Miscellaneous publication No. 1

JARRAH ROOT ROT

This pamphlet was prepared by officers of the Forests Department, under the direction of W. R. Wallace, Conservator of Forests.

April, 1971

Typical dieback symptoms in a mature jarrah tree

Front cover—53-year-old jarrah stand, east of Dwellingup. Dominant height 80 ft.

JARRAH ROOT ROT

INTRODUCTION

Timber was exported from Western Australia as early as 1836. From that time, the timber industry has ranked among the leading primary industries of this State and has greatly assisted decentralisation and the development of the South West. Apart from timber values alone, the 4,500,000 acres of dedicated State Forest assist the conservation of water, wildlife and wildflower resources and are an important recreational asset.

Jarrah *(Eucalyptus marginata)* is the most important timber species in this State yielding a cut with an annual value of approximately $23,000,000. This forest is threatened by a disease caused by a microscopic soil-borne fungus, *Phytophthora cinnamomi.* The fungus attacks the fine feeding roots, depriving the tree of access to soil moisture and nutrients, with the result that most under-storey species and finally the jarrah trees themselves, succumb to protracted starvation. *P. cinnamomi* does not attack the stem or branches of the tree and has no effect upon the strength or durability of the timber.

The purpose of this pamphlet is to describe, in simple terms, the disease, the organism responsible and the known methods of control. This knowledge is essential to all forest users, sawmillers, tourists and the general public, if control measures are to be fully effective.

RECOGNITION OF DISEASED AREAS

The first signs of the disease usually appear in the understorey layers of the forest where bull banksia *(Banksia grandis),* blackboy *(Xanthorrhoea preissii)* and zamia palm *(Macrozamia reidlei),* turn yellow and die.

Jarrah trees show the effects at a later stage—often after all of the banksia understorey has died. Symptoms in jarrah are

Bull banksia *(B. grandis)*

Blackboy *(X. preissii)*

Zamia palm *(M. reidlei)*

thinning of the crown and dying back of the tree's branches. The condition becomes progressively more severe until the tree succumbs. Death of the branches is merely an indication of a damaged root system and does not indicate the development of any disease in the above ground parts of the tree.

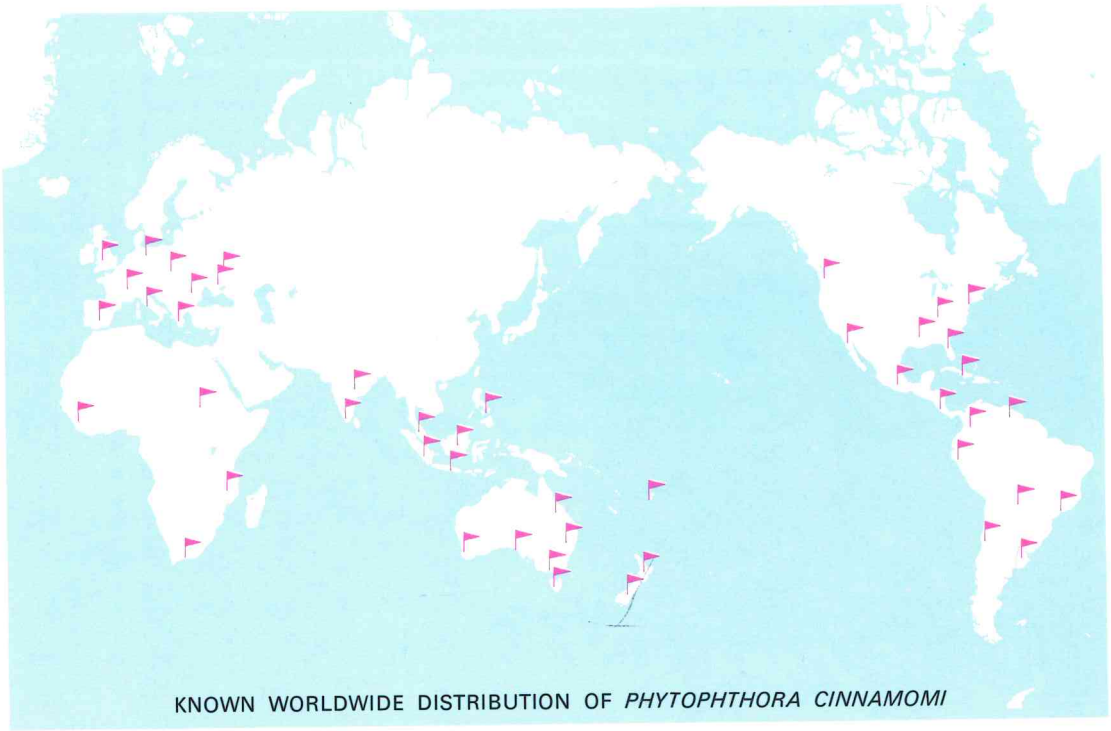
Diseased areas usually spread outwards slowly, however, the rate of movement can be quite variable depending on the forest type, the site and the season.

