HEALING TIME FOR PRUNED DOUGLAS-FIR

September 1951

INFORMATION REVIEWED
AND REAFFIRMED
1958

No. R1907

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison 5, Wisconsin
In Cooperation with the University of Wisconsin

HEALING TIME FOR PRUNED DOUGLAS-FIR

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Second-growth Douglas-fir trees 30-50 years of age can be pruned with the expectation that, within 10 years, most of the branch stubs will be healed and clear wood forming over them. The diameter of the pruned branch has less effect upon healing time than the stub length and rate of diameter growth of the pruned trees.

These results of research on the healing time required for Douglas-fir were obtained by the U. S. Forest Products Laboratory on pruned second-growth trees grown on the Olympic Peninsula and near Stevenson, Wash. Roughly, the average healing time of pruned branches compares with periods of a century and longer[2] required in the course of natural pruning before trees can grow wood over the broken stubs of dead branches that drop off very slowly. No evidence was found in the trees studied that pruning exposes the trunk wood to infection by decay fungi.

The trees had been pruned 8 to 13 years earlier by saw, Hebo club, or ax, and were selected so as to get trees representative of different rates of growth. Collecting of samples was done in cooperation with the Pacific Northwest Forest Experiment Station. Examinations for decay were made by George Englerth, Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering.

Significance of the studies lies in the fact they show that artificially pruned trees begin to produce clear lumber rather than knotty common grades in one-tenth of the time required for trees in which the pruning is left up to natural processes. The work also gives clear indications as to which trees to select for pruning, with regard to rates of growth. Fast-growing young trees, it was found, heal over their branch stubs more quickly than do relatively slow-growing trees, as determined by the number of annual growth rings per inch of diameter. Likewise, the shorter the stub, the quicker it is healed over.

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Paul, Benson H. Knots in Second-growth Douglas-fir. Forest Products Laboratory Report No. R1690, November 1947.

Sources of Material Examined

Kugel Creek

In the fall of 1936 a stand-improvement project of thinning and pruning 38-year old Douglas-fir, growing on land of site quality III was begun in the Kugel Creek area on the Olympic National Forest near the Snider Ranger Station. This stand was of natural second-growth believed to have developed after a fire approximately 50 years ago. Permanent sample plots were established by the Pacific Northwest Station in the thinned stands which, though predominantly even-aged, contained trees from 30 to 50 years old. Competition had developed by the time of thinning and had resulted in some decrease in diameter growth. The live crown extended only about one-third of the distance down the stems. Before pruning, the dead limbs extended virtually to the ground. The pruning operation removed only dead branches and did not extend into the live crown. Pruning to height of reach was done with an ax, and above this, to 20 feet from the ground, with a saw.

From each of 12 of these pruned trees, one bolt to include one whorl of branches was taken at an average of 5 feet above ground to represent ax pruning. From each of 9 of the same trees, a bolt was taken at an average height of 12 feet to represent saw pruning.

Wind River

In the winter of 1940-41 a time study of 18-foot pruning in small pole Douglas-fir on the Wind River District of the Gifford Pinchot National Forest was undertaken by the Pacific Northwest Station. The pruning work was done by CCC labor.

This latter stand was pure Douglas-fir about 28 years old which had been established by natural reseeding soon after a 1910 burn. Site-quality measurements in the vicinity indicated a poor site III.

Trees designated as crop trees for pruning averaged about 15 feet to the live crown when pruned. The live crowns of some of the less crowded dominants began about 10 feet above ground. No natural limb shedding had occurred. Limb disintegration was noted to be negligible except on the lower 4 feet of the bole, where twig-shedding was nearly complete while the branchlets were in process of breaking up. Pruning of the lower limbs was done with a Hebo club, while for higher limbs pole saws were used. The Hebo pruning club is essentially a heavy wood handle shod on the end with a piece of 1/8-inch thick steel. The limbs are removed by one or more blows at or near their base.[3]

From each of 10 of the trees in the Wind River area, a bolt to include one whorl of branches at an average of 4 feet above ground was taken to represent pruning with the Hebo club. From each of the same trees a bolt was taken at an average of 12 feet above ground to represent saw pruning.

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[3]Kachin, Theodore. Hebo Pruning Club. Journal of Forestry, Vol. 38, No. 7, July 1940, Pg. 596-597.

