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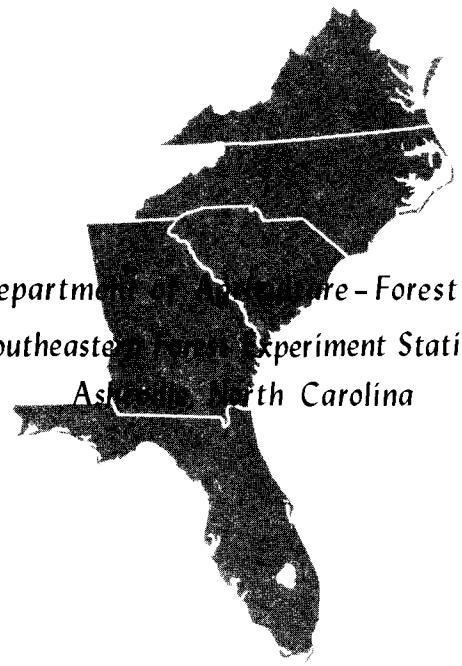

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Growth and Development of Thinned Versus Unthinned Yellow-Poplar Sprout Clumps

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Abstract.--Yellow-poplar stump sprouts are capable of very rapid growth and often dominate stands on good sites following harvest cutting. Thinning to one stem per stump at 6 years of age did not affect either height or diameter growth over the succeeding 18 years. The untreated clumps thinned themselves to an average of two stems per clump during the same time period. Thinning to one stem had no apparent effect on butt rot potential from the parent stump, but did reduce the potential for rot from dying ancillary stems.

Keywords: Height growth, diameter growth, butt rot, mortality, fungi, multiple stems, stumps.

When yellow-poplar (*Liriodendron tulipifera* L.) is harvested in second-growth stands, its stumps sprout prolifically. Wendel found that 97 percent of the yellow-poplar stumps produced sprouts on two harvested areas in West Virginia.[1] Trees ranging from 6 to 22 inches in diameter produced an average of 42 sprouts per stump 1 year after harvest. True reported an average of 21 sprouts on 1-year-old yellow-poplar stumps ranging from 6 to 26 inches in diameter.[2] As the size of the stump increased, the percentage of stumps sprouting and the number of sprouts per stump decreased. But even stumps as large as 26 inches produced eight or more sprouts. Similar observations have been made throughout the Southern Appalachians.

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[1] Wendel, G. W. 1975. Stump sprout growth and quality of several Appalachian hardwood species after clearcutting. USDA For. Serv. Res. Pap. NE-329, 9 p. Northeast. For. Exp. Stn., Upper Darby, Pa.

[2] True, R. P. 1953. Studies on sprout reproduction of yellow-poplar as related to decay. W. Va. Agric. Exp. Stn. Curr. Rep., 3 p.

Because yellow-poplar stump sprouts grow faster than yellow-poplar seedlings and sprouts of other species, they often comprise a significant portion of new stands that develop after harvest of mature second-growth stands. To effectively manage stump-sprout stands the forester needs to understand the development of sprout clumps, their potential for producing desirable crop trees, and the cultural practices that enhance development of sprouts into desirable crop trees.

The major objective of the study was to determine if thinning of sprout clumps affects the growth rate of remaining trees. The study also provided the opportunity to examine development of stump sprouts and their suitability as crop trees.

METHODS

The study was conducted on the Bent Creek Experimental Forest in western North Carolina at an elevation of about 2,400 feet. Two groups of 60 sprout clumps each were selected in an area that had been commercially harvested 6 years previously. One group of sprout clumps was on an east-facing slope with a site index for yellow-poplar of about 110 feet at 50 years. The other group of sprout clumps was located in a streambottom where, probably due to poor drainage, site index for yellow-poplar was only about 80 feet at 50 years.