Some native species, notably marri *(E. calophylla)*, blackbutt *(E. patens)*, bullich *(E. megacarpa)* and wandoo *(E. wandoo)*, are resistant to the disease and continue to grow within the affected areas. In other forest types, particularly the Southern jarrah forest and some eucalypt forests in the Eastern States of Australia, *P. cinnamomi* can be associated with dieback of eucalypts without extensive mortality in the understorey plants.

Note the clear boundary between the diseased understorey (right) and the healthy understorey

Dieback area near Dwellingup. Scattered blackboys may survive on some sites

Dieback area. Note healthy marri *(E. calophylla)* in the foreground



KNOWN WORLDWIDE DISTRIBUTION OF *PHYTOPHTHORA CINNAMOMI*

THE FUNGUS

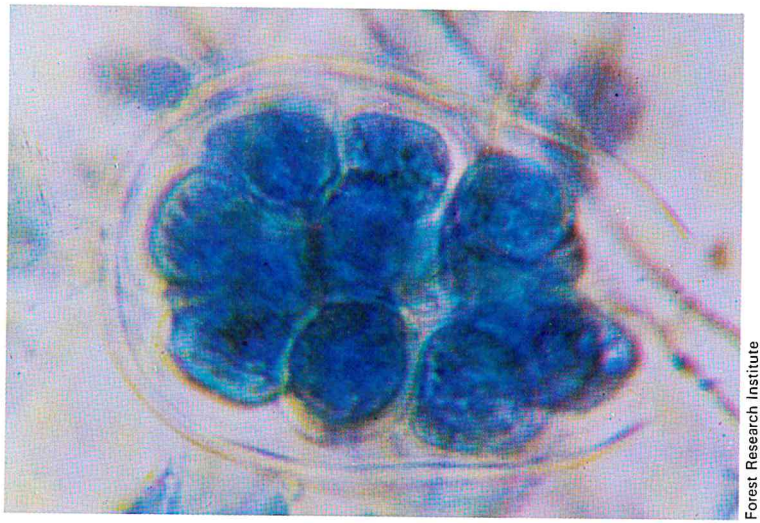
Fungi are lower forms of plant life which obtain their food either by parasitising living organisms or by decomposing dead organic matter. They may range in size from the relatively large mushroom to microscopic organisms undetectable to the naked eye.

The fungus *Phytophthora cinnamomi* causes serious disease in many plant crops and is widely distributed throughout the world, including the Eastern and Southern States of Australia. More than 400 plant species have been listed as being affected including azaleas, camellias, peaches, plums, avocado, pineapple, oak, cypress, eucalypts and pines. Available evidence strongly indicates that the fungus was introduced into Western Australia in the early years of this century, probably in infected soil on imported ball-stock. The fungus attacks the small root hairs leaving them blackened and dead. It has never been cultured from large jarrah roots and the fungus has no deleterious effect on the strength or the durability of jarrah timber.

Small piece of infected root showing the threadlike fungal hyphae (approximately × 100 magnification)

Forest Research Institute

Mycelium of *P. cinnamomi* growing from infected root pieces into nutrient medium (natural scale)



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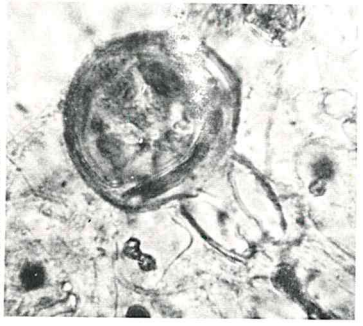
Sporangium of *P. cinnamomi* enlarged approximately 1,400 times. It will release 20 to 30 zoospores which swim in the soil water, germinate and may infect plant roots (artificially stained blue)

Oospore of *P. cinnamomi* (approximately × 600 magnification)