The bolts were band sawed radially along the grain of the trunk at each knot and the sawn surfaces jointed to give a smooth working surface. In this manner a vertical, radial surface was laid open as shown in figure 2. Bark indications of healed-over knots were plain and easily seen. Radial growth was measured along four radii 90° apart on the end surfaces of the bolts. Each knot lying within the 90° segment represented by a given radius was assigned the growth rate as measured along that radius. Subsequent comparisons of growth rate with time required for the knot to be overgrown by clear wood were made with these paired values regardless of the particular tree in which the knot had originated. Such pairing avoids the combination of knots and growth rates from different radii of the same tree when the cross section shows eccentric growth.

Knot diameters were measured on a line parallel to the pith of the trunk. Stub length represents length of the branch stub as measured from the outside of the ring formed just before pruning to the outer tip of the stub. These measurements were made to 0.1 inch.

A knot was considered to be completely healed only when clear wood was being produced beyond the stub end. Such wood was usually of irregular grain; straight grain had developed over only two of the healed-over knots examined. Curvature of the fibers, of course, was localized to the vicinity of the knot.

Results

In all, 263 knots from 41 bolts were examined. They were segregated according to locality of growth, pruning method, and whether the branch was alive or dead when pruned. The number of knots that had healed over completely to the point where clear wood was being produced, and the number of years required for this, are shown in table 1.

To illustrate more clearly the healing process, the number of overgrown knots is shown in figure 1 as a cumulative percentage of pruned branches. The figure brings out the fact that at Wind River the knots were being overgrown by clear wood earlier than at Kugel Creek because the stubs on the Kugel Creek trees were longer than those on the Wind River trees. This pruning was done at an early time when not enough emphasis was given to close and careful pruning. At Wind River, 9 years after pruning, 81.4 percent of the branches examined had been covered by clear wood. At Kugel Creek, after 13 years, only 66.4 percent had reached the same point in healing.

That branch condition at the time of pruning can be no more than a partial explanation for this difference is brought out in figure 1, which shows that knots from both live- and dead-pruned branches at Wind River were ahead of similar knots at Kugel Creek in the healing process. Further, the club pruning work at Wind River shows little difference between those branches pruned live and those pruned dead.

Diameter growth rate is known to affect the healing rate. In this study the growth rate during the period subsequent to pruning was chosen because it is logical to assume that the vigor of the tree during, rather than prior to,

the healing period is the important factor. These trees probably were not pruned severely enough to cause a setback of any kind from loss of green branches. Furthermore, the Kugel Creek stand was thinned when pruned, a factor reflected only in the period of growth subsequent to pruning.

The average rates of growth, expressed as rings per inch, for the knots healed over in each year following pruning are given in table 2. These values show that there is a relation between healing time and growth rate. The greater the number of rings to the inch, the slower was the healing. The relationship is more apparent in the Kugel Creek material, especially when the unhealed knots are considered.

That there are still other underlying causes for differences in healing rates between the two areas is brought out by the saw-pruned material from Kugel Creek. It was 6 years before any of these knots were overgrown by clear wood although the growth rate for these first-healed knots was close to that for the first-healed knots in all the other columns of table 2.

This leads to a consideration of stub length left after pruning. Table 3 shows the effect of this variable. Under similar conditions of pruning, the knots with longer stubs took longer to heal. Both ax- and saw-pruned material from Kugel Creek had longer stubs and took longer to heal before clear wood was produced than did the material from Wind River (fig. 1).

While working conditions and skill of the men in pruning may have some influence on the length of stub left, it appears that the bark thickness accounted for the longer stubs at Kugel Creek. The operator of a pruning tool, especially a saw, is restricted by the bark in his attempt to get close to wood of the bole of the tree and leave a short stub. At comparable heights at the time of felling it was found that bark thickness, while variable, average from 0.1 to 0.2 inch thicker at Kugel Creek than at Wind River.

Stub length is undoubtedly affected by the type of tool used in pruning. No comparison of tools is made here, however, because different tools were used at the different heights in each stand and the stands were growing under quite different conditions and were of different age classes.

The effect of knot diameter is given in table 4, which shows no apparent relationship between time to heal and knot size. On the average, the healed knots were as large, or larger, than the unhealed knots in most cases. Furthermore, the knots which healed over in 3 or 4 years were usually just as large as those which healed later or not at all. Only from saw-pruned dead branches at Wind River are the unhealed knots of appreciably greater diameter than the healed.