Within each sprout clump, the single best tree was designated as a crop tree on the basis of size, form, and location on the stump. Only sprouts originating at or below ground line were chosen as crop trees. Measurements made for each clump included:

1. Diameter of the originating stump.

2. Total number of sprouts on each stump.

3. Number of sprouts likely to compete strongly with the selected tree; i.e., sprouts nearly equal in size to selected crop tree.

4. Height and diameter of the selected tree.

Within each block, half the clumps were designated at random to be treated. Treatment consisted of cutting all sprouts in a clump except the designated crop tree. The other half of the clumps were left unthinned.

Height and diameter measurements of the designated crop trees were made 6, 12, and 18 years after treatment. When the study stumps were created in 1952 by a commercial harvest, trees up to 12 inches d.b.h. were left standing. The residual trees overtopped and suppressed some of the treated sprout clumps by 1975. Consequently, only sprout clumps that were not suppressed were analyzed for thinning effects. A total of 71 sprout clumps, well distributed by treatment and block (table 1), was included.

Table 1.--Pretreatment conditions for 71 stumps used in treatment analysis

	Clumps	Initial sprouts		Stump diameter		Crop tree height		Crop tree diameter	
		Average	Range	Average	Range	Average	Range	Average	Range
	- - - - Number - - - -			- - Inches - -		- - Feet - -		- - Inches - -	
Poor site									
Thinned	18	7.4	1-16	18.9	12-26	23	16-31	2.2	1.5-3.2
Unthinned	20	7.0	2-14	20.7	4-28	25	15-35	2.6	1.4-4.8
Good site									
Thinned	18	5.3	2-9	15.3	6-25	28	19-37	3.0	1.9-4.4
Unthinned	15	5.7	2-11	13.8	8-20	29	21-40	3.2	2.3-4.4

RESULTS

STATUS OF SPROUT CLUMPS AT AGE 6

At age 6 there was an average of 6.4 sprouts per stump but only half of the sprouts (3.1) were considered strong enough to survive (table 1). There was a maximum of 20 sprouts on the 6-year-old stumps, and only 15 stumps (21 percent) had more than 10 sprouts. Assuming that the stumps produced more sprouts shortly after cutting--as indicated by Wendel's and True's findings (see footnotes 1 and 2)--there had already been considerable mortality during the first 6 years. In Wendel's study, the average of 42 sprouts per stump at age 1 had dwindled to five sprouts 10 years after harvest.

There was no relationship between stump size and number of sprouts at age 6 or between stump size and number of strong competitors. If smaller stumps tend to produce more sprouts as reported by True (see footnote 2), differential mortality had obliterated this tendency in 6 years.

Stems that attained nearly 40 feet in height and 5 inches in diameter by age 6 demonstrated the exceptional growth of yellow-poplar stump sprouts. There was no relationship between size of crop tree sprouts and size of stump.

EFFECT OF THINNING

Stump size was tested as a possible covariant in the analysis of treatment effects. However, both height and diameter growth were independent of parent stump size. Sprouts from stumps as small as 4 inches grew at the same rates as sprouts from stumps as large as 32 inches.

Thinning at age 6 to a single stem per stump did not affect height growth during the subsequent 18-year period. On the good site the treated stems grew 52 feet in height as opposed to 51 feet for untreated stems. Although on the poorer site the untreated stems actually outgrew the treated ones (33 feet vs. 27 feet), this difference was not statistically significant. Analysis of height growth by 6-year periods showed that there was neither a short-lived response to thinning nor a delayed one masked by lumping growth periods (table 2).

As was the case with height growth, thinning to a single stem per stump did not significantly affect diameter growth of crop trees (table 3). On the good site slightly, but not significantly, greater growth occurred on the treated stems than on untreated stems. On the poor site the untreated stems had greater diameter growth in the second- and third-growth periods than the treated stems. This difference is not believed to be correlated to treatment, but to a rising water table which affected treated stems more than untreated stems due to their positions in the block. In contrast, the height and diameter results on the good site are believed to be typical for good yellow-poplar sites.

