

PERFORMANCE OF A BIOLOGICAL
CONTROL FOR LIMITING SURFACE DECAY OF WOOD POLES

A Two Year Report Submitted To

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Introduction

Preservative treatment provides an excellent barrier against biodeterioration, and the use of this technology has markedly extended the useful life of many wood products used under adverse conditions. Over time, however, the preservative present near the wood surface can either degrade or migrate from the wood, leaving the wood vulnerable to renewed fungal attack, particularly by soft rot fungi. Soft rot attack on the surface of structures, such as poles, decreases the cross sectional area, sharply reducing bending strength.

Surface decay on wood poles is typically limited by periodic application of external groundline bandages. These systems contain combinations of water- and oil-soluble biocides. The water soluble components can migrate for varying distances into the pole to eliminate fungi in wood, while the oil component remains on the surface to prevent renewed fungal attack. For many years, wraps contained mixtures of creosote, pentachlorophenol, fluoride, and other chlorinated phenols. Increasing concerns about the safety of these chemicals lead to substitution and reformulation of these systems to the point where the primary chemicals used in external bandages in North America are currently limited to boron and copper naphthenate. Both of these chemicals have much lower toxicity profiles than the earlier systems, but many utilities remain concerned about the potential risks of leaching and subsequent effects on ground and surface water.

One alternative to chemical prevention of surface decay is to alter the environment around the pole to the point where fungal attack is severely limited. One approach to achieving this goal is to reduce the amount of available oxygen to the point where soil microorganisms are unable to colonize the wood. While many soft rot fungi are capable of growing under low oxygen tension conditions, virtually all require that some oxygen be present. Limiting oxygen may, therefore, represent a viable approach to limiting the potential for fungal attack.

In this report, we describe field tests of a soil nutrient supplement designed to encourage oxygen depletion in the environment surrounding a pole.

Approach

Testing the proposed surface decay control strategy posed some difficulty. Developing substantial surface decay on preservative treated pole sections would require a decade or more. Similarly, identifying poles in service with existing surface decay would require a fairly extensive field test. In addition, the residual preservative retention in these poles and the extent of fungal attack would likely vary widely between test poles. We opted to use untreated Douglas-fir pole sections as the test material. While untreated wood is more susceptible to decay, it eliminates the variations in preservative retentions and represents a more severe test than would be found if preservative treated wood were used. It also allowed us to develop meaningful results in a shorter time period.

Materials and Methods

Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) pole sections (250 to 300 mm in diameter by 1.2 m long) were obtained from a local pole manufacturing facility. The pole sections were set to a depth of 0.6 m into the ground at the Peavy Arboretum test site, located approximately 10 km north of Corvallis, Oregon. The site receives approximately 1 m of rainfall per year, with most precipitation falling between November and April. The climate is moderate with few days below 0 C and few above 32 C. Untreated Douglas-fir stakes at this site fail within 2 years, while posts typically last 3 to 4 years.

One set of 15 pole sections were left untreated, while the other 15 received the Triangle labs materials, inserted, according to the instruction around the base of the pole to a depth of 75 mm. Eight bars of the material were equally spaced around the circumference of each pole section.

The condition of the posts was assessed annually after treatment using bioassays and mechanical tests. For bioassays, plugs (12.7 mm in diameter by 50 mm long) were removed from 3 equidistant locations around each post, 300, 225, 150 and 75 mm below groundline as well as at groundline and 75, 150 and 225 mm above that zone. The plugs were then flamed to removed any contaminating surface flora and placed on the surface of malt extract agar in plastic petri dishes. The plates were incubated at room temperature and observed over 30 days for evidence of microbial growth. Any growth was removed and subcultured onto fresh malt extract agar for later identification.

The effects of field exposure on wood properties was assessed using a Pilodyn. This spring-driven, pin-penetration device provides a relative measure of wood density which in turn can be related to wood strength. Pilodyn tests were performed at 3 locations around each pole at the sample locations used for culturing. Pin penetration values were subjected to an ANOVA then the means were subjected to a students t-test ($\alpha = 0.05$).

