HIGHLIGHTS FROM THREE DECADES OF SCIENTIFIC RESEARCH INTO DIEBACK DISEASE

Although many scientists in Western Australia have contributed to an understanding of the cause, mechanisms and effects of dieback disease, most of the knowledge obtained was from research conducted at the Dwellingup and Como Research Centres of CALM and its predecessor, the Forests Department of Western Australia. During the period under review almost all of the research was based in the jarrah forest.

During the period 1980-87 in particular, research was stimulated by funding provided by a Foundation for Jarrah Dieback Research. This Foundation was financed by the alumina and timber industries, largely in response to concerns that bauxite mining would intensify dieback and that the quality of the water supply from the jarrah forest would deteriorate if disease extended into catchments with high salt hazard.

Only the major achievements have been listed here. Further information is available in the following:

- Shearer B.L. and Tippet J.T. 1989. Jarrah dieback: the dynamics and management of *Phytophthora cinnamomi* in the jarrah (*Eucalyptus marginata*) forest of South-western Australia. *CALM Research Bulletin* **3** (76pp).

- Shearer B. 1990. Dieback of native plant communities caused by *Phytophthora* species - a major factor affecting land use in South-western Australia. *Land and Water Research News* **5**: 15-26.

- Shea, S. 1991. Dieback disease in Western Australia. *CALM Briefing Paper* 5/91 (10pp).

Major Findings

- The association between mortality of jarrah and infection by the fungus *Phytophthora cinnamomi* was established unequivocally in 1965. Before this breakthrough the cause of the dieback first observed in jarrah forest in the 1920's was a mystery.

- *Phytophthora cinnamomi* is not native to Western Australia. This means that none of the plant species present have had the opportunity to evolve in association with the fungus, and over time develop adaptations to withstand infection.

- As a result Dieback Disease reduces plant species diversity. Many plant species belonging to the families Proteaceae, Epacridaceae, Dilleniaceae, Xanthorrhoeaceae and Fabaceae are susceptible.

- Resistant species such as sedges and grasses then become commoner and the proportion of the marri trees in jarrah forest increases. The stand no longer has the appearance of jarrah forest.

- *Phytophthora* fungi can infect and kill a large number of native plant species. Jarrah is the only eucalypt species present in the forest killed by *Phytophthora cinnamomi*.

- At least 5 other species of *Phytophthora* are present in Western Australia. One of these species, *Phytophthora citricola*, is of concern as marri is susceptible to infection by it.

- *Phytophthora cinnamomi* is distributed widely throughout the jarrah forest but shows greater impact in the western portion, particularly on water-gaining sites and on upland sites with impeded drainage.

- Other factors that influence the expression of the disease include climate, weather, vegetation, soil, topography, time since infection, and the extent of disturbance by humans.

- The life cycle and biology of *Phytophthora cinnamomi* in the soil and in plant tissue in the jarrah forest has been elucidated. This is the essential first step in understanding the biological processes that result in the patterns observed in nature.

- Soil moisture and temperature influence the survival of *Phytophthora cinnamomi* throughout the year. Free-draining, well-shaded soils are unfavourable to the fungus. In the jarrah forest these soil types are interspersed with sites favourable to the fungus.

- Moist conditions facilitate dispersal of *Phytophthora cinnamomi.* Nevertheless *Phytophthora cinnamomi* can be dispersed in infested soil, certainly by humans and probably by native and introduced animals.

- In the jarrah forest *Phytophthora cinnamomi* can occur at depth in the soil profile, in contrast to elsewhere in the world, where it inhabitats only surface soil.

- Transient perching of water in upland jarrah forest facilitates survival and dispersal of the fungus, infection of the host plant, and impact of the disease.

- Floristic composition of the understorey influences survival of the fungus during summer in jarrah forest soils. *Banksia grandis* is especially significant in this regard. *Acacia* species are antagonistic to the fungus because they promote changes to the microbial, physical and chemical environment of the soil.

- Some soils harbour more micro-organisms antagonistic to *Phytophthora cinnamomi*. For this and other reasons, the jarrah forest is a mosaic of hazard types ranging from low hazard fertile red loams to high hazard infertile sandy gravels.

- Girdling of the vertical tap root system of jarrah by the fungus interferes with uptake of water from deep within the soil. This leads to desiccation, crown decline and eventually death.

- The interaction between fungus and host plant is not one-sided, as jarrah can resist the advance of the fungus in its roots. The outcome of this interaction is influenced strongly by seasonal and climatic conditions. For example, damage (lesions) is more extensive in jarrah trees with low water stress than in those experiencing high stress levels.

- Genotypes of jarrah resistance to *Phytophthora cinnamomi* have been discovered. These plants survive better than, and grow faster than, susceptible genotypes. A seed orchard of resistant jarrah genotypes has been established. Individual seedlings have also been propagated by tissue culture, planted in susceptible sites and have shown outstanding performance.

- *Phytophthora cinnamomi* causes not only death of jarrah trees but less visible and more subtle impacts, including reduced root development and decreased tree growth.

- Results of research have been integrated and incorporated into a system of disease management, involving rating the degree of hazard inherent in sites in the jarrah forest, reducing the risk of spread through the adoption of hygiene procedures, reducing the density of *Banksia grandis* in jarrah stands, and applying chemicals.

- By reducing the density of vegetation, dieback disease has increased the yield of water from jarrah forest catchments.

- Phosphorous acid, inoculated into jarrah, has been shown to contain the growth of *Phytophthora cinnamomi*.

- Radiata pine has been shown to possess genetically-based resistance to *Phytophthora cinnamomi*. Their performance after 12 years growth is vastly superior to that of susceptible pine trees. This *Phytophthora cinnamomi*-

resistance character has been incorporated into the radiata pine breeding program in WA.

Since 1987 most of CALM's research effort involving *Phytophthora* has been focussed on heaths and woodlands, particularly the Stirling Range and Fitzgerald River areas. These areas are particularly rich in plant species highly susceptible to dieback disease.