The greater influence of other factors than knot diameter is further shown in figures 2, 3, and 4. Both knots in figure 2, from different trees, were the result of dead branches pruned 13 years previous to examination. Because of the more rapid diameter-growth rate of tree A, clear wood was produced after 10 years as compared to tree B, which had no clear wood after 13 years. The knot in tree B was 0.2 inch in diameter and that in tree A was 1.2 inches. Also, it should be noted that both the bark thickness and length of the stub were greater in tree A than in tree B. The thick bark probably accounted for the longer stub in A, 0.9 inch, as compared to the 0.4-inch stub in B.

No decay was found to have entered the trunk wood from any of the pruned branches. A little rot was noted in the outer part of some of the remaining stubs, but its progress apparently was stopped when the stubs were healed over.

A minute opening, visible with a hand lens, had developed between wood of the branch and that of the trunk beyond the ring at which the branch died. In every case this opening had been filled with pitch, making a sheath around the branch. Healed-over stubs also had a layer of pitch across the cut or broken ends.

This study gives results of pruning trees 30 years or more in age. Consideration of the data indicates somewhat greater advantages might be gained by pruning when the trees were possibly no more than half as old as the trees studied. These advantages include:

(1) A smaller knotty core.

(2) Shorter branch stubs due to thinner bark.

(3) Elimination of the encased portions of branches by pruning before they die.

(4) Quicker healing over of wounds because of the reasons given in 2 and 3.

(5) Less work in pruning since branches will be smaller at time of cutting.

Further experiments are needed on younger trees to substantiate these points.

Table 1.--Distribution of healed and unhealed knots in pruned Douglas-fir grouped according to area sampled, method of pruning and condition of branches at time of pruning

Area, pruning method, and condition of branches	Years required for healing													Knots not healed	Total knots
	1	2	3	4	5	6	7	8	9	10	11	12	13		
	Number of knots														
Wind River															
Saw															
Dead	0	0	1	0	1	3	1	4	4	...	...	...	...	4	18
Live	0	0	2	2	4	15	9	6	0	...	...	...	...	10	48
Both	0	0	3	2	5	18	10	10	4	...	...	...	...	14	66
Hebo Club															
Dead	0	0	1	4	11	7	7	6	5	...	...	...	...	8	49
Live	0	0	1	2	1	2	1	3	2	...	...	...	...	2	14
Both	0	0	2	6	12	9	8	9	7	...	...	...	...	10	63
Kugel Creek															
Saw															
Dead	0	0	0	0	0	1	5	3	13	4	9	2	2	13	52
Ax															
Dead	0	0	1	1	2	5	7	6	6	9	7	3	3	32	82

Table 2.--Diameter growth rate after pruning of Douglas-fir, for healed and unhealed knots grouped according to area sampled, method of pruning, and condition of branches at time of pruning

Healing time	Growth rate							
	At Wind River						At Kugel Creek	
	Saw-pruned			Hebo-club pruned			Saw-pruned	Ax-pruned
	Dead	Live	Both	Dead	Live	Both	Dead	Dead
Years	Rings per inch	Rings per inch	Rings per inch	Rings per inch	Rings per inch	Rings per inch	Rings per inch	Rings per inch
1								
2								
3	7	8	8	8	7	8		7
4		8	8	10	10	10		8
5	10	11	10	10	9	10		10
6	10	11	10	11	12	11	6	7
7	16	10	10	10	20	11	10	11
8	14	12	13	14	8	12	9	10
9	15		15	11	12	11	14	12
10							13	11
11							18	12
12							10	14
13							16	16
Unhealed	13	13	13	14	9	13	31	22

Table 3.--Length of stub left in pruning Douglas-fir branches grouped by area sampled, method of pruning, condition of branch when pruned, and time required to heal

