Chapter 5

PHYTOPHTHORA AND OTHER FUNGAL PLANT DISEASES

by B.L. Shearer[A] and F.E. Batini[B]

[A]Department of Conservation and Land Management, Dwellingup Research Centre, Dwellingup, W.A. 6213
[B]Department of Conservation and Land Management, Environmental Protection Branch, P.O. Box 104, Como W.A. 6152

Abstract

Diseases caused by introduced and native fungi are part of the biological environment of native plant communities throughout south-western Australia. Any development requiring the large scale modification of the natural environment must consider the impact that diseases have on susceptible plant communities and species and make a commitment to design appropriate disease management policies. These requirements have not been addressed in the ERMP for the Hill River Project. The proponents have only addressed the issue of dieback disease caused by Phytophthora species and no consideration has been given to other plant diseases that may occur in the area.

Dieback disease associated with Phytophthora species is briefly mentioned in the ERMP. Despite having acknowledged that the Lesueur area contains many susceptible and sensitive plant groups and that there is potential for the spread of the disease, the proponents have failed to address vital issues relating to the potential impacts of the project. These issues are: an assessment of the hazard to susceptible vegetation, an appraisal of the risk of infestation and spread of the disease, and a commitment to disease management in terms of prevention and monitoring.

The risk of introduction of plant diseases during the 30 year time frame of the project is high. If introduced, Phytophthora species would have a high impact on the vegetation, causing local extinctions of many plant species and massive changes in species diversity.

5.1 INTRODUCTION

Diseases caused by fungi are part of the biological environment of native plant communities throughout south-western Australia. Land use must take into consideration the occurrence and impact of soil-borne fungi, mainly *Phytophthora* species, although others like *Armillaria luteobubalina* and those which cause plant cankers need to be considered.

Proposals for development within the Lesueur area, like the Hill River Project, need to take into account the occurrence of plant diseases and the significant impacts they can have on native vegetation. A clear understanding of the biology and impacts of such diseases on the biological environment in a local or regional context, along with an assessment of how they will be managed and monitored if introduction occurs, would be the minimum requirement needed to assess the likely impact of such a project in the Lesueur area. The proponents of the Hill River Project have failed to address these issues adequately in their ERMP.

5.2 PLANT DISEASES OF THE NORTHERN KWONGAN - A REVIEW

Before an assessment of the proponents treatment of the plant disease issues, as presented in the ERMP for the Hill River Project can be made, it would be appropriate to discuss aspects of our understanding of the diseases in the northern kwongan and in particular the Lesueur area which are of relevance to the project. This review follows on from Hill's (1990) report, updating information where new data have become available. It also provides information on aspects of the biology of *Phytophthora* species which is relevant to any discussion on the impacts of such a project. In addition, this review provides information on two other plant diseases caused by fungi which have the potential to have significant impacts on the flora of the Lesueur area.

5.21 Dieback diseases caused by soil-borne *Phytophthora* species

Dieback disease caused by soil-borne *Phytophthora* species is a major threat to the ecology and

conservation of susceptible plant communities in south-western Australia (Shearer 1990). Four species of *Phytophthora* have been isolated from patches of dying native vegetation within a 30 km radius of the proposed Hill River Project (Hill 1990, Department of Conservation and Land Management 1990, Figure 5.1). They are *P. cinnamomi*, *P. citricola*, *P. megasperma* var. *megasperma* and *P. nicotianae* var. *parasitica*. At least two areas infected with *P. citricola* occur within 10 km of the proposed project.

The following summarizes key aspects of the biology of *Phytophthora* species in south-western Australia relevant to the Lesueur area and statements made by the proponents within the ERMP:

i. *Phytophthora* species have been introduced into the south-west of Australia (Podger 1972; Shearer and Tippett 1989). Seven taxa of *Phytophthora* have been isolated from dying native vegetation in this State (Shearer 1990).

ii. Humans have been the main agents of dispersal through the movement of infected moist soil and plant material. Operations involving disturbance and movement of soil have a high risk of introducing and spreading *Phytophthora* species.

iii. Spores of the fungi are also passively dispersed in water. Inoculum can be dispersed in lateral seepage of water within 5 m of the soil surface and in overland flow following introduction of the fungus into a site. Activities favouring sub-surface seepage and overland flow of water through disturbance and ponding of water have a high risk of introducing and spreading *Phytophthora* species.

iv. *Phytophthora citricola*, *P. megasperma* var. *megasperma* and *P. nicotianae* var. *parasitica* are homothallic and readily produce thick walled oospores that survive unfavourable conditions. *Phytophthora nicotianae* var. *parasitica* also readily produces resistant chlamydospores. These spore types enable the *Phytophthora* species to persist for long periods.

v. All the *Phytophthora* species recovered from native plant communities kill a wide range of plant species; the flora of the Lesueur area, particularly the area surrounding the proposed mine and power station contains a large number of susceptible species (Hill 1990).

Our understanding of the distribution and biology of *Phytophthora* species north of Perth is very incomplete. Current knowledge of the distribution of the disease can quickly change as a result of continuing surveys. For example, recent isