

EFFECTS OF ARMILLARIA ROOT ROT IN THINNED AND UNTHINNED COASTAL DOUGLAS-FIR STANDS.

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CONTRAST #
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Armillaria root rot, caused by *Armillaria ostoyae* (Romagn.) Herink. is common in young (<50 yr) Douglas-fir stands in coastal British Columbia. Beale (1987) found it in % of stands surveyed in the Quadra TSA. In contrast with the severe and sustained losses by *Armillaria* root rot in southern interior forests, the coastal disease has been considered to cause little damage (<3%) and to be confined to very young trees (Morrison 1981). The ability of older trees to callus out the disease indicates a relationship to host vigor. Foster and Johnson (1963) opined that some root rot (mostly *Armillaria*) might be beneficial as a natural thinning agent in overstocked stands. However, there have been no studies of the effects of the disease over a rotation, nor how they might interact with silvicultural treatments such as thinning.

The objectives of this study are:

1. From permanent plot data, to determine the spatial, temporal, and host-tree size distribution of *Armillaria* root rot in coastal Douglas-fir plots.
2. By simulation, to determine the effect of *Armillaria* root rot on tree and stand growth over a rotation, with or without thinning (juvenile spacing).

ANALYSIS OF ARMILLARIA ROOT ROT DISTRIBUTION

METHODS

Permanent plot data were obtained from Forestry Canada plots at Campbell River and Tsable River (Foster and Johnson 1963, Wallis 1976) in which incidence of Armillaria root rot has been recorded together with tree diameters and locations at approximately 5-yr intervals from 1958-1990. The distribution of mortality by Armillaria root rot was mapped by location and year. The diameter distribution of killed trees was compared with that of healthy trees at different stand ages.

RESULTS

SPATIAL DISTRIBUTION

In the plots analyzed, Armillaria root rot occurs in two major patterns:

1. As loose aggregations of trees within certain areas of a stand. These can be considered as concentrations of the disease. In two plots, the majority of infected trees occurred inside concentrations; in a third they were approximately equal (Table 1).
2. As scattered individual trees in the remainder of a stand (Figs 1-3).

In this respect, Armillaria root rot differs from Phellinus root rot which occurs in highly aggregated centers and not as scattered trees. The distribution of inoculum and the infection mechanisms of the two diseases probably accounts for their unique spatial patterns.

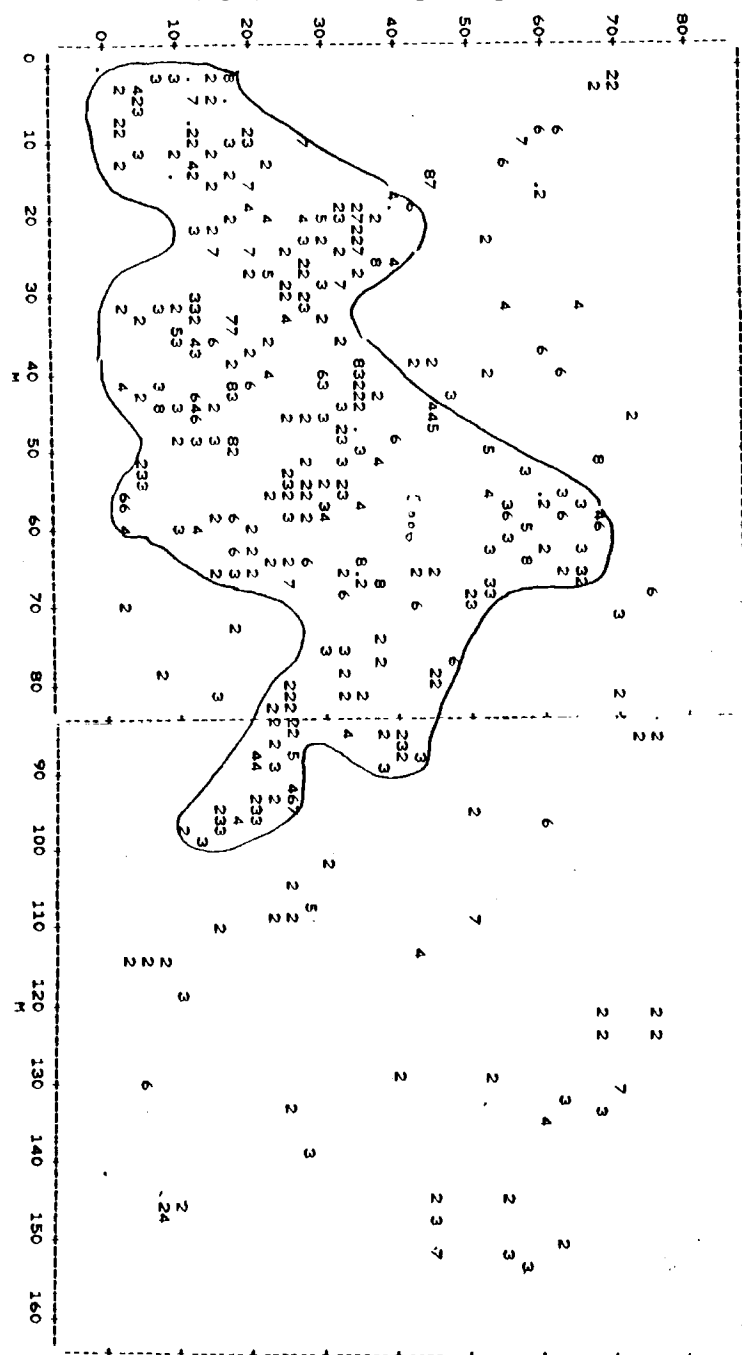
The plots differed in the spatial distribution of concentrations of Armillaria root rot. At Campbell R., there were numerous concentrations of various sizes. At Tsable R., there were one large to three medium size concentrations. Differences in distribution of initial inoculum levels could explain the distribution differences among stands. Also differences in microsite factors, especially soil moisture could account for disposition of trees to infection (Foster and Johnson 1963).