Results and Discussion

Total fungal isolations after the first year differed little between treated and untreated pole sections. Fungi were classified as either basidiomycetes (termed decay fungi) or non-decay fungi. Isolation frequencies for non-decay fungi differed little with either treatment or distance above or below the groundline. Total isolation values for decay fungi tended to vary with distance from groundline and treatment. Non-decay fungi were omni-present in the pole sections 2 years after installation, suggesting that the treatment had little or no effect on the incidence of these fungi. Caution must be exercised when viewing this data since many non-decay fungi are prolific sporulators. Isolations could represent germination of spores rather than growth of hyphae established in the wood. The role of microfungi in wood degradation remains poorly understood. Some of these wood inhabiting fungi likely contribute to degradation, but others may inhibit the activity of other fungi.

Decay fungi were more abundant in untreated pole sections one year after treatment 300 and 225 mm below groundline and 225 mm above groundline, while decay fungi were more abundant in the treated pole sections 75 and 150 mm above groundline one year after installation. The reasons for these differences are unclear. The primary decay fungi isolated were *Stereum sanguinolentum* and *Sistrotrema brinkmanii*. Both of these fungi are common inhabitants of Douglas-fir sapwood at the early stages of degradation and the former fungus is often in many trees at the time of felling.

Isolation frequencies of decay fungi from pole sections two years after treatment did not differ between treated and untreated samples at or above the groundline. However, isolation frequencies below ground differed markedly. Only 10 to 15 % of cores from the untreated control poles contained decay fungi 2 years after installation, while 50 to 65 % of treated poles contained decay fungi. Four taxa of basidiomycetes comprised most of the isolates: *Postia placenta*, *Stereum sanguinolentum*, *Antrodia vaillantii* and an unknown species we have labeled Taxa C. Both *P. placenta* and *S. sanguinolentum* are common invaders of Douglas-fir logs. The latter fungus was only isolated at or above the groundline. Although this fungus was more abundant in treated pole sections, the differences were generally slight. *Postia placenta* was primarily isolated from treated sections and was present in cores from 5 of the 8 heights sampled. This fungus is primarily a heartwood decayer and we suspect that our isolations reflect the presence of the fungus near the sapwood/heartwood interface.

Antrodia vaillantii was present in both treated and untreated pole sections, but was much more abundant in treated sections at or below groundline. This fungus is regarded as a common copper tolerant fungus, but has not previously been isolated from this site. The Unknown Taxa C appears to have characteristics similar to *Phaeolus schweinitzii*, a root and stem rotter of conifers that occurs in trees surrounding this site. It has not, however, been isolated previously from wood exposed at our test site. This fungus is generally not a decayer of wood products and its presence in the wood is perplexing, particularly since it appears to be prevalent above ground in untreated and below ground in treated samples.

Pilodyn Pin Penetration: As noted earlier, the Pilodyn is a reasonable predictor of wood density which in turn can be used to detect changes in mass caused by fungal attack. While the Pilodyn is less sensitive to the early stages of decay than other mechanical properties, it is easy to use and allows repeated sampling of materials over the course of a study.

Pilodyn readings in treated and untreated poles 1 year after treatment averaged between 9.6 to 23.2 mm depending on location (Table 1). Penetration was shallowest at or above the groundline in both treated and untreated poles reflecting the limited potential for surface degradation out of soil contact. Pilodyn readings below ground ranged from 14 to 15.9 mm in treated sections and 13.9 to 23.2 mm in untreated sections. The largest difference between treated and untreated occurred 300 mm below ground, where penetration varied by over 7 mm.

Penetration values 2 years after installation again showed little difference between untreated and

treated poles above the groundline. Below groundline, the posts all exhibited evidence of decay. Pin penetrations steadily increased with depth in both treated and untreated pole sections. the degree of damage in the treated pole sections was consistently lower than that found in the untreated sections and these differences were significant 150 and 300 mm below the groundline. These results clearly indicate that the treatment had influenced the rate of decay.

Conclusions

Pole sections treated with the biological control appear to have a different fungal flora and a significantly reduced degree of fungal damage 2 years after treatment. These results suggest that this approach has merit for altering microbial growth below ground around a pole to slow fungal decay. Further field trials in actual utility poles are warranted with this material.

Figure 1. Isolation frequency of non-decay fungi a.) one and b.) two years after application of a biological treatment for limiting surface decay of poles.

