts, many of which predated the roadway clearing. Fifteen of these 110-year-old spruce trees were selected for study. Internodal growth was measured on epicormic branches along the side of the bole facing the clearing.

Epicormic branches showed a trend toward accelerated growth which was significant at about the 8-percent level of probability (fig. 4). While not conclusive, this result supports general observations that elongation of epicormic branches tends to accelerate when trees are exposed to increased light. However, growth acceleration was more gradual than spectacular. Supposition that growth of existing branches would increase rapidly when trees were released suddenly and completely, as along a new right-of-way, was not supported.

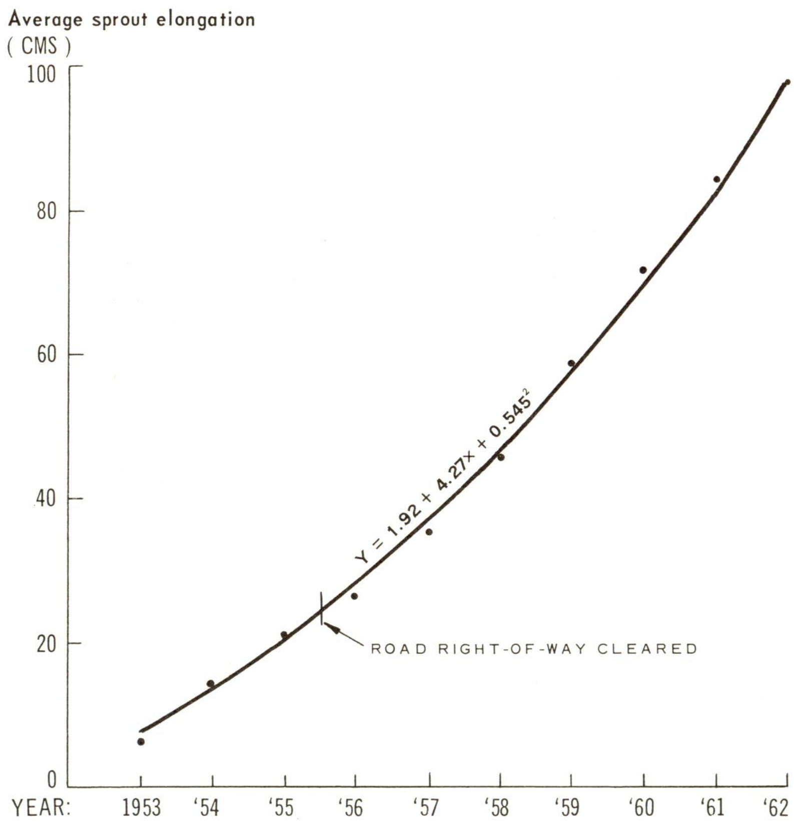


Figure 4.--Average total elongation of Sitka spruce sprouts along road right-of-way.

Concomitant observations of unreleased trees in stands behind the right-of-way border trees showed epicormic sprouts were shorter than those of their released neighbors. Border trees had fewer small, dead, lateral branches, and their needles were more abundant, longer, and larger in diameter. All border trees had more and longer sprouts on the side toward the road clearing.

ORIGIN AND DEVELOPMENT OF EPICORMIC SPROUTS

Epicormic sprouts can develop from either dormant or adventitious buds (Stone and Stone 1943b, Wahlenberg 1950). However, most sprouts originate from dormant buds at the end of bud strands (Stone and Stone 1943a, Stone 1953). These strands originate in the pith and primary xylem of the parent stem or branch. As the stem or branch grows in diameter, the bud strand grows with it, and the dormant bud continues to lie just under or at the surface of the bark.

In a study of the origin of epicormic sprouts of Sitka spruce, several short bolts containing branches were cut from 110-year-old trees. More than a dozen radial sections were carefully cut to expose dormant bud strands. These strands were traceable from pith to bark. The bud strand is believed to originate in the leaf axil together with the primary bud that develops into the original live branch (Stone and Stone 1943a). Except near the stem pith of the tree, the strand was found in a line perpendicular to stem surface. Next to the pith, it sloped upward from pith toward stem surface (fig. 5). This bend is opposite to that observed in *Eucalyptus* spp. (Jacobs 1955).

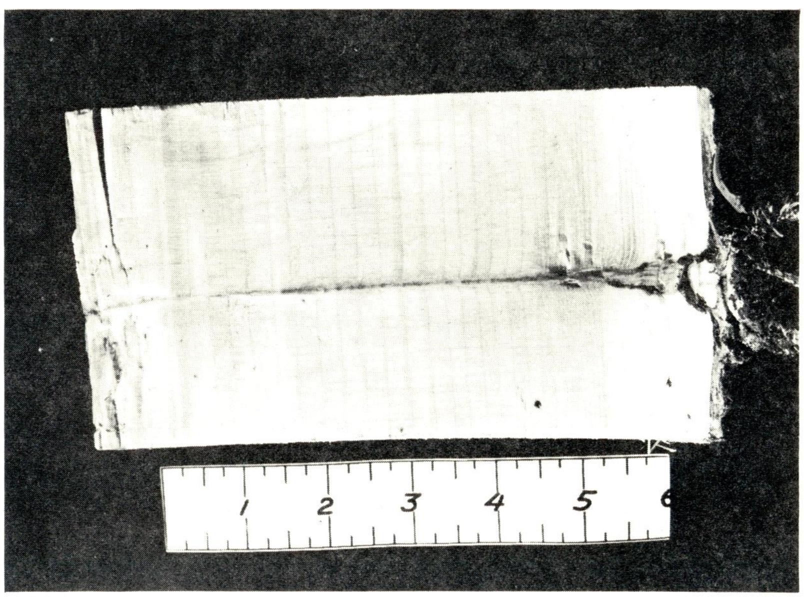


Figure 5.--Bud strand grew radially outward from pith of stem. Initially, growth was upward, but later it became horizontal.

