THE CONTROL OF YELLOW LAMINATED ROOT ROT OF DOUGLAS FIR [1]

D. C. BUCKLAND [2] and G. W. WALLIS [3]

D. C. Buckland worked as a research assistant with the B.C. Forest Service during the summers while attending the University of B.C. where he received the degrees of B.A. in 1941 and B.S.F. in 1942. Following this he was employed in forest pathology in Victoria with the Dominion Science Service. He was a fellow of the Yale School of Forestry for two years, receiving the degrees of M.F. in 1943, and Ph.D. in 1945. Following a year as Acting Officer-in-Charge of the Victoria Laboratory of Forest Pathology, he was appointed as Associate Professor of Forest Pathology at the University of B.C. in 1948. He was Editorial Representative, Vancouver Section, C.I.F., from 1949-54; Chairman, Vancouver Section, C.I.F., 1954-55; Director, National Council, C.I.F., 1955-56; Chairman, C.I.F. Standing Committee on Forest Entomology and Pathology, 1955-56; Chairman, Sub-Committee on Forest Pathology, Terminology Comm., Can. Phytopath. Sec., 1951-56; Director, Western Division, C.N.I.B., 1954. He was an Honorary member of the Literary and Scientific Exec., University of B.C. and the Canadian Forestry Association; and a member of the C.I.F., S.A.F., Can. Phytopath. Soc., and Amer. Phytopath. Soc.

Yellow laminated root rot, caused by *Poria weirii* Murr., is a very destructive disease of Douglas fir and is known to occur on all northwestern conifers of commercial importance. The extent of the damage caused by this disease is not clearly understood and will always be difficult to assess. Estimates based on the number of trees lost per acre do not give a true picture of the damage caused by the disease. The fungus spreads out from a center of infection destroying patches of timber resulting in irregular stocking. Snow press and windthrow occur around openings caused by the disease, and bark beetle populations build up in the dying trees, further complicating estimates of damage.

Devising a satisfactory silvicultural control of the disease is greatly hampered by the behavior of the fungus. Symptoms of the disease exhibited by infected trees vary markedly, often within the same center of infection. Yellow laminated rot might develop in the butt of a tree and externally the tree will show no symptoms of disease. In another case the fungus will move up the sapwood of the roots and before it has reached the root crown the foliage will turn yellow, thin out rapidly, and the tree will develop a "distress" crop of cones (a large crop of small cones in the upper crown) the year previous to death. While the fungus does not produce rhizomorphs nor apparently can it travel free in the soil, it spreads readily from one root contact to another, and as roots down to one millimeter have been found infected, many contacts between infected and healthy trees will exist in most stands. Inoculum will remain viable for long periods of time in old resinous stumps and roots of Douglas fir, inoculum having been found viable after 50 years. No northwestern conifer

[1] A paper presented at the 47th Annual Meeting of the Canadian Institute of Forestry, Saskatoon, Sask., in a panel discussion of root diseases of conifers, October 6, 1955.

[2] Associate Professor of Forest Pathology, University of B.C., Vancouver. (Deceased).

[3] Research Officer, Canada Division of Forest Biology, 409 Federal Building, Victoria. Biographical reference, *Forestry Chronicle*, Vol. 31:356.

seems to have any appreciable immunity to the disease. The disease is destructive on all forest sites. While stands 40 to 100 years of age seem to be most severely damaged by the disease, Douglas fir from 6 years to several hundred years of age have been found infected.

Several methods of controlling the disease have been or are being tried, but to date, the results have not been satisfactory. The following are some of the control methods that have been considered:

Trenching: Digging a trench around an infected area to eliminate root contact with adjacent trees was tried by the B.C. Forest Service at the Cowichan Lake Forest Experiment Station over a 20 year period. This method proved satisfactory in preventing the spread of the disease from one center, but is impractical. The trench must be dug well outside any trees with visible symptoms of the disease to make sure the disease is limited within the trenched area. Infection centers usually appear irregularly over many decades and to trench about each of these centers as they become visible is economically out of reason. Further, trenching merely controls the disease during the current rotation while inoculum will remain viable within the trenched area to infect the reproduction following harvesting.

Breeding Resistance: To date no Douglas fir has been found immune to the disease. The fir that appear to be most resistant are those that show no external symptoms of attack by the disease and are apparently capable of restricting the fungus to the heart of the roots and butt. From the long term point of view, however, these trees are unsatisfactory for breeding purposes as the stumps and roots, containing large amounts of resin, are preserved for long periods of time. Thus, the fungus is able to remain viable in such material to infect the succeeding rotation.

Rotation of Crop: The suggestion that western hemlock might well be grown as an alternate crop to Douglas fir is not practical. On average Douglas fir sites the yield of western hemlock would never be as great as that of Douglas fir except where the latter is very heavily infected. Further, while the disease does not seem to spread so readily from hemlock to hemlock the species appears to be just as susceptible, if not more susceptible, to the disease. Finally, in one rotation it is doubtful if there will be any appreciable reduction in the amount of inoculum capable of infecting succeeding rotations.