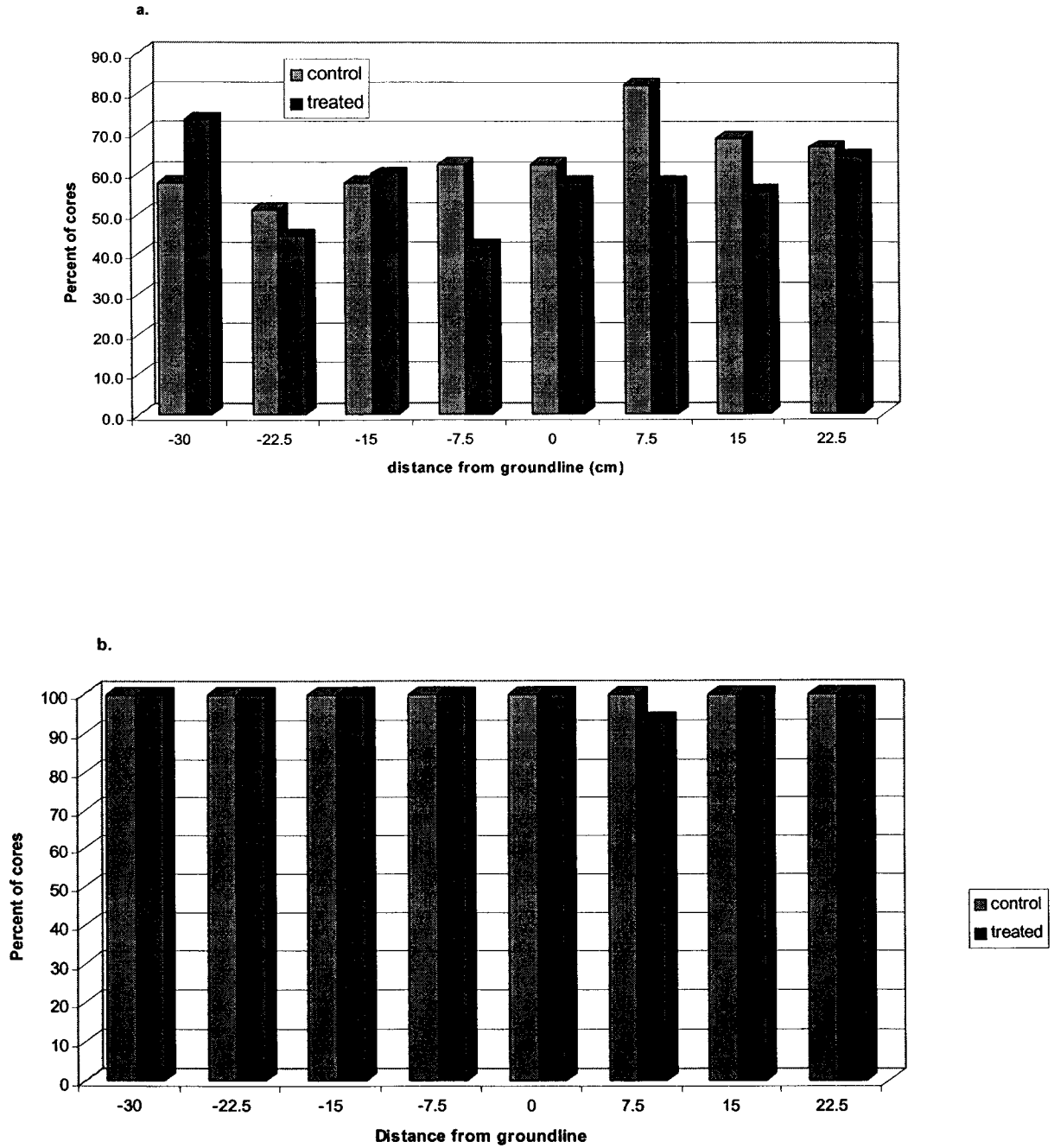


Figure 2. Isolation frequency of basidiomycetes from Douglas-fir poles a.) one or b.) two years after application of a biological treatment for inhibiting surface decay below groundline.