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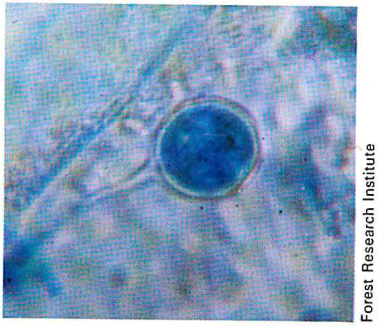
Chlamydospore of *P. cinnamomi* (approximately × 150 magnification, artificially stained blue)



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CONTROL

Photo mapping indicates that less than 5 per cent of the total forest area is affected and that most of the infections occur on the poorer jarrah sites. Control by fungicides or by mechanical means is theoretically possible but costs would be prohibitive for all but the most valuable of agricultural crops. The best method of control in the forest is therefore to prevent the spread of the fungus into the 95 per cent of the forest area which has not yet been affected.

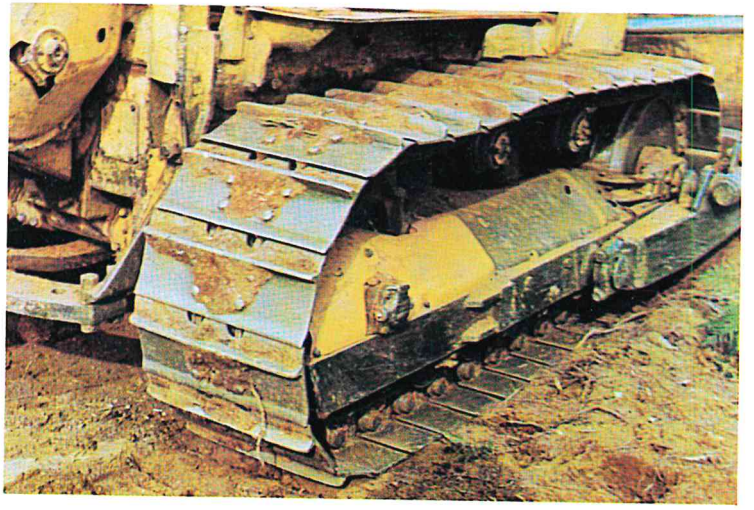
Spread of the fungus by natural means within the soil is very slow in comparison to its distribution by the transport of soil containing infected root material. Man, with his ability to transport large quantities of soil over great distances in a very short time, is the most efficient carrier of this disease into healthy areas. Large volumes of soil are constantly being moved within the forest area on bulldozing, logging and road-building equipment and it is these units which constitute the greatest source of danger.

Prevention of this artificial spread is the greatest single step which can be taken to reduce the serious threat to our forests.

An intensive education programme of all forest users (sawmillers, S.E.C., P.M.G., M.R.D., Shires and Forestry personnel) is well under way. With the full co-operation of the sawmilling industry, logging prescriptions aimed at minimising the artificial spread of the fungus on infected machinery have been drawn up and are being implemented in all major sawmilling permits.

Logging hygiene involves the segregation of logging areas and of logging routes into healthy and diseased sectors. To reduce artificial spread of diseased soil into healthy forests, these operations are kept entirely separate. Infected equipment is thoroughly washed if transfer into a healthy area becomes necessary. Forest roads are relocated to bypass diseased areas. New gravel pits are located in healthy forest, "diseased" gravel pits are closed. Where possible, the entire logging operation is

Soil clinging to rubber tyred and tracked logging equipment

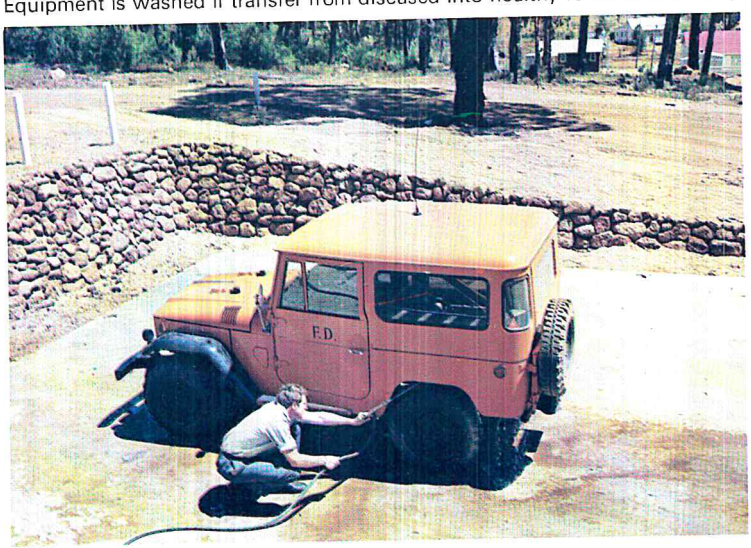


concentrated on the diseased areas in order to minimise timber losses through degrade. This sanitation programme is working well, but it is obvious that the co-operation of all parties involved will be essential for its continuing success.