Following thinning, most treated stumps produced from 1 to 25 new sprouts. The average for treated clumps was five new sprouts per stump. However, these new sprouts grew very little and died quickly. Only two or three of the new sprouts were still alive 18 years after treatment. Thus, resprouting posed no threat to the selected crop tree in thinned clumps.

Table 2.--Mean height growth of surviving crop stems

	1958-1963	1964-1969	1970-1975	1958-1975
	- - - - - - - - - - Feet - - - - - - - - - -			
Poor site				
Thinned	12	8	7	27
Unthinned	13	12	8	33
Good site				
Thinned	25	16	11	52
Unthinned	23	16	12	51

Table 3.--Mean diameter growth of selected crop trees

	1958-1963	1964-1969	1970-1975	1958-1975
	- - - - - - - - - Inches - - - - - - - - -			
Poor site				
Thinned	2.4	0.9	0.9	4.2
Unthinned	2.2	1.6	1.4	5.2
Good site				
Thinned	3.6	1.7	1.6	6.9
Unthinned	3.5	1.5	1.4	6.4

SURVIVAL OF CROP TREES

McCarthy remarked that yellow-poplar stump sprouts are poor risks for future crop trees because "... they are subject to serious if not disastrous damage from wind and sleet, since the young stumps from which they spring decay very rapidly and afford them little support."[3] Excessive losses did not occur in the present study. Survival after 24 years averaged 87 percent overall. The unthinned clumps were tallied as surviving if there was one live stem, whether or not it was the crop tree designated at age 6. Thus, survival was somewhat better for the unthinned clumps than for thinned clumps (93 percent vs. 80 percent). Wendel (see footnote 1) reported similiar results; 91 percent of the stumps with sprouts at age 1 still had one or more viable sprouts at age 10.

Mortality was unrelated to parent stump size. The average stump size for clumps that died differed little from the overall average for stump size. Complete mortality of clumps occurred over the full range of stump sizes from 4 to 32 inches.

DEVELOPMENT OF UNTHINNED CLUMPS

At age 6 there was an average of 6.4 stems per unthinned sprout clumps on both sites, with a range of 2 to 14 stems per stump. Eighteen years later, at age 24, only 2.1 stems per stump remained alive. No stump had more than four live stems remaining.

Based on the relative size and vigor of the surviving stems, it appears that a natural thinning will continue. It is estimated that about 65 percent of the unthinned clumps will eventually contain only one stem, 25 percent will have two stems, and the remaining 10 percent will produce three codominant trees per parent stump.

POTENTIAL FOR BUTT ROT OF CROP TREES

One question that always arises with respect to trees of stump-sprout origin is whether or not they will contact butt rot. Yellow-poplar sprouts may become infected by butt rot fungi through the parent stump and/or through death or removal of inferior noncrop stems by suppression or thinning.[4] From visual inspection of each of the 24-year-old crop trees, it appeared that about 50 percent had not contacted butt rot from the parent stump and were unlikely to do so, because the stumps had completely rotted away and no longer served as open infection courts. In many instances there was little or no evidence that the tree originated as a stump sprout (fig. 1). The other half of the crop trees

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[3] McCarthy, E. F. 1933. Yellow-poplar characteristics, growth and management. p. 18. U.S. Dep. Agric. Tech. Bull. 356.

[4] True, R. P., and E. H. Tryon. 1966. Butt decay in yellow-poplar sprouts in West Virginia. W. Va. Univ. Agric. Exp. Stn. Bull. 541-T, 66 p.

contained open infection courts from the decaying parent stump, ranging from small holes at the base to large segments of decaying stumps (fig. 2).