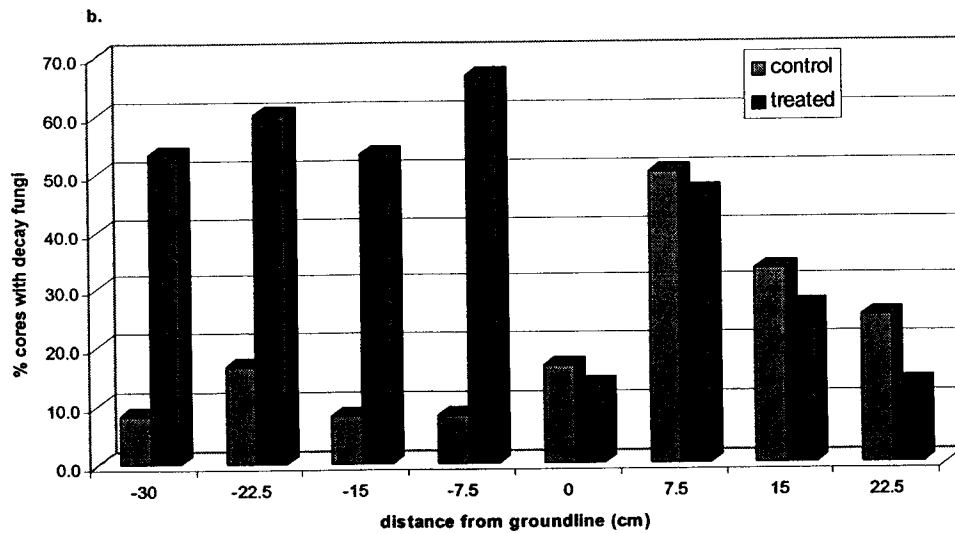
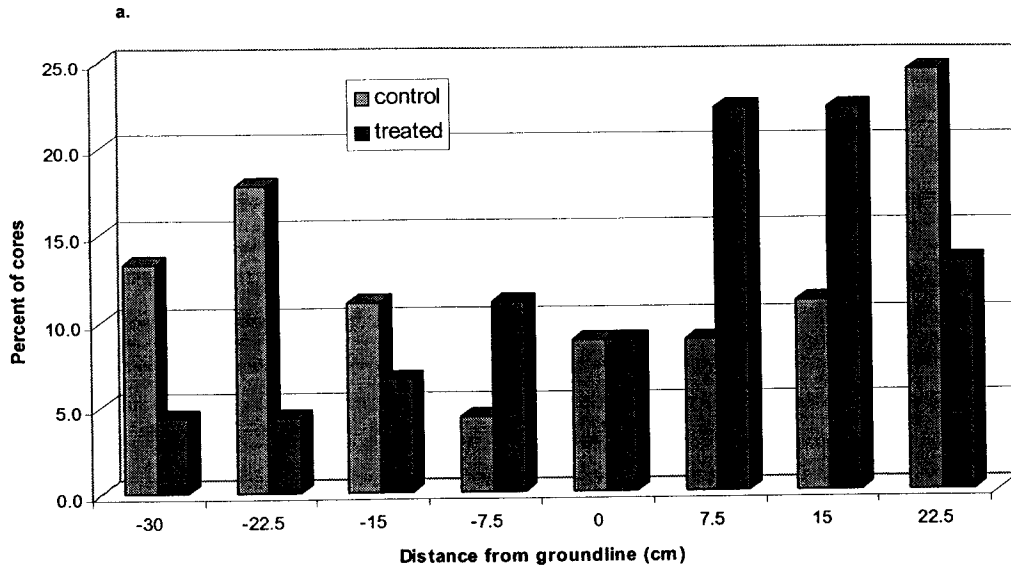


Figure 3. Isolation frequency of a.) *S. sanguinolentum*, b.) *S. brinkmanii* and c.) Taxon C from Douglas-fir poles one year after application of a biological treatment for inhibiting surface decay below ground.