FIGURE 2

Tsable R. Block 1 Armillaria Infection by 5-yr Age Class

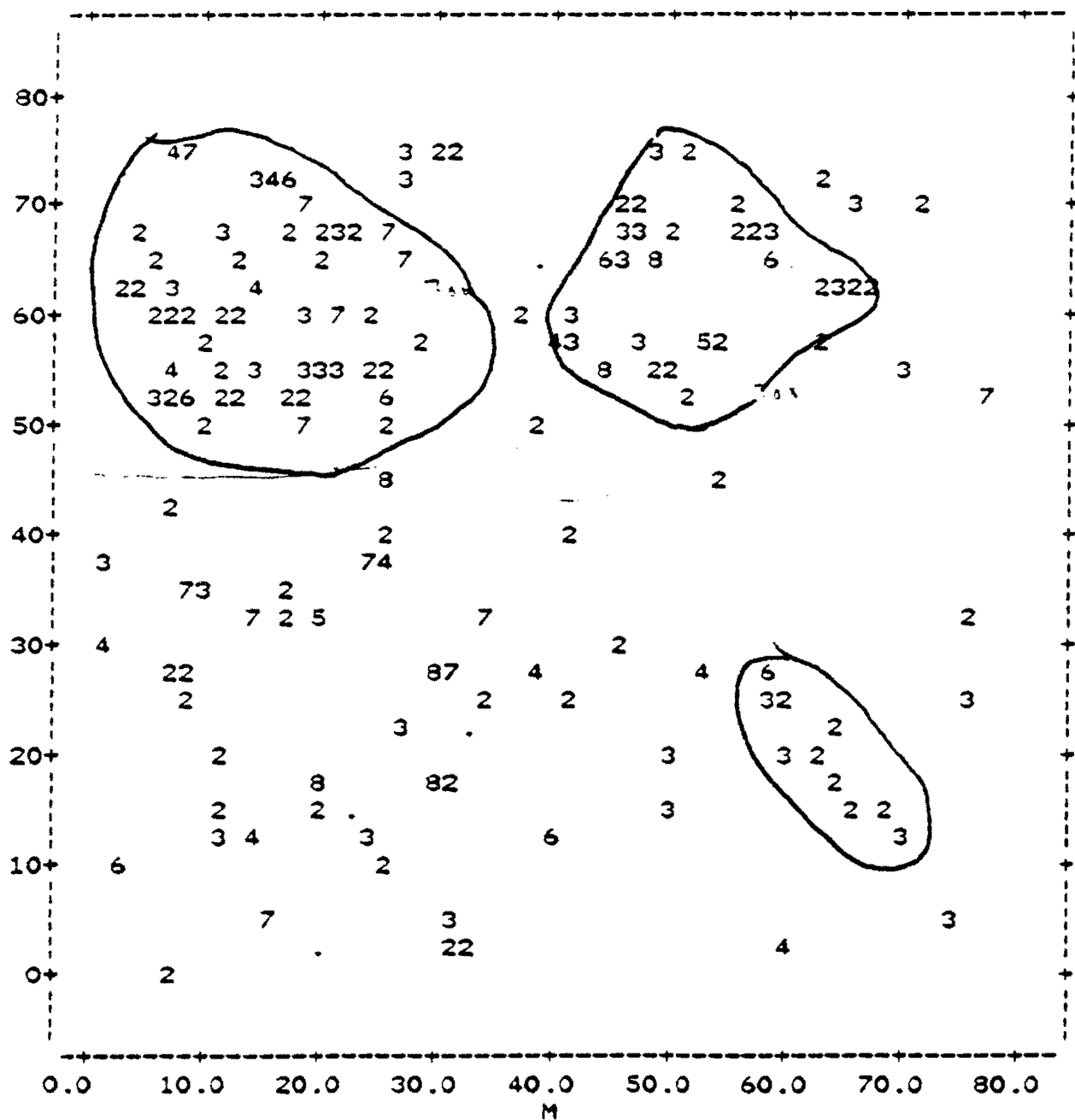
Top section(left): Number of points plotted: 287

Bottom section(right): Number of points plotted: 91



TSABLE R. BLOCK 2 ARMILLARIA INFECTION BY 5-YR AGE CLASS

Number of points plotted = 174



T a b l e 1 .**Spatial Distribution of Armillaria Root Rot in Plots**

Plot	Area ha	Trees/ha	No. concns	Area sq.m	No. inf. Trees/ha inside concns	No. inf trees outside concns	Inf. Trees /ha
Cambell R.	2.91	1900	3	1000	164	60	224
			1	800			
			2	300			
			2	225			
			2	175			
			1	100			
			5	75			
Tsable R.							
Block 1	1.14	1850	1	5000	264	52	316
Block 2	0.54	2100	1	700	167	155	322
			1	500			
			1	200			

TEMPORAL DISTRIBUTION

Temporal distribution of Armillaria root rot occurred as two patterns:

1. At Campbell R.. as a variable rate over time with peaks and troughs ranging between 10 - 25% of total mortality, but exhibiting no trend (Fig.4 -5)
2. At Tsable R.. as a high rate (almost 50% of total mortality) at age class 10-15 yr followed by sharp declines to less than 10% in subsequent age classes (Figs. 6-7). Possible explanations for the two differing patterns are
 1. The presence of high inoculum levels at Tsable R. prior to planting. This could have resulted in widespread infection and death of young susceptible trees. Subsequent infection could have been reduced due to increasing resistance as the stand increased in age. In contrast, a lower inoculum level at Campbell R. could have resulted in a slower initial infection rate, and a lower subsequent rate of infection.
 2. Greater stress on trees at Tsable R. than at Campbell R. due to site conditions. The former occupy a southern-facing bench, while the latter is in a valley bottom. A combination of both factors is likely.