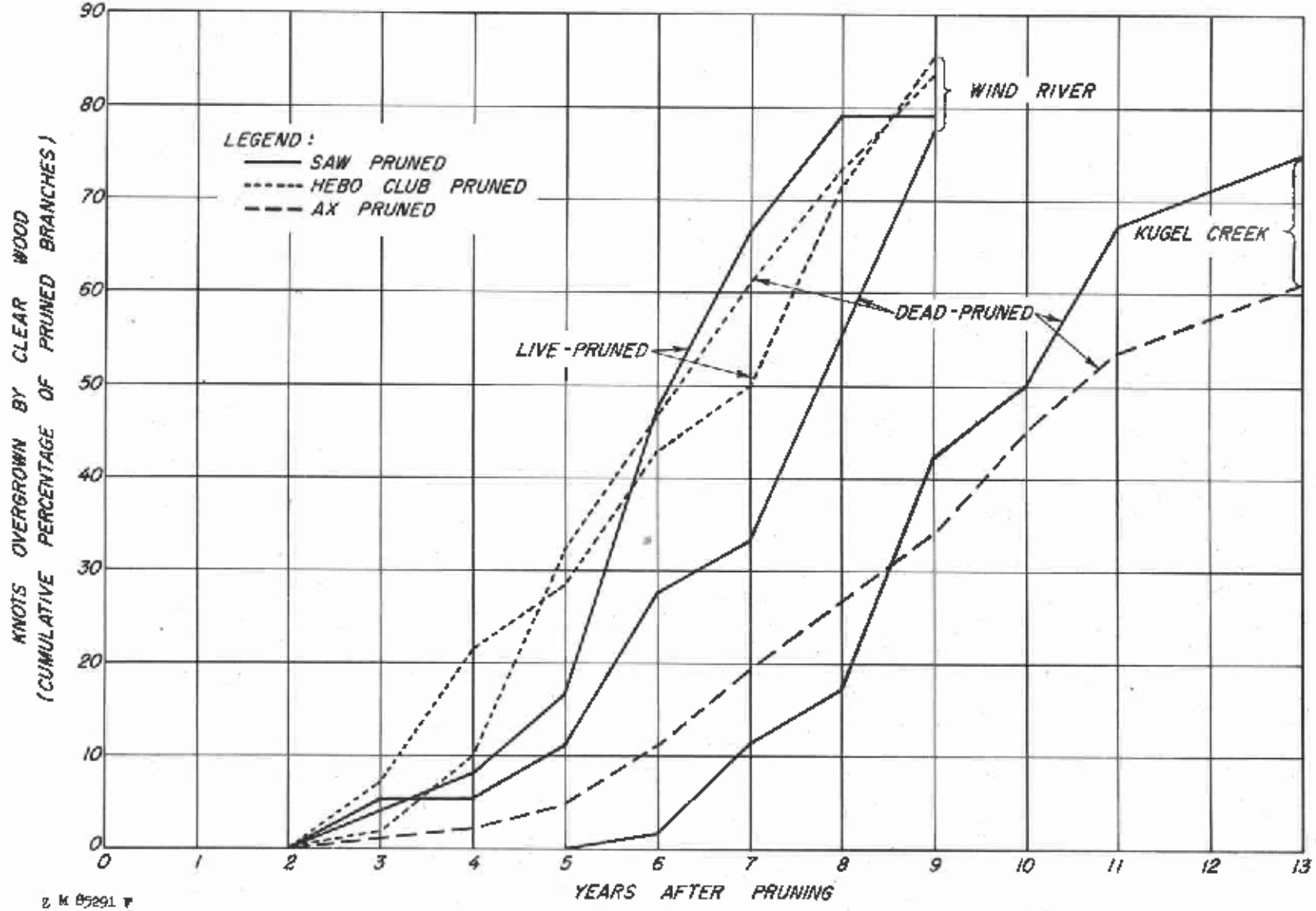
Healing time	Stub length							
	At Wind River						At Kugel Creek	
	Saw-pruned			Hebo-club pruned			Saw-pruned	Ax-pruned
	Dead	Live	Both	Dead	Live	Both	Dead	Dead
Years	Inch	Inch	Inch	Inch	Inch	Inch	Inch	Inch
1								
2								
3	0.2	0.1	0.1	0.4	0.0	0.2		0.6
4		.2	.2	.2	.2	.2		.6
5	.6	.2	.3	.3	.2	.3		.5
6	.5	.4	.4	.4	.2	.3	0.7	.4
7	.4	.4	.4	.6	.3	.5	.6	.7
8	.7	.5	.5	.4	.3	.3	.6	.9
9	.3		.3	.5	.3	.4	.6	.8
10							.6	.9
11							.7	.9
12							.8	.8
13							.7	.9
Unhealed	.6	.6	.6	.8	.3	.7	.6	.9

Table 4.--Knot diameter parallel to pith of trunk in pruned Douglas-fir; knots grouped according to area sampled, method of pruning, condition of branch when pruned, and time required to heal