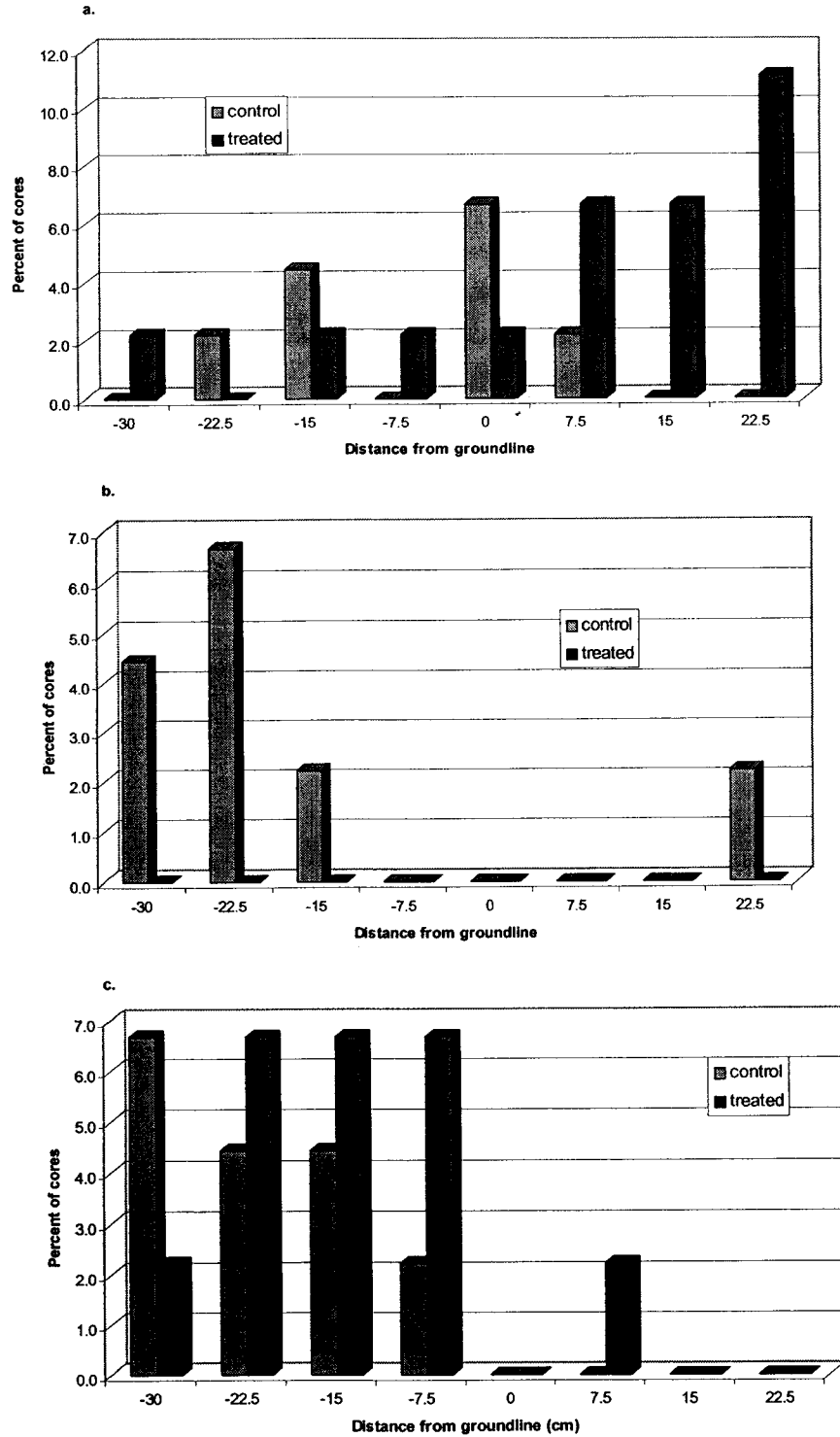
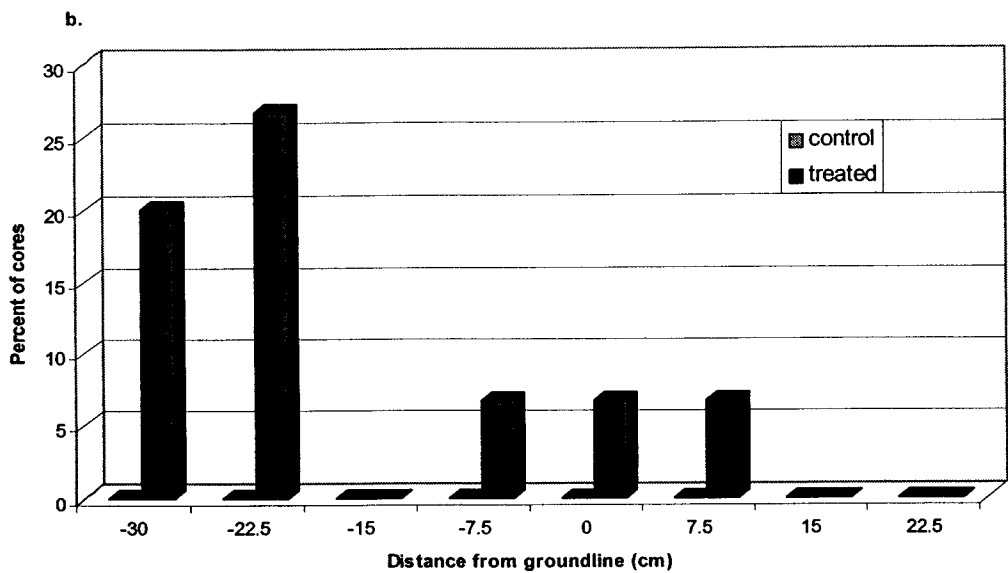