There appeared to be no difference in decay potential between crop trees in thinned and unthinned clumps. There was, however, a tendency for greater rot potential from the larger stumps and in the less vigorous stems. Sprouts

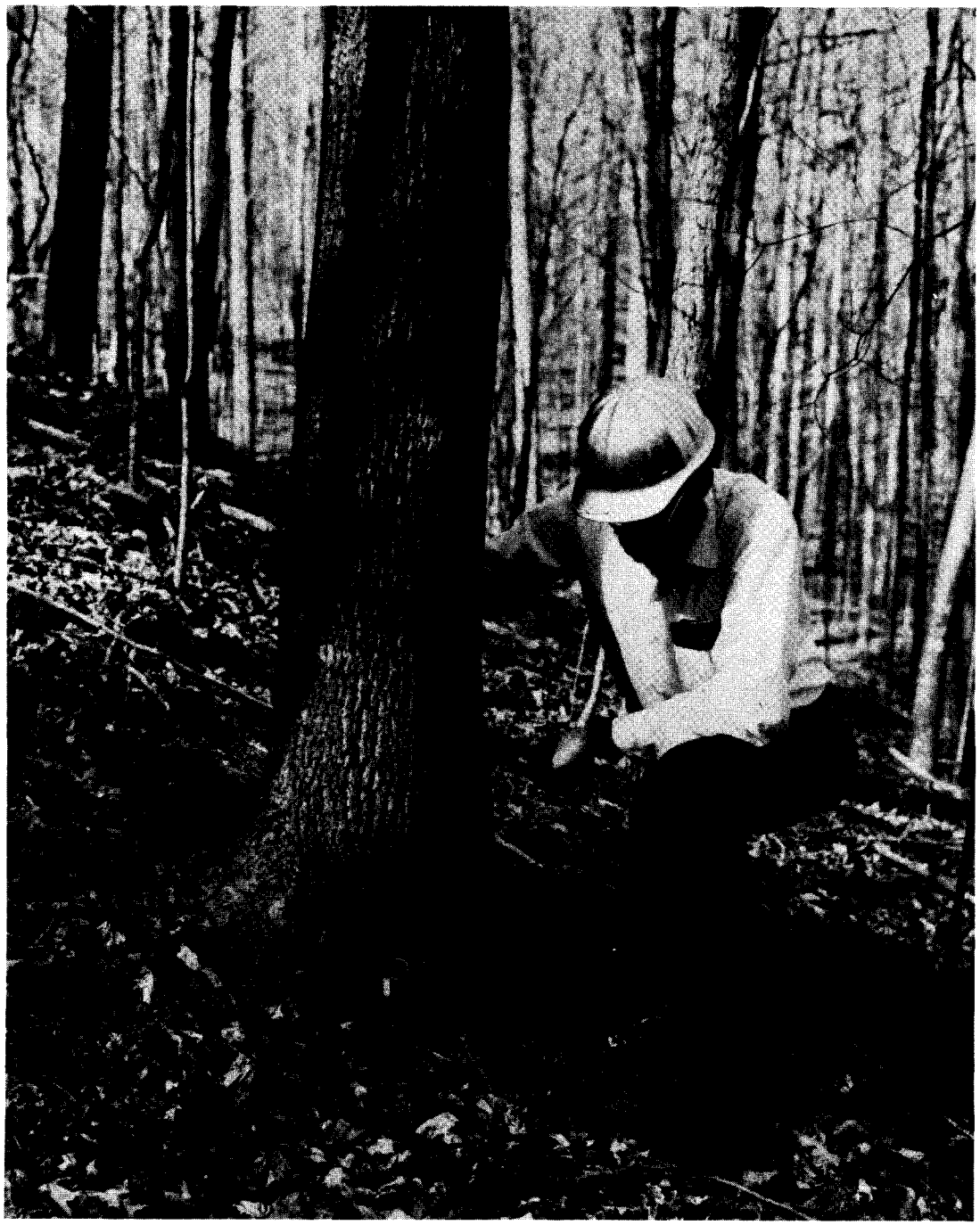

Figure 1.--All evidence of the 8-inch parent stump has been obliterated by this 24-year-old stump sprout. Tree is 11.8 inches d.b.h. and 78 feet tall.

from the larger stumps apparently are more susceptible to rot due to the slower decay of the parent stumps. A majority of crop trees with large, open infection courts (fig. 2), originated from stumps over 15 inches in diameter. Clumps on the poor site and those suppressed by residuals had more crop trees with open infection courts than did the vigorously growing trees on the good site.

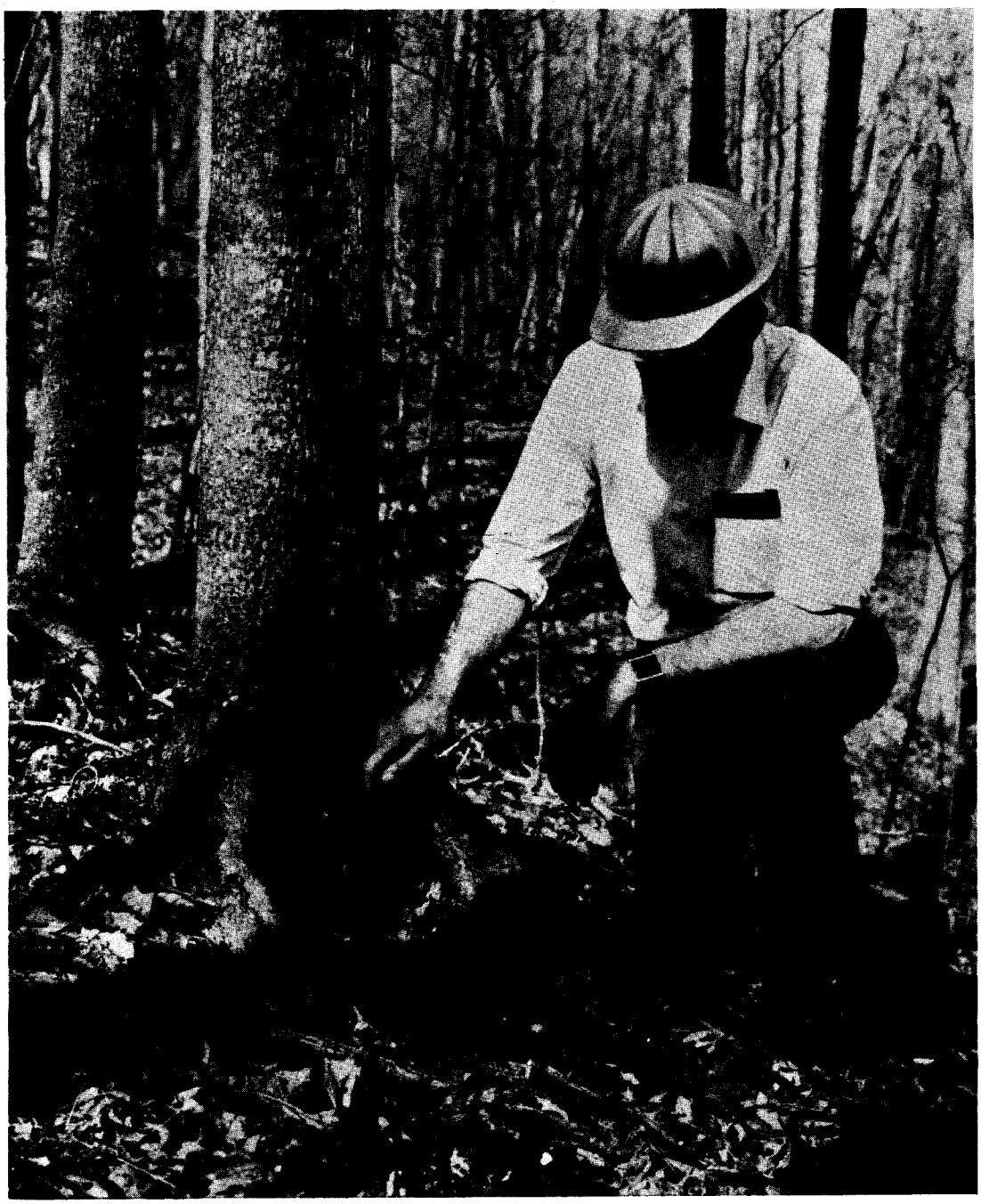

Figure 2.--A decaying, 18-inch stump still serves as open infection court for butt rot in a 24-year-old sprout. Tree is 9.0 inches d.b.h. and 79 feet tall.

In addition to the hazard of butt rot from decaying parent stumps, crop trees in the unthinned clumps are susceptible to decay from dying ancillary stems. Overall, about 55 percent of the crop trees in unthinned clumps had dead stubs or dying ancillary stems which could serve as infection courts before the trees reach large sawtimber size (fig. 3). It is not known to what extent decay will result or the extent of damage from decay, only that the potential

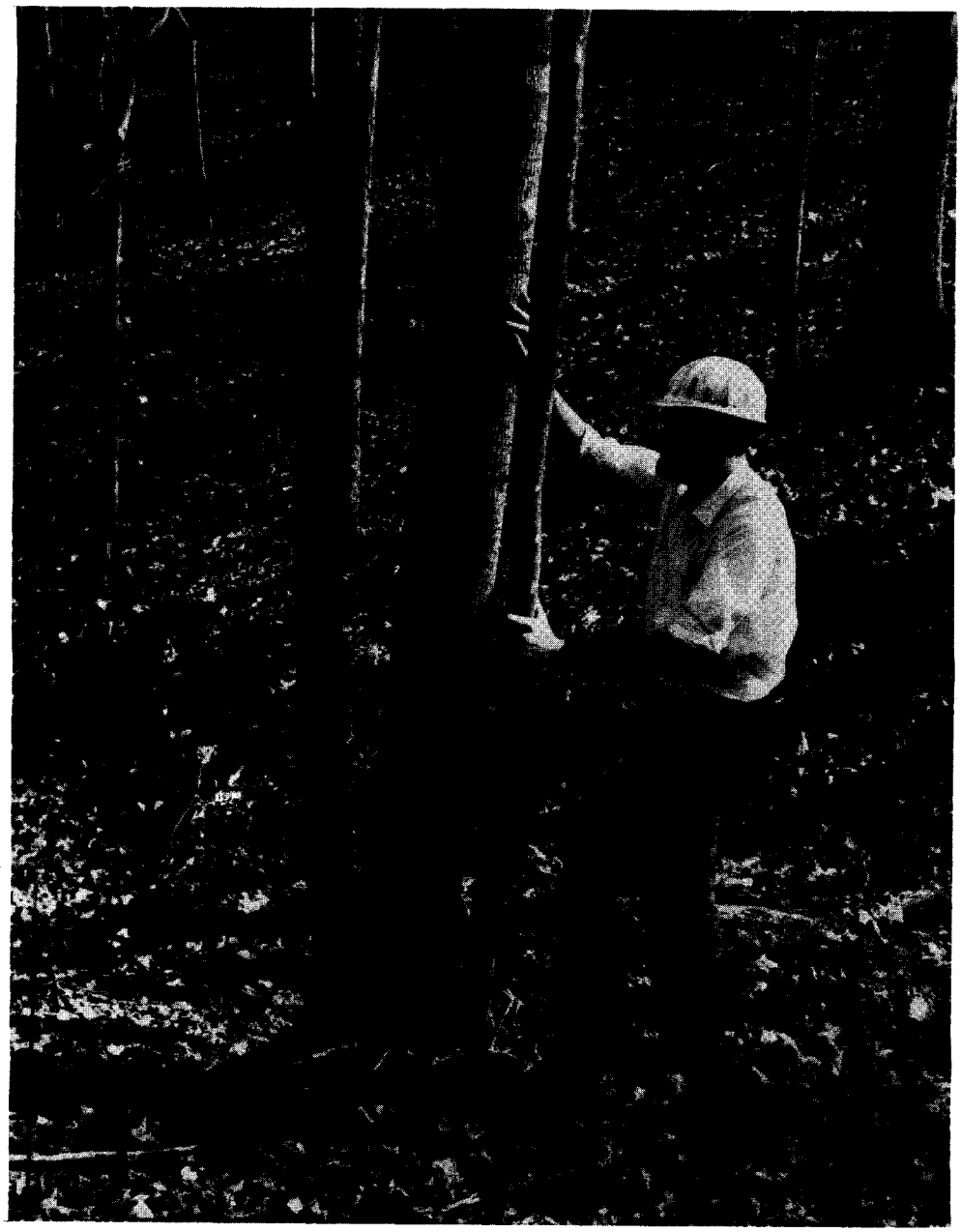

Figure 3.--A 24-year-old sprout clump which originated from an 18-inch stump. Small stem on right is dead, and small stem on left will probably not survive to rotation end. Both can provide entry for butt rot fungi into the elite stem, which is 9.2 inches d.b.h. and 84 feet tall.

for decay exists. In other cases of multiple stems, the trees were of nearly equal size and appeared likely to survive (fig. 4). In cases like these, the potential for rot is small if twin sprouts are treated as one and are either cut or left together.

Figure 4.--Twin stems from 8-inch stump at 24 years of age. Stem on right is 12.2 inches d.b.h. and 87 feet tall. Stem on left is 12.0 inches d.b.h. and 88 feet tall. These stems should be treated as one and either both removed in thinning or both carried to rotation.

SUMMARY AND CONCLUSIONS

Stumps of yellow-poplar sprout profusely after harvest of mature, second-growth stands. One or more of these sprouts on each stump are usually capable of very rapid height and diameter growth. On the good site in this study, the best crop tree on each stump averaged 80 feet tall and 9.6 inches d.b.h. at 24 years of age. Some sprouts were over 90 feet tall and nearly 14 inches in diameter.

Thinning to one stem per stump at 6 years of age did not affect either height or diameter growth over the succeeding 18 years. Yellow-poplar sprout clumps in this and other studies have demonstrated outstanding ability to thin themselves. At age 6 there were approximately six stems per stump, and by age 24 the unthinned clumps contained an average of 2.1 stems per clump. No stump had more than four surviving sprouts at 24 years of age. As a result of the rapid and almost complete natural thinning, it is not necessary to thin artificially to encourage growth of crop trees.

Early precommercial thinning with yellow-poplar sprout clumps has been recommended to reduce incidence of butt rot by (1) favoring low-origin stems, (2) eliminating all sprouts from large stumps, and (3) reducing clumps originating from small stumps to one stem prior to heartwood formation in the sprouts (see footnote 4).

From the results of the present study, it appears that thinning to the one best low-origin stem at an early age will have little effect on incidence of butt-log rot caused by the parent stump. About half the crop trees in this study had open infection courts resulting from decaying parent stumps. True (see footnote 2) reported that 80 percent of the sprouts arise at the soil line. Furthermore, this and other studies indicate that low-origin sprouts survive better than high-origin sprouts, which are subject to breakage. As a result, the stem(s) which dominate a sprout clump will probably be of low origin, whether or not they are artificially thinned.

This study shows that the greatest incidence of rot occured on the largest stumps--particularly those over 15 inches in diameter. Thus, elimination of all sprouts from large stumps will reduce the incidence of butt rot in crop trees. Ancillary stems dying after heartwood has formed in them (fig. 3) can introduce rot into the dominant crop tree. Thinning to one stem on small stumps at an early age is a valid strategy for reducing chances of rot.

On the other hand, this research indicates that waiting until a commercial thinning can be made is an important option to consider. At 24 years of age the majority of the stump sprouts on the good site are of pulpwood size, and some are even small saw-log size. Poor-risk stump sprouts can probably be removed at this point on a break-even basis, if not a profit. Sound stems of stump-sprout origin (about 50 percent of all stump sprouts in this study) and stems of seedling and seedling sprout origin should provide sufficient crop trees.

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