Healing time	Knot diameter							
	At Wind River						At Kugel Creek	
	Saw-pruned			Hebo-club pruned			Saw-pruned	Ax-pruned
	Dead	Live	Both	Dead	Live	Both	Dead	Dead
Years	Inch	Inch	Inch	Inch	Inch	Inch	Inches	Inches
1								
2								
3	0.4	0.6	0.5	0.4	0.8	0.6		1.1
4		.9	.9	.5	.8	.4		.3
5	.3	.8	.7	.5	.8	.5		.7
6	.4	.6	.6	.5	.7	.6	0.7	1.0
7	.6	.8	.8	.5	.6	.5	.8	.5
8	.5	.8	.7	.6	.9	.7	1.1	.6
9	.5		.5	.5	.8	.6	.7	.6
10							.7	.7
11							.7	.7
12							.7	.5
13							.7	.6
Unhealed	.8	.7	.7	.5	.9	.6	.5	.5

Figure 1.--These cumulative curves show the percentage of pruned branches that had been overgrown by clear wood at the end of each year after the pruning date. This point in healing was being reached sooner in the Wind River than on the Kugel Creek trees, apparently because longer stubs were left on the Kugel Creek trees rather than because of the pruning method or the condition of the branches when pruned.

ZM 85291 F


KNOTS OVERGROWN BY CLEAR WOOD
(CUMULATIVE PERCENTAGE OF PRUNED BRANCHES)
LEGEND :
SAW PRUNED
HEBO CLUB PRUNED
AX PRUNED
WIND RIVER
KUGEL CREEK
DEAD-PRUNED
LIVE-PRUNED
YEARS AFTER PRUNING
0
10
20
30
40
50
60
70
80
90
0
1
2
3
4
5
6
7
8
9
10
11
12
13

Z M 85291 F

Figure 2.--Both of these knots were dead when pruned with a saw 13 years before the tree was felled. In A, comparatively rapid diameter growth covered the 0.9-inch long stub with clear wood in the eleventh year after pruning. In B, a knot of smaller diameter having a shorter stub (0.4 inch), but from a tree with slower growth rate, had not been overgrown nor would it have been overgrown for several additional years. The thicker bark on A may account for the longer stub.