In localised and high value crops (e.g. nurseries and orchards), control may be achieved by soil sterilisation, fumigation or the use of fungicides. Due to the high cost of treatment, this approach is impractical on a forest scale and could only be used in very limited areas. However, physical barriers such as ditching and poison-band killing, draining of susceptible sites and replanting with resistant species have been used to control the natural spread of the fungus within the forest area.

Rehabilitation of affected areas is essential if total timber production is to be maintained from State Forests. Over 50

Equipment is washed if transfer from diseased into healthy forest is necessary



tree species with known commercial potential have been tested for resistance to *Phytophthora* so far and among these, three species of pine and at least five eucalypts have shown both a significant degree of resistance and the ability to become readily established on areas affected by dieback. Field trials are continuing, but in the meantime over 600 acres are being rehabilitated each year using resistant species. The oldest plantings of *P. pinaster* in a dieback area were established in 1950 and this species has grown in the diseased areas for twenty years without any ill effects.

Pinus pinaster growing on a former dieback area. This stand of pine was planted in 1950

Three years old planting of *P. pinaster* in a dieback area

Plot of *E. microcorys* three years after planting

Natural regeneration of marri *(E. calophylla)* in a dieback area

A range of Eastern States eucalypts growing on a former dieback area

RESEARCH

Research into various aspects of jarrah dieback is being carried out at Departmental research centres at Como, Dwellingup and Manjimup. The Forests Department has also funded two research scholarships at Australian Universities. The Commonwealth's Forest Research Institute is maintaining a research station at Kelmscott and has already sponsored two eminent forest pathologists to visit Western Australia and advise on avenues for research and possible control measures.

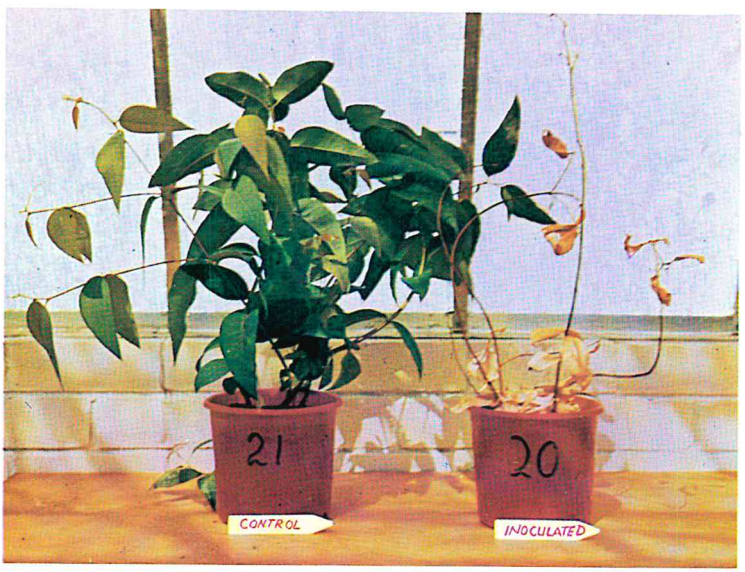
In November, 1969, the Forests Department organised a seminar on *Phytophthora cinnamomi* at the Como research centre. Twenty-seven research scientists from throughout Australia attended the proceedings. Included were representatives from the N.S.W. and W.A. Departments of Agriculture, C.S.I.R.O.,

the Australian National University, the University of W.A., the Waite Institute and the Victorian, N.S.W. and Queensland Forests Commissions. Research into various aspects of *P. cinnamomi* is currently being undertaken in the Eastern States, where damage from this fungus is considered to be of economic importance to both forestry and agriculture.

RESISTANCE OF OTHER FOREST TYPES IN WESTERN AUSTRALIA

Work to date indicates that karri *(E. diversicolor)*, marri *(E. calophylla)*, wandoo *(E. wandoo)* and blackbutt *(E. patens)*, the other important timber species in Western Australia, are resistant to this disease. The local plantations of *Pinus pinaster* and *Pinus radiata* also appear to be safe from the effects of the fungus.