Initially, as bud strands of Sitka spruce grow upwards, they are also displaced laterally, thus circumventing the wood of the swelling limb base. Dormant bud tissue at the junction of a newly formed leader and a lateral is believed to be located above rather than below the lateral, and consequently initially proceeds upward as new xylem is laid on. Beyond the swelling influence of the parent branch base, the strand proceeds at a right angle to the longitudinal axis of the stem, as described by Jacobs (1955) for eucalypt and by Berntsen (1961) for red alder (*Alnus rubra* Bong.).

In contrast to Sitka spruce, epicormic bud strands of eucalypt grow in a line below that of the parent branch. Because the strand proceeds in a line at a right angle to the bole surface as the wood is laid on, the dormant bud or epicormic sprout is normally below that of its parent branch (Jacobs 1955). The position of Sitka spruce epicormic sprouts in relation to their parent branches was not as consistent, probably because of the spruce habit of near-horizontal branching. A few of the spruce strands were found above a parent branch stub where the branch apparently grew downward. However, most strands were found below or alongside a parent branch.

Spruce with diameters from 10 to 40 inches were examined to determine if divergence increased between dormant bud strand and parent branch as the tree grew larger. Analysis of measurement data showed that the larger the stem, the farther were the dormant buds or epicormic sprouts from the parent branch (fig. 6).

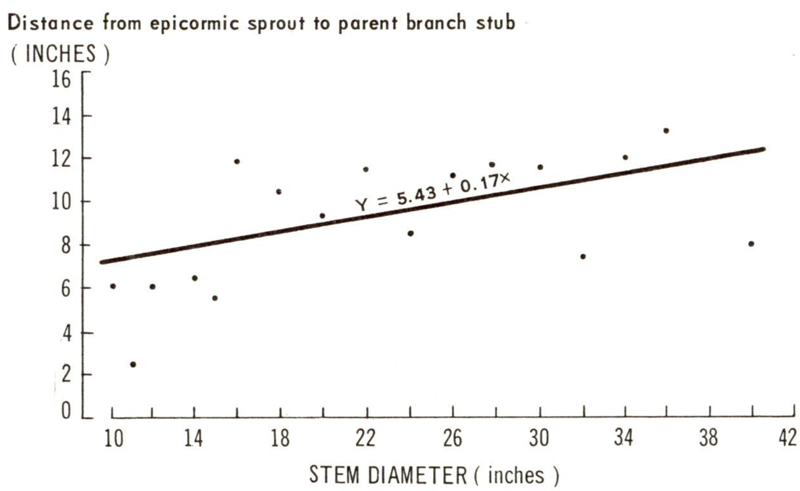


Figure 6.--Relationship of Sitka spruce stem diameter to distance between epicormic sprout and parent branch.

DISCUSSION AND SUMMARY

Experience gained in these exploratory studies and concomitant field observations suggests that perhaps the most limited of cuttings would tend to at least maintain established sprouts and might even stimulate additional sprouting. Spruce in unthinned 110-year-old stands usually supported at least a few epicormic sprouts. Perhaps the presence of a few sprouts is normal, at least for stands of this age class and density.

Thinning 20 percent of basal area in a 110-year-old stand containing Sitka spruce did not cause significant increases in abundance of epicormic branching. However, epicormic sprouts growing at time of thinning continued to grow with some increase in vigor. Growing conditions apparently were not so marginal as to cause them to die. Nor were postthinning conditions so favorable as to suddenly accelerate internodal elongation of existing sprouts or production of new sprouts.

Most study trees that were clear of sprouts before thinning did not produce epicormic branches after thinning. It is reasonable to suspect that genetic differences exist in reference to degree of sprouting ability. That these differences are associated with varying initial production of dormant bud tissue or with varying response to level of light intensity can only be speculated.

Exposure of 110-year-old Sitka spruce stems to increased solar radiation by cutting a logging road right-of-way resulted in increased growth of existing epicormic branches and production of new ones. Accelerated sprout development following marked release has also been noticed in younger, denser stands, which displayed only occasional sprouts prior to release.

Apparently moderate or heavy thinnings will stimulate epicormic branching of Sitka spruce. Future production of high quality spruce veneer and lumber is, therefore, unlikely unless supplementary measures can be taken to suppress sprouting. In contrast, sprouting should have little influence upon quality of pulpwood and structural lumber and may not be a serious factor where these products are the primary goal of management.

In summary, the most significant observations in this study were:

1. Most Sitka spruce trees in a 100-year-old stand had some epicormic branching prior to any release.

2. Light thinning resulted in some invigoration and continued slow elongation of existing sprouts.

3. New sprout production during the succeeding 10 years was slight.

4. Road right-of-way clearing (heavy release) tended to stimulate new sprouting and vigor and growth of existing sprouts, although not spectacularly.

5. Sprouts were formed from dormant buds, with bud strands clearly traceable to the pith.

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