ZM 85292 F

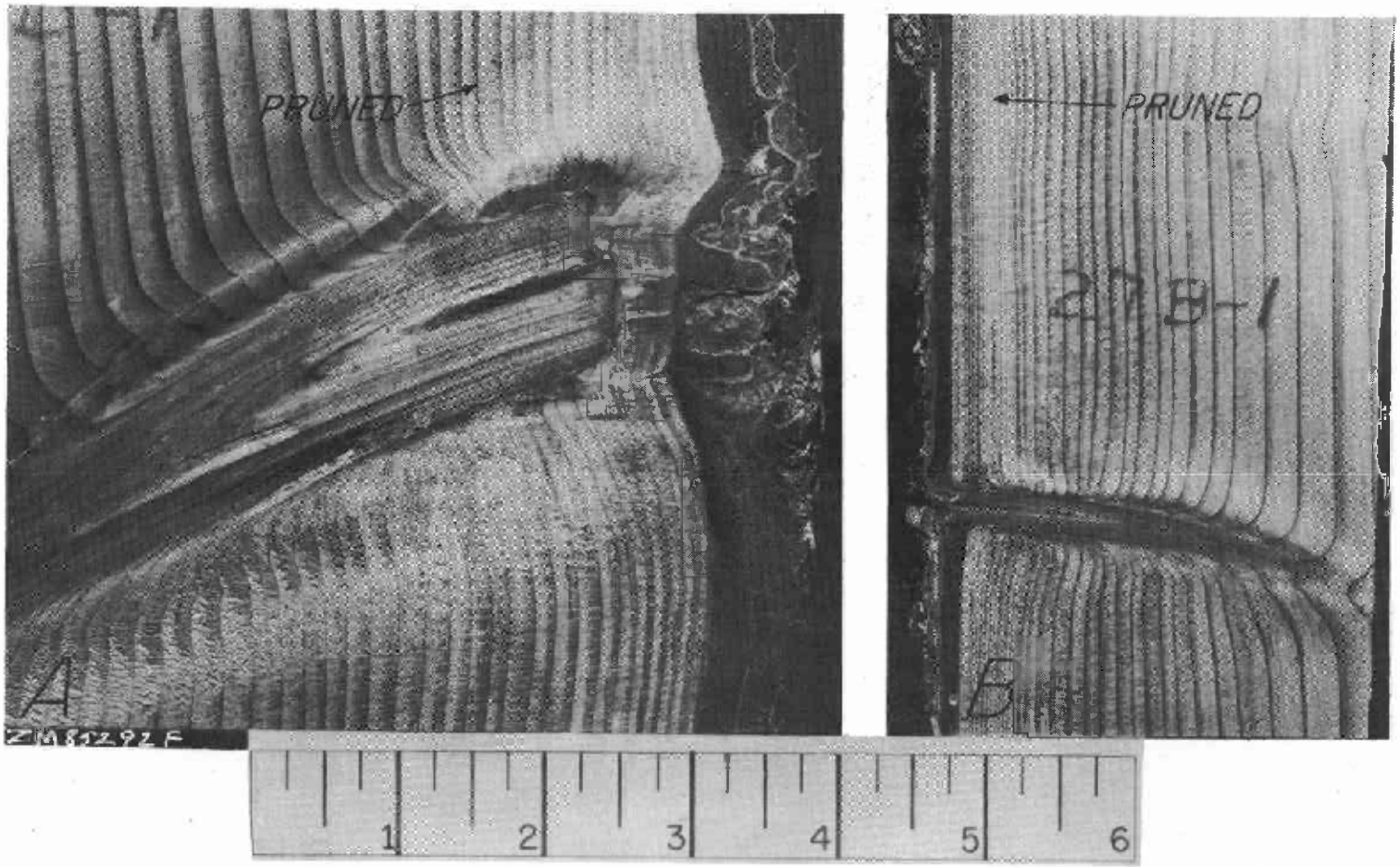

PRUNED
A
PRUNED
B
1
2
3
4
5
6

Figure 3.--Pruned branch showing covering of cut surface by growth of the last year. Shorter branch stubs or pruning while the branch was alive presumably would have saved several years in accomplishing this result.