FIGURE 4 (t o p) - Periodic Armillaria Mortality, Campbell River

FIGURE 5 (b o t t o m) - Cumulative Armillaria Mortality, Campbell River

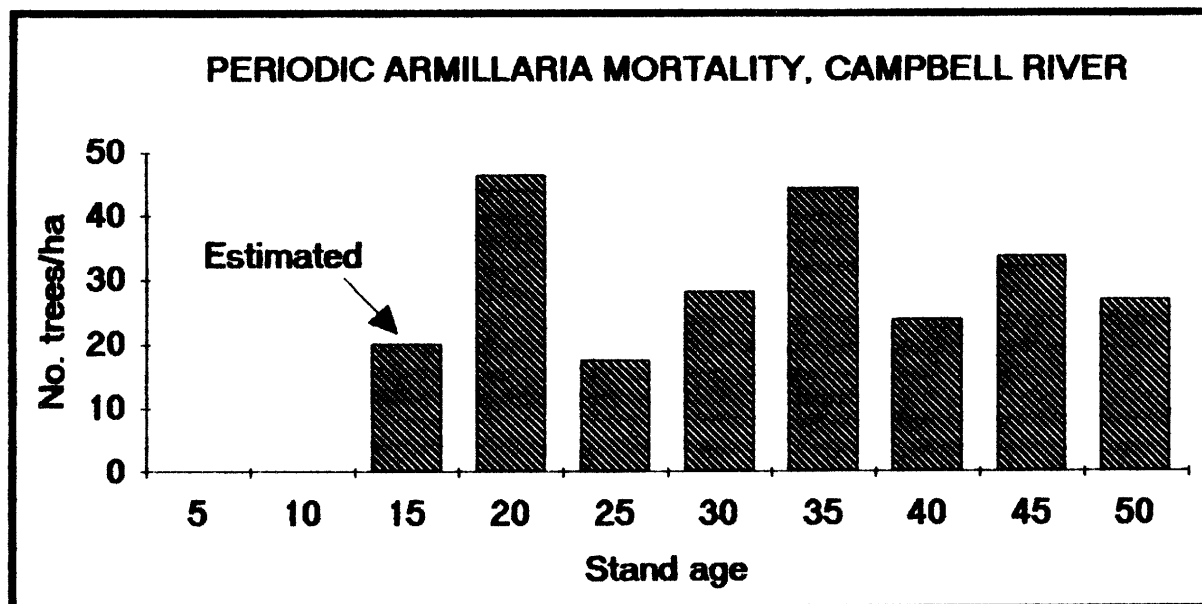