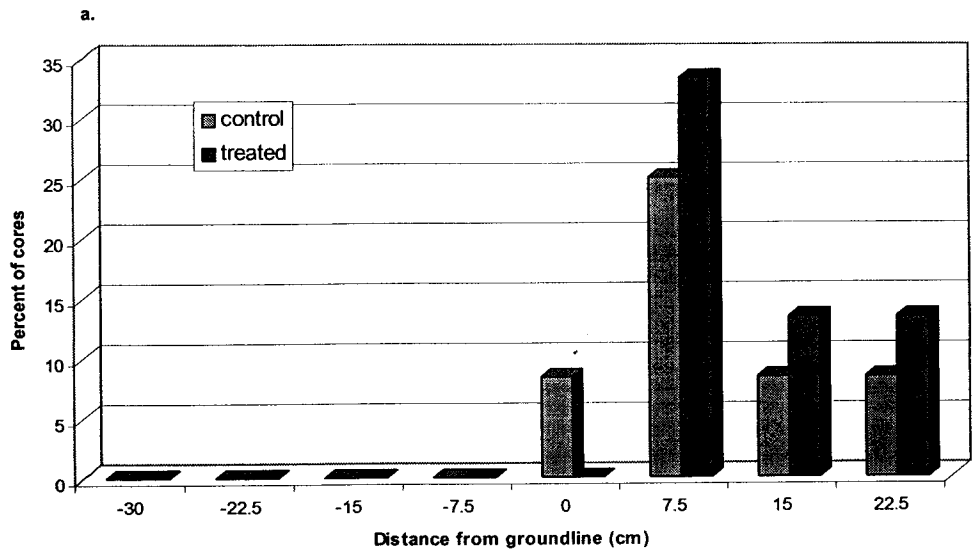
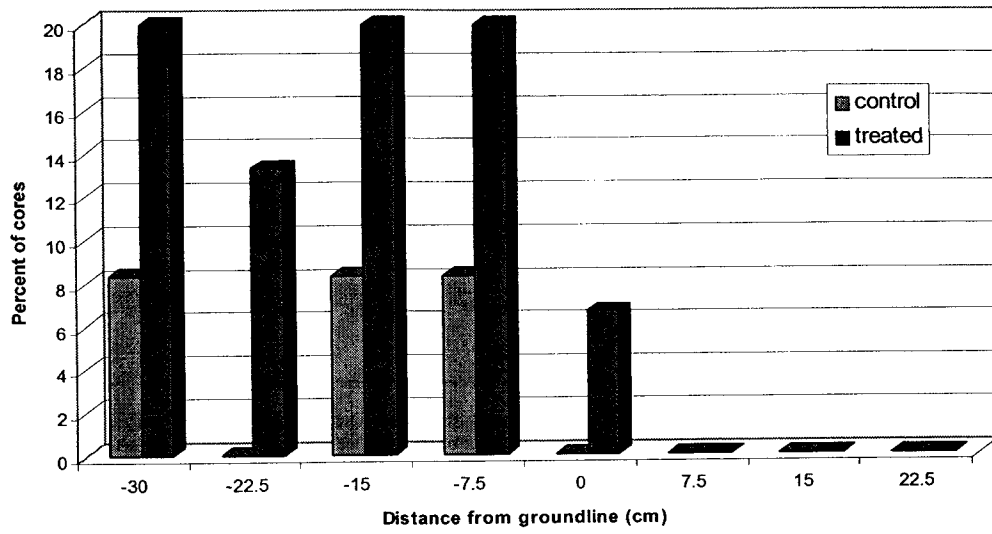