Mixed Stands: As no western conifer has been found completely immune to the disease and as several of the larger centers of infection have contained a mixture of three or four species of conifers, all of which have been attacked and killed by the fungus, a mixture of species in the stand should have no appreciable influence on the control of the disease.

Thinning: Thinning to remove infected trees and increase the vigor of residual trees has yet to be shown of any value. *Poria weirii* will attack trees of any vigor class. In the original thinning it is impossible to eliminate every infected tree because of the frequent lack of external symptoms of the disease. Further, the fungus will remain viable in dead roots and stumps over extended periods and the roots of released trees are liable to reach out and contact viable inoculum. No conclusive results have been reached to date in this field. While it is thought that thinning will be ineffective in controlling the disease, some material that would have been lost through the action of the fungus will be salvaged in the thinning operation.

Wide-spaced planting: Wide-spaced planting or very heavy thinning of natural regeneration to avoid early contact of roots holds very little promise for control except in the early stages of stand development. It would be necessary to repeatedly thin throughout the development of the stand to hold mass contact of roots to a minimum. When the stand reaches the critical age, however, there seems little possibility of preventing the disease from spreading unless the stand is so wide-spaced that stocking is very poor and the quality of wood is greatly reduced. Furthermore, with such wide spacing natural regeneration would be encouraged, nullifying the objective of this method, prevention of root contact.

Burning: In an article by Buckland, Molnar and Wallis[4] it was suggested that burning as severely as practicable would exert a degree of control on the disease. Such burning will prevent fruiting of the fungus and the site conditions will be adverse for further development of the disease. Burning will not destroy the organism dormant in roots and stumps, however, so cannot be considered as a control of the disease.

Currently major attention is being focussed on the details of the biology of the fungus. It is felt that an understanding of the conditions influencing the spread[5] of the fungus and a close knowledge of its behavior will be a key to determining the most effective method of controlling the disease.

DISCUSSION

FOLLOWING PAPERS BY WARREN, VAN GROENEWOUD, AND BUCKLAND

Question

I should like to ask Mr. van Groenewoud whether there is any relation between the weevil and *Polyporus*—is it occasional? Is it invariable?

Answer

In almost all stand openings there are trees with roots wounded by the weevil, though *Hypomolyx* also occurs in other spots. It is not limited to those stand openings.

Question: Crossley

I would like to ask Mr. Warren a question in connection with *Hypomolyx*. As you know our lodgepole pine stands growing on the east slope of the mountains and in British Columbia, too, are overly dense. Do you think that there Hypomolyx might be an effective thinning agent?

---

[4] Buckland, D. C., Molnar, A. C., and Wallis, G. W. Yellow laminated root rot of Douglas fir. Can. Jour. of Botany 32:69-81. 1954.

[5] Wallis, G. W. Poria weirii root rot of Douglas fir. Interim report. Mimeo. Canada Forest Biology Division, Victoria. June, 1955.

Answer: Warren

The most severe mortality rates are in young stands. But *Hypomolyx* is hardly a thinning agent. I have never seen very much mortality in mature timber so, if your lodgepole pine is mature timber, *Hypomolyx* wounding along with disease will hasten its downfall but it could hardly be considered a thinning agent.

Question: Crossley

As I understood your previous remarks, you said that heavy mortality took place up to forty years of age. Now our stands are very dense in their early ages, but they thin themselves out as they go along. In many cases they never get properly thinned out right through to maturity. Wouldn't *Hpyomolyx* be serving a beneficial purpose by thinning our stands out? In other words, if we had an effective means of control would we be wise to use it?

Answer: Warren

I have yet to see *Hypomolyx* in what could eventually become a good stand, killing the young trees.

Question: Jorgenson

I would like to thank Dr. Buckland for his very interesting paper on *Poria.* I have been working a little on *Fomes annosus* in Denmark for the last five years and I have seen that *Poria weirii* seems to behave very similarly to *Fomes annosus.* It was interesting to me to hear that trenching has been tried as a means of controlling *Poria weirii.* Some 70 years ago in Europe trenching was tried as a means of control of *Fomes annosus* but it did not work out very well. They got a very heavy production of fruiting bodies so they gave the control up. I should like to ask Dr. Buckland if *Poria weirii* will develop a heavy production of fruit bodies on diseased roots severed and exposed by trenching and, if so, will the disease be more severe than it was before the trenching? Further, have you the impression that there is a difference between the attack on former arable soils and that in natural stands?