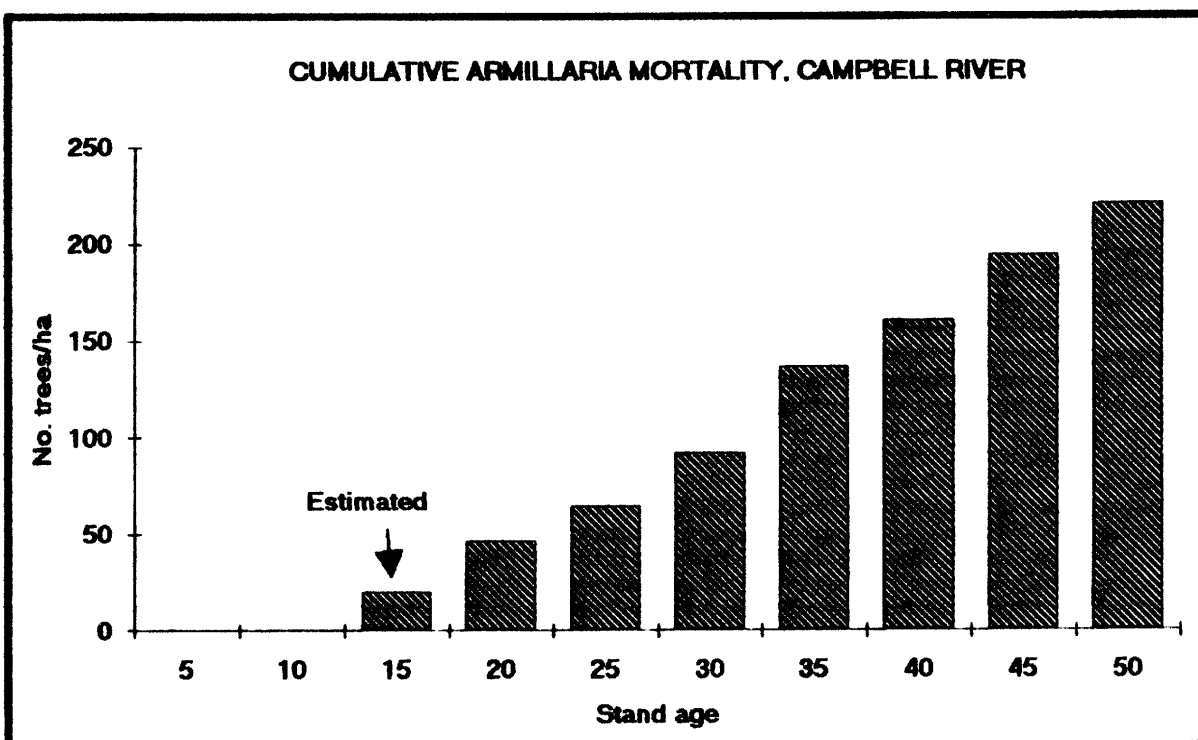
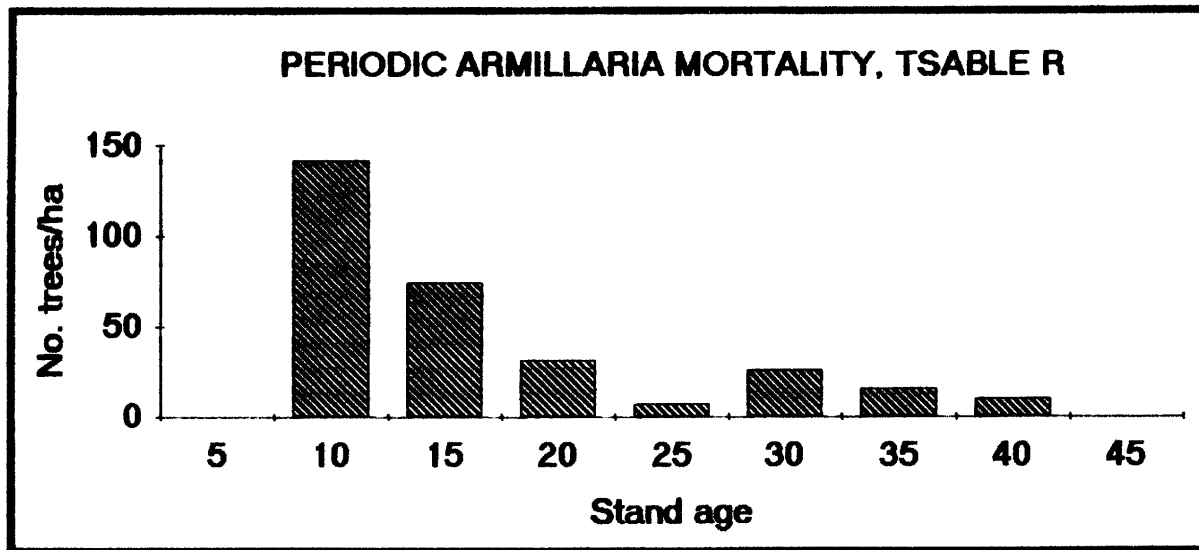
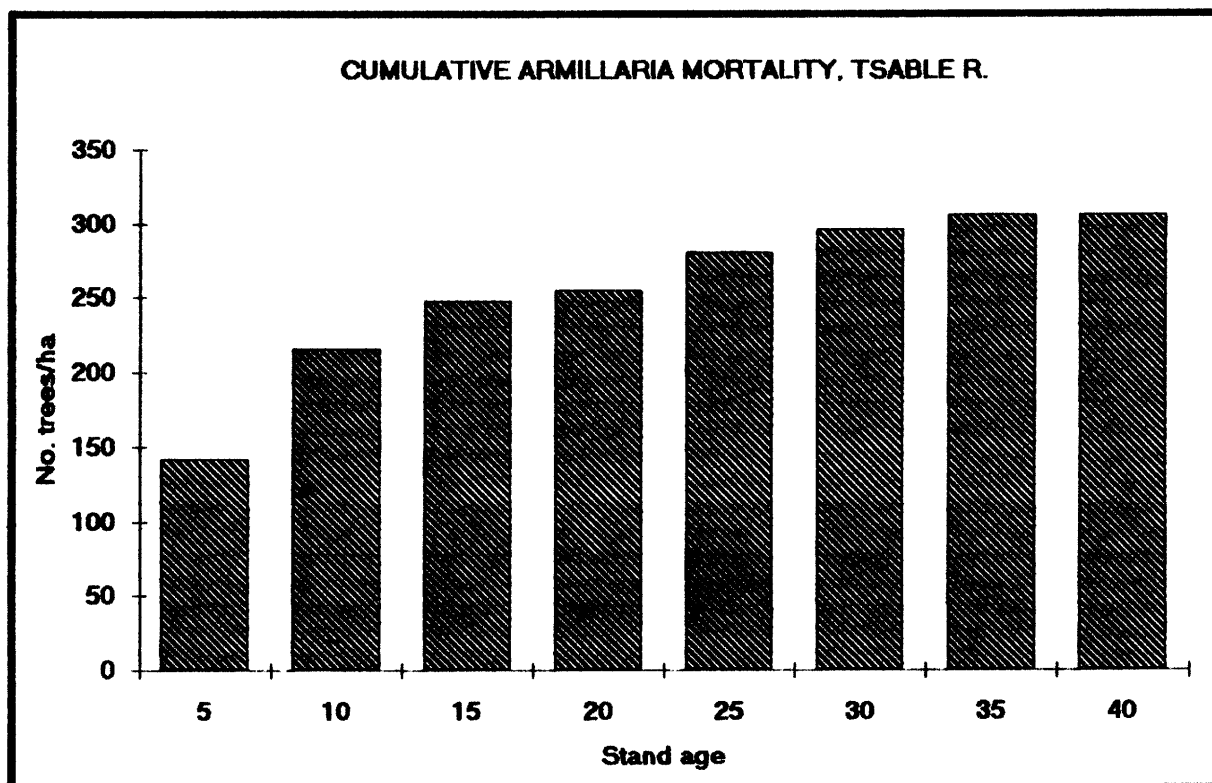


FIGURE 6 (t o p) - Periodic Armillaria Mortality, Tsable R.