Figure 4. Isolation frequency of a.) *S. sanguinolentum*, b.) *P. placenta*, c.) *A. vaillantii* and d.) Taxon C from Douglas-fir poles two years after application of a biological treatment for inhibiting surface decay below ground.



c.



d.

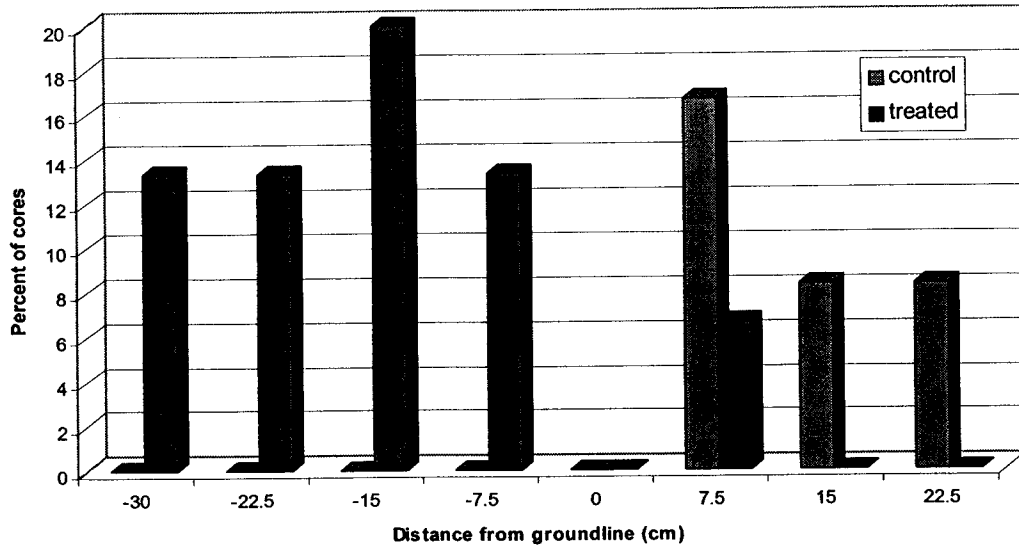


Table 1 Effect of a biological treatment to limit below ground surface decay on Pilodyn pin penetration at selected distances above and below groundline of Douglas-fir poles sections 1 or 2 years after installation.									
Treatment	Year	Mean Pilodyn Pin Penetration (mm) ^a							
		Distance above or below groundline (mm)							
		-300	-225	-150	-30	g1	75	150	225
None	1	23.2 (6.3)	18.9 (6.4)	18.3 (6.9)	13.9 (4.2)	12.3 (2.6)	10.4 (2.4)	10.4 (2.7)	10.7 (2.6)
	2	33.2 (7.5)	30.2 (9.8)	29.0 (10.3)	25.3 (12.2)	20.8 (11.8)	10.2 (2.8)	10.5 (2.5)	10.3 (2.3)
Triangle	1	15.9 (5.8)	14.0 (5.2)	15.1 (5.0)	14.5 (6.4)	11.3 (4.2)	9.6 (1.7)	9.9 (2.1)	10.0 (1.7)
	2	27.1 (8.8)	24.7 (10.20)	21.7 (8.4)	19.5 (8.6)	15.6 (9.1)	10.3 (5.8)	10.1 (3.3)	9.7 (3.0)

^a Values represent means of 15 replicates. Figures in parentheses represent one standard deviation.