Answer: Buckland

The answer to your first question is that there are a great many similarities between *Fomes annosus* and *Poria weirii.* There are a few differences in their action, however. One thing is that we only wish for the sake of biological research—nothing to do with forestry here—that we could get more fruiting bodies so we could study the thing. We have gone through a period of four or five years without being able to obtain a reasonable sample of fruiting bodies. Now we have never found a fruiting body on any of the cut roots in that trenching experiment but that does not mean much. The fruiting bodies are formed on the under side of the boles of fallen trees if the site is right. Now I doubt if you'll ever find a fruit body on a site lower than—well we never found any on sites 4 and 5—that's the poorest site—we haven't got any on site 1 to have a look at but, on site 2, where you have quite a lot of moisture available, you do occasionally find fruiting bodies.

As for your second question, I don't know of any plantations on arable land. Too, our plantations are still rather young to determine how important the disease will be. When I was conducting a survey of this disease during the ten years prior to 1949, I never saw any in plantations which were then up to 18 or 22 years of age. In recent years several outbreaks have been noted in the Campbell River plantation which is the first sign that the organism has remained viable in those extensively burned areas, and the fact that it might be important.

Question: Dr. Riley

I might point out that the Stand Openings as referred to in Mr. van Groenewoud's paper mean a little more than the term would indicate. We used this name in the beginning so stuck with it, but it may refer to relatively open areas with poor looking stands in which there are a lot of trees dying. Mr. van Groenewoud has defined the term to cover the same soil conditions and the same plant communities associated with those conditions, whether it's over a large area or a small, definite stand opening. I would like to ask Lyman Warren whether he has found the root weevil associated particularly with the stand opening conditions. Definitely the weevil wounds are a source of infection.

Answer: Warren

As Mr. Groenewoud has said, *Hypomolyx* isn't necessarily found only in stand openings. I was in a stand of very good spruce in Northern Saskatchewan recently and there was a lot of rot and *Hypomolyx*. Practically all of the roots showing rot were very bady damaged but the trees did not appear to be dying.

Question

I note that the two types of soil on which the openings develop are the sandy and the shallow and I wonder if that could not be a drought condition?

Answer: van Groenewoud

No, we took daily measurements of moisture conditions in sandy soils in 13 different localities and wherever spruce woods occurred the moisture content in the soil was never below permeability.

Question

In other words, shallowness of soil is not due to lack of moisture but to the character of the parent material. It would tend then towards a sandy soil itself.

Answer: van Groenewoud

Well, in the sandy soil I think that the shallowness of the root systems is due to lack of moisture. The subsoil of the sandy soil was below the permeability point for quite a few years.

Question: Robbie Reid

Dr. Buckland, you mentioned the occurrence of *Poria weirii* in plantations as just a recent occurrence and then mentioned that this was from a residual infection. Can you be sure that it is from a residual infection or could it be a new one from spore infection.

Answer: Dr. Buckland

It's circumstantial evidence entirely, but the odds of spore infection causing infection in standing trees is almost ruled out with any root disease. In the case of plantations, the Campbell River plantation for example, it is pretty hard to believe that the spore of any polypore could travel far enough to get into those trees to cause infection.

Dr. Prebble

I would like Dr. Fettes to speak on the subject of control of root weevils.

Dr. Fettes

We have been trying out a number of experiments in the last two years on heavily infested plantations of scotch and red pine Christmas trees in Ontario, and I think we have sufficient indications to feel optimistic about the possibilities of eliminating or nearly eliminating infestations of root-collar weevils on given trees. It may turn out to be an expensive operation which would have to be written off against the value of the trees. Our first approach was to attempt to kill the infestation present in the root collars. We had success with a number of fumigants but especially ethylene dichloride which eliminated the entire population. However the fumigant dissipates very quickly so gives no lasting protection. This season we have concentrated on residual insecticides hoping to protect against further infestation. Indications are that no further infestation has taken place. Our next step will be to attempt to combine fumigants and residual insecticides thereby getting rid of the present population and preventing future ones. It will be expensive as the trees will have to be treated individually; perhaps the cost will run somewhere around 5c a tree.

Dr. Bier

Dr. Buckland, many of the stands that we are now examining for Poria root rot have come in after the cutting of a mixed stand of Douglas fir, hemlock, and cedar. Subsequent to cutting and burning, the regeneration came in very heavy to Douglas fir with smaller numbers of hemlock and cedar. This disease is caused by an endemic fungus. Is it possible this disease has a heavy intensity in the younger stands, but as they become older the openings caused by the disease become filled with other species which, although susceptible, are not killed to the same extent as Douglas fir? Are we dealing with normal stand development changing gradually from a Douglas fir stand to a mixture of the species which were on the area originally?

Dr. Buckland

Quite right, but when a mature stand is cut (280 years of age and up) many of the hemlock and cedar are of merchantable size. In other words the infection centre years ago filled in with hemlock and other species, and the disease stopped spreading rapidly. Now we are cutting second growth, at a rotation of approximately 100 years and these openings have filled in with hemlock and cedar which will be unmerchantable when you harvest the fir.