FIGURE 7 (b o t t o m) - Cumulative Armillaria Mortality, Tsable R.



DIAMETER DISTRIBUTION

The diameter distribution of trees killed by Armillaria root rot followed that of healthy trees in the early life of the stand up to about 2S yr (Figs. 8-9). Thereafter, it became more skewed to the lower diameter classes (Figs 10-11). Evidently, all trees were susceptible to the disease at an early age but as the stand got older, the less vigorous ones were more susceptible.

F I G U R E 8 - DBH Distribution, Campbell R., Stand Age 20

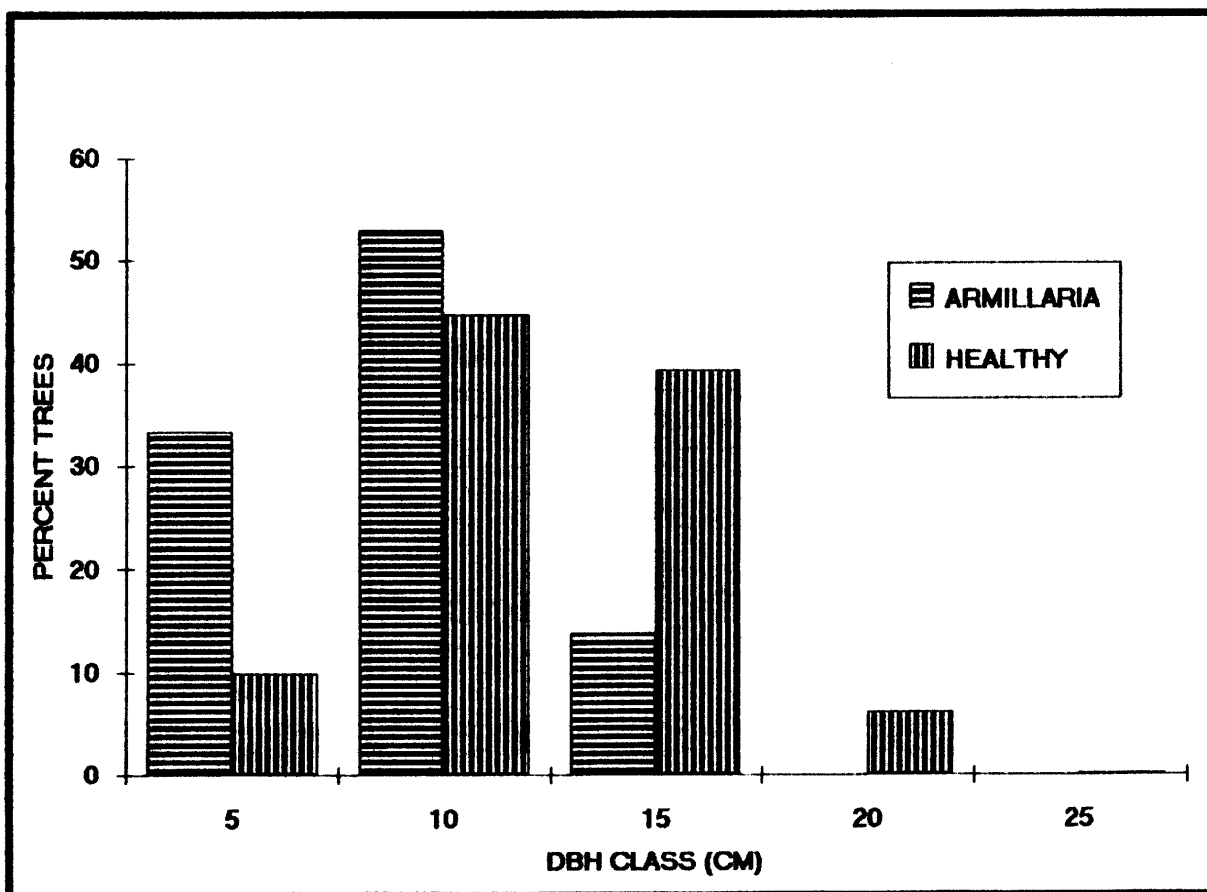


FIGURE 9 (t o p) - DBH Distribution, Campbell R., Stand Age 45

FIGURE 10 (b o t t o m) - DBH Distribution, Tsable R., Stand Age 20 (00312)

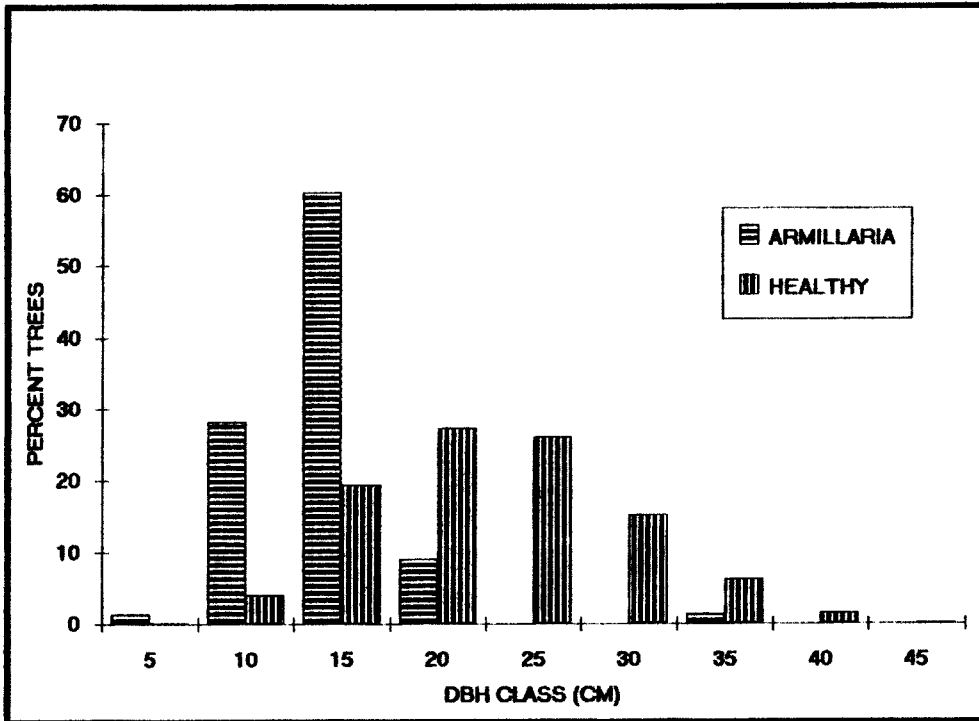
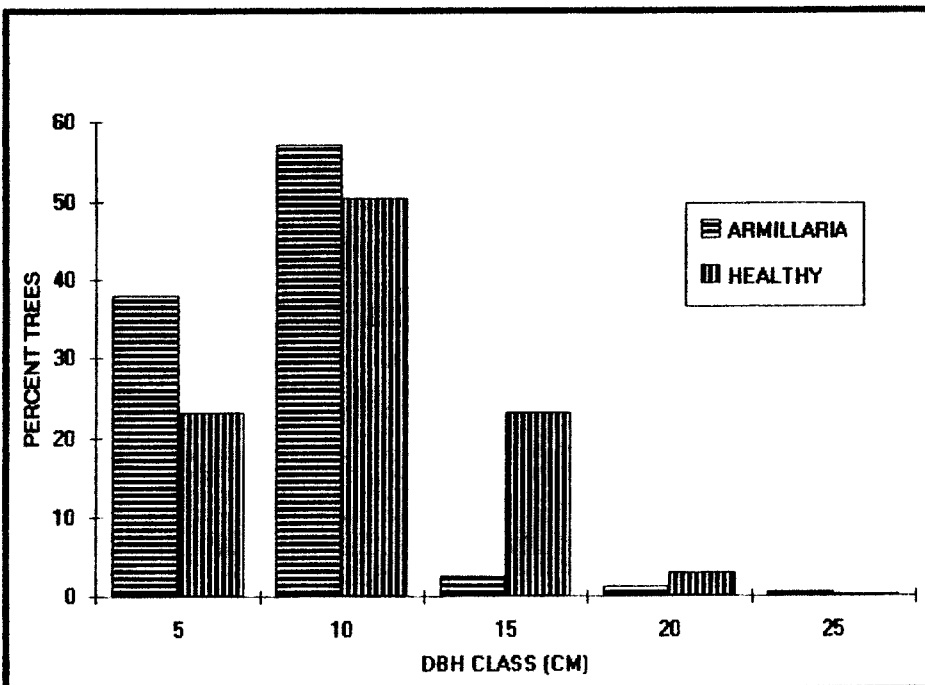
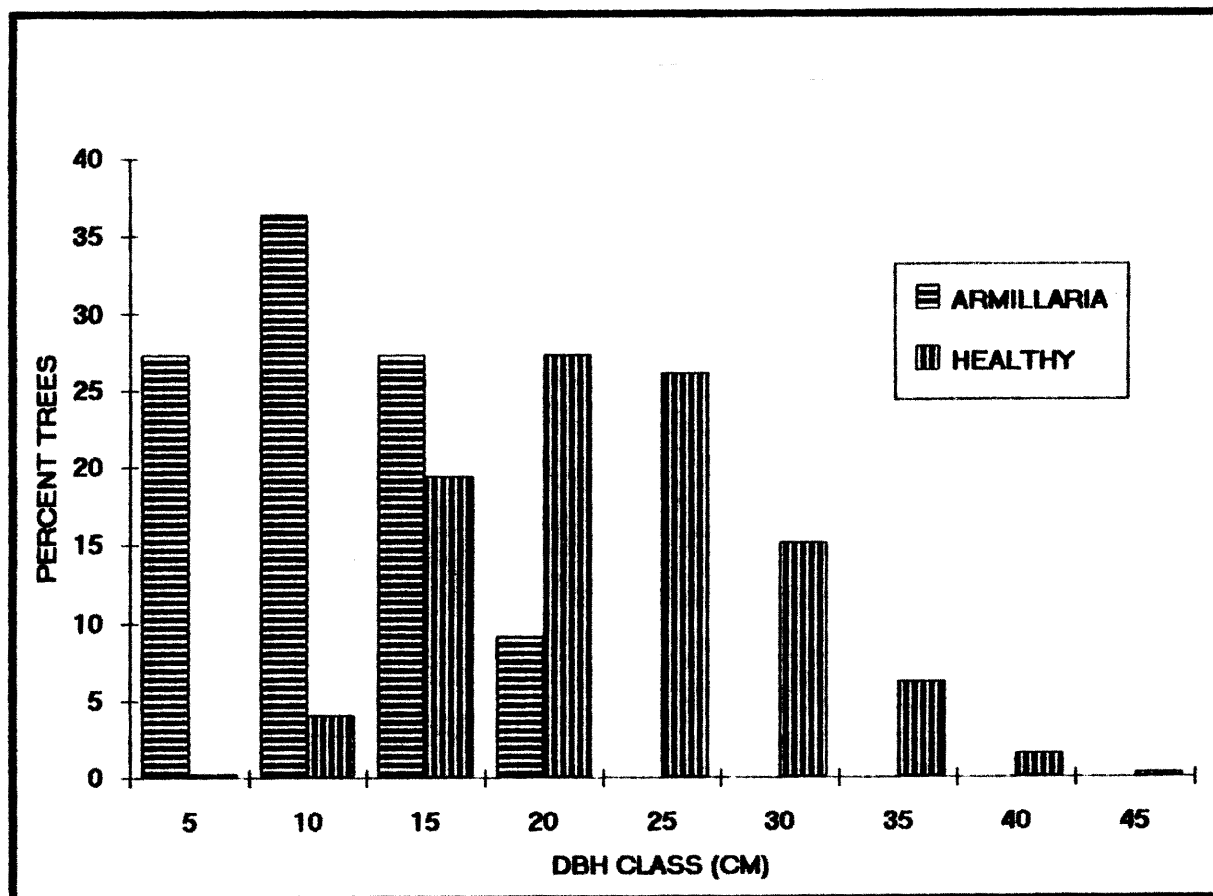


FIGURE 11 - DBH Distribution, Tsable R., Stand Age 45



In summary, the diameter distribution of Armillaria root rot indicates limited diameter preference until 20 yr. thereafter a preference for trees intermediate between the dominant and suppressed classes. i.e., subdominants and intermediates. A possible explanation is that, although suppressed trees have little vigor to resist Armillaria attack, their small root systems reduce the probability of becoming infected by root contact. Dominant trees possess the necessary vigor to resist the disease, while intermediates have large enough root systems to increase infection probability but insufficient vigor to resist attack.

IMPLICATIONS FOR FOREST MANAGEMENT

SPATIAL DISTRIBUTION

The scattered type of Armillaria distribution has no importance in forest management because it probably will not result in understocking, whereas concentrations of mortality may cause local understocking, especially if mortality continues after the stand has been spaced to its final stocking.

TEMPORAL DISTRIBUTION.

Depending on when the stand is spaced, and on the type of temporal distribution, understocking may occur. If spacing is carried out before 20 yr. it may coincide with the type of mortality that occurs mainly during that period.

DIAMETER DISTRIBUTION

Up to 20 yr. Armillaria root rot may attack final crop selection trees, thereby reducing stocking. Thereafter, it may attack trees which, though not dominant, may be selected to maintain evenness of stocking.

Figure 22

Effect of Armillaria on Average Volume in Coastal Douglas-Fir Thinned to 500 SPH

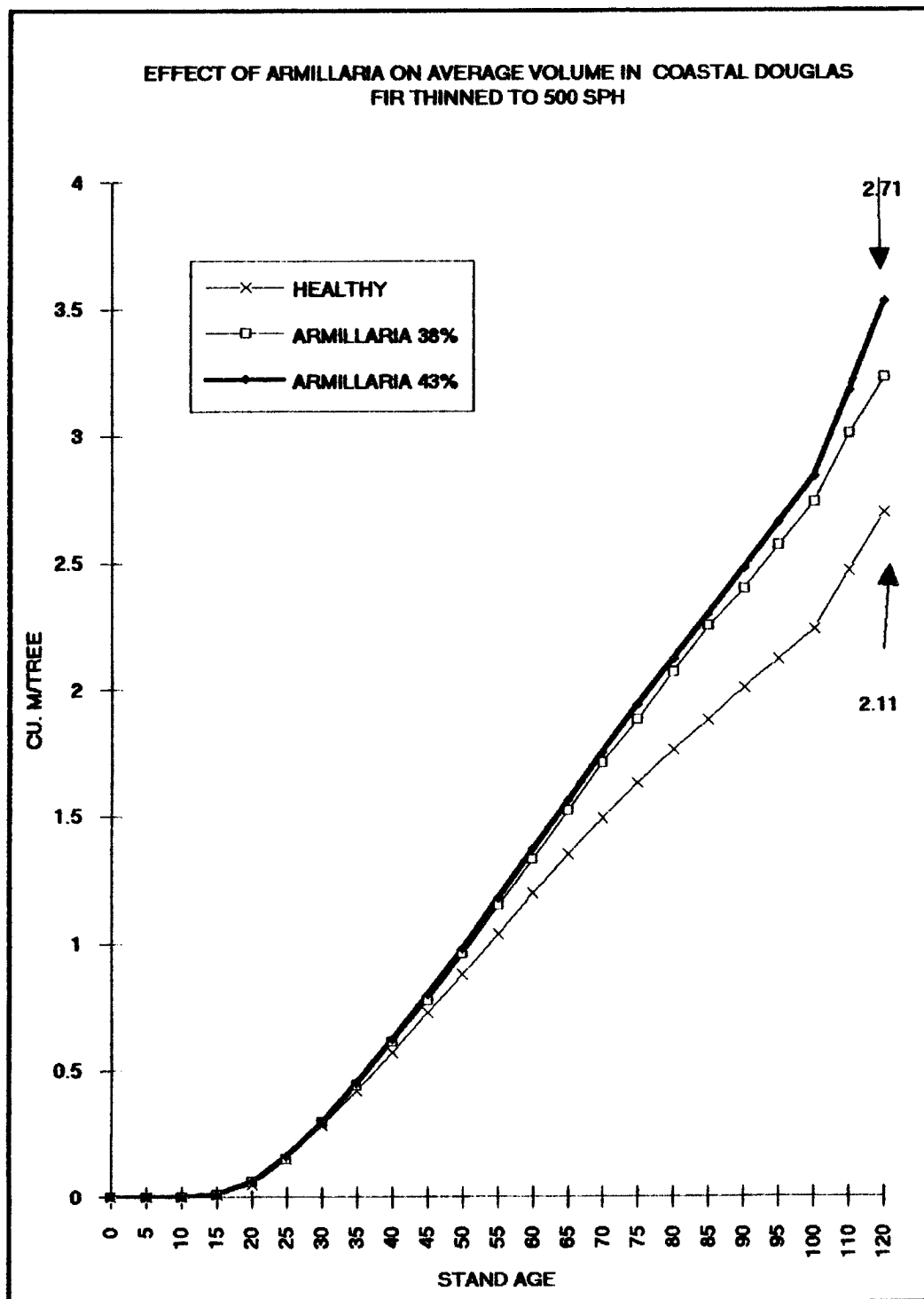


FIGURE 21

Effect of Armillaria on Average DBH in Coastal Douglas-Fir Thinned to 500 sph

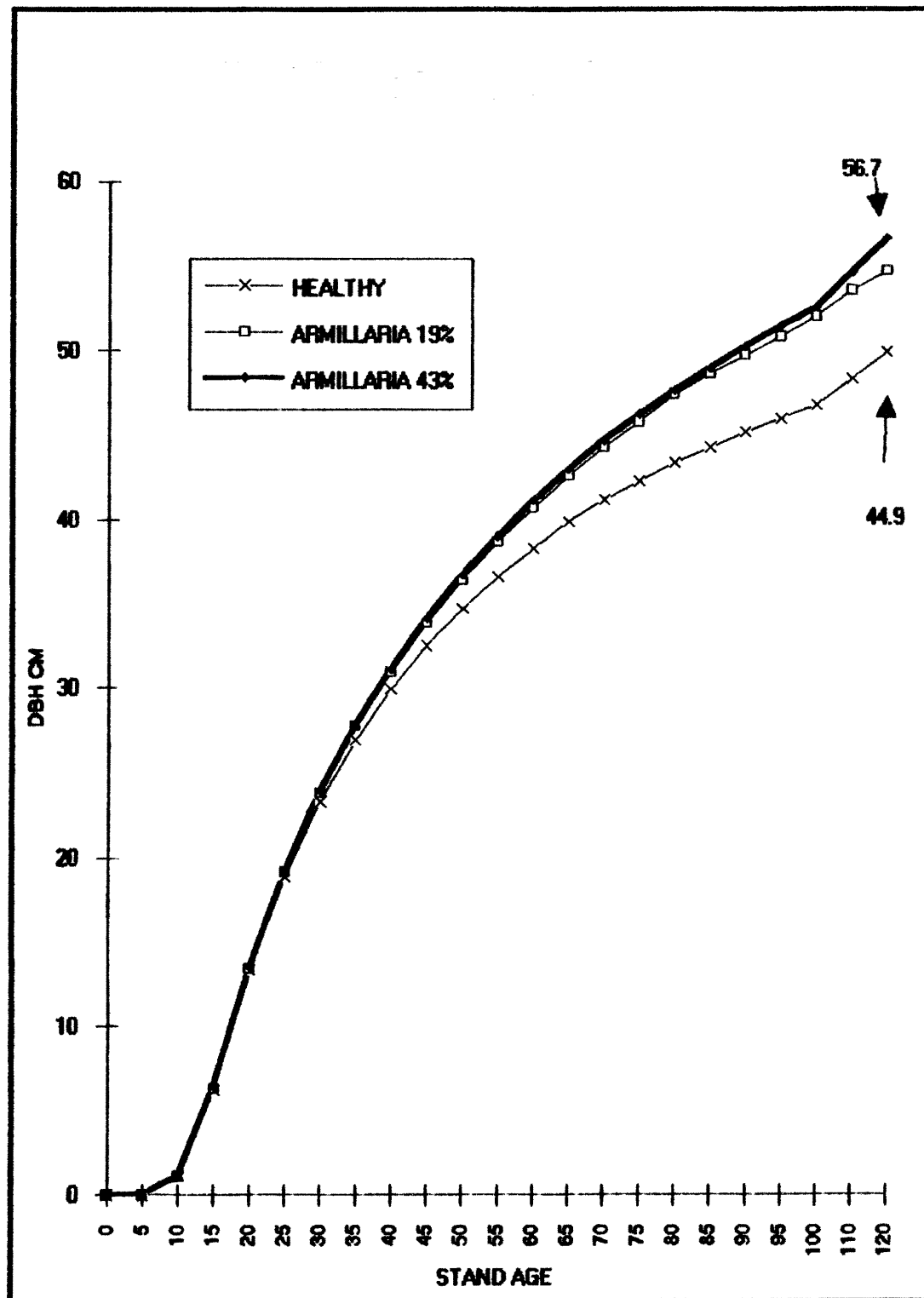


FIGURE 20

Effect of Armillaria on Stand Density in Coastal Douglas-Fir Thinned to 500 sph