ZM 85102 F

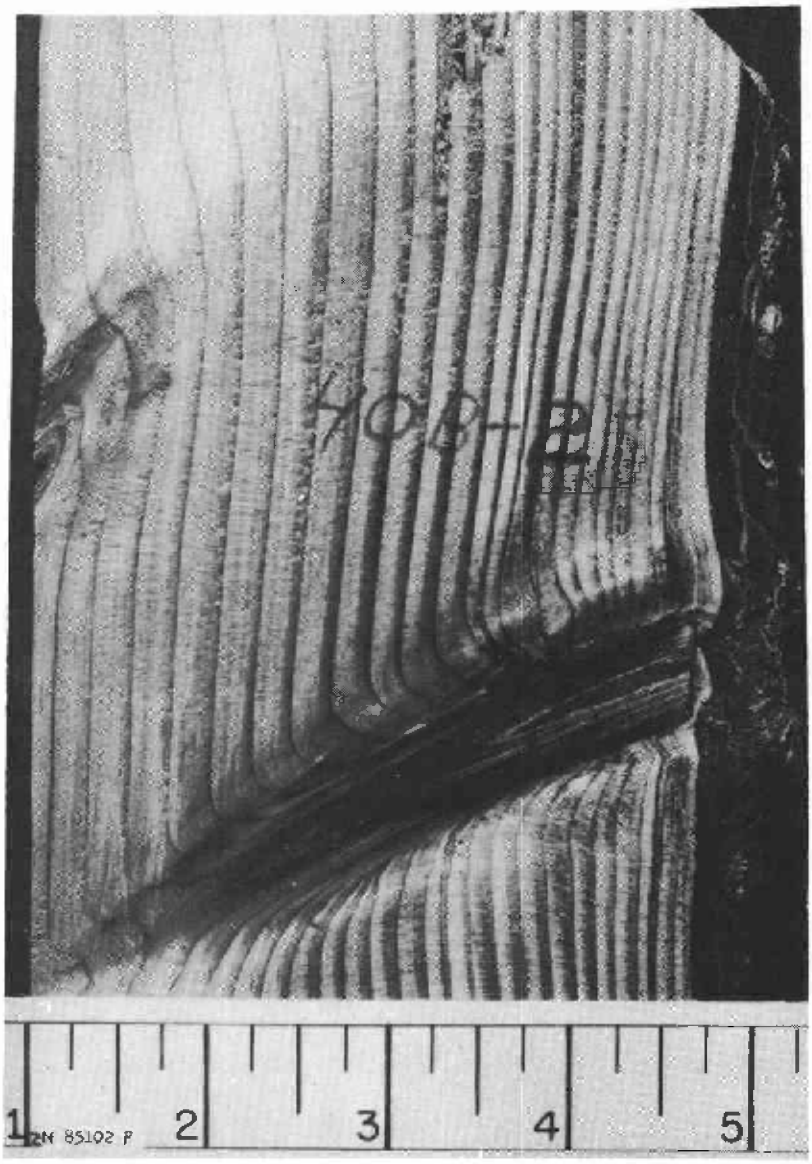
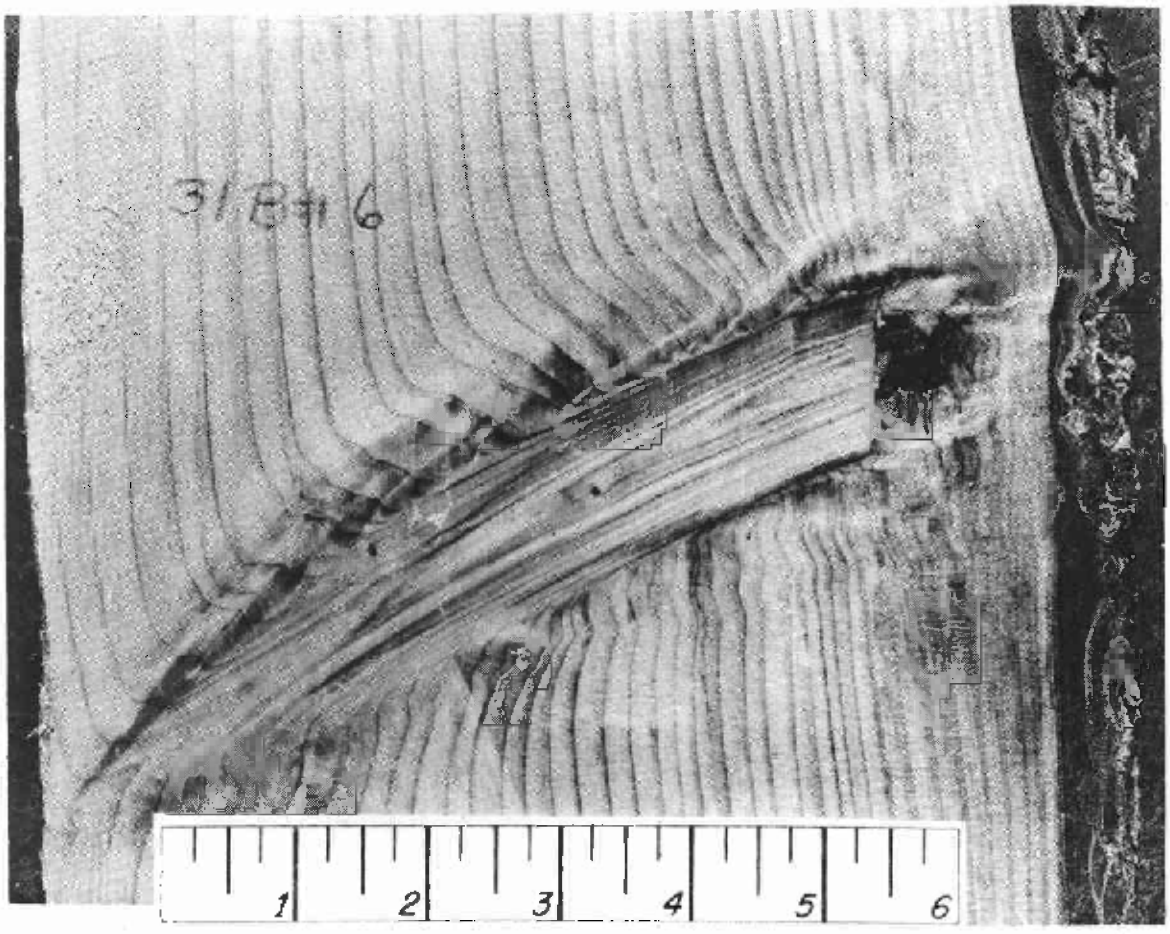

1
2
3
4
5

Figure 4.--Formation of clear wood over large branch stubs may be delayed by accumulations of pitch and bark.

ZM 84563 F



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