Screening for resistance. The plants on the right were inoculated with mycelium of *P. cinnamomi*, those on the left were not treated



CONCLUSION

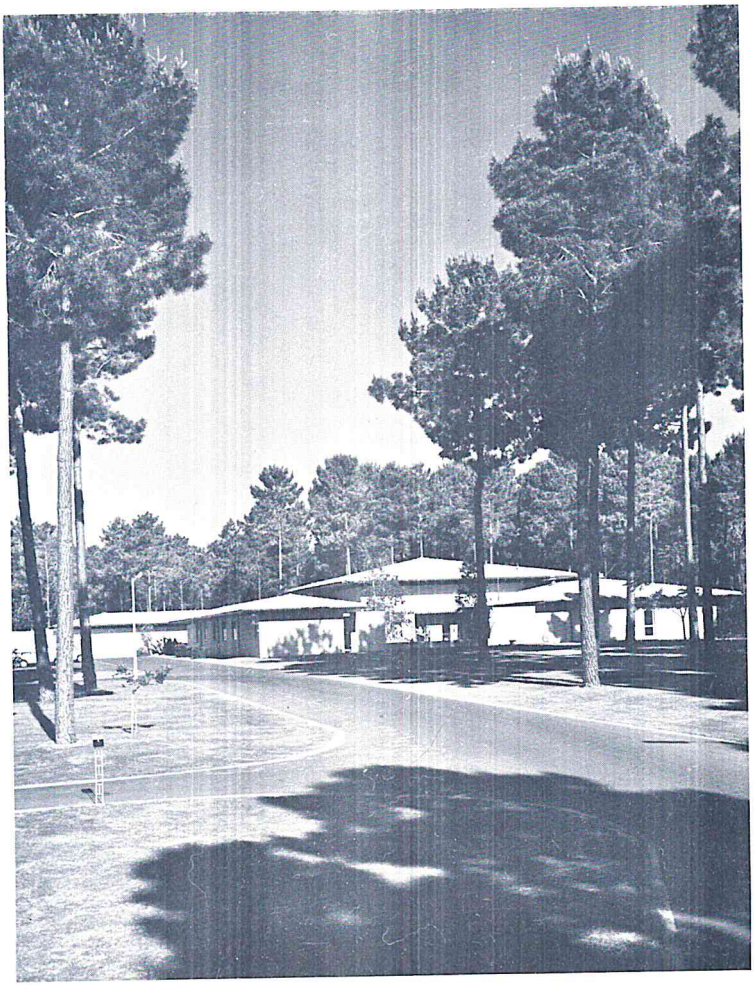
Though eradication of this disease is not possible at this stage, its rate of spread can be markedly reduced by appropriate forest hygiene, and its effects upon forest productivity can be offset by rehabilitation with resistant species. Much remains to be learnt about *Phytophthora* root rot and further research will be needed before foresters are happy that every possible measure is being used to safeguard our valuable forest resources.

The first step is to ensure that soil containing infected plant material is not transported into healthy forests, farms or gardens within the State. The timber industry has already voluntarily adopted precautionary logging hygiene but this matter extends beyond the responsibility of sawmillers and foresters and every user of the forest, Government bodies, tourists and travellers alike must co-operate in the control of this disease, thereby accepting their share of responsibility towards conservation of the forest resources of the State.

KNOWN RESISTANT SPECIES

The following are species which, to date, have been found quite resistant to the effects of *Phytophthora cinnamomi* in both pot and field screening trials. These species are being tested extensively in field trials to gauge their performance in our environment. A number of species have demonstrated above average growth rates on suitable sites.

Botanical Name	*Common Name*
Pinus elliottii	Slash pine
P. pinaster	Maritime pine
P. taeda	Loblolly pine
Eucalyptus botryoides	Bangalay
E. cladocalyx	Sugar gum
E. globulus	Tasmanian blue gum
E. goniocalyx	Mountain gum
E. maculata	Spotted gum
E. microcorys	Tallowwood
E. resinifera	Red mahogany
E. robusta	Swamp mahogany
E. saligna	Sydney blue gum



Institute of Forest Research and Protection, Como—the Forests Department's main research centre.

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Back cover—Healthy virgin jarrah forest near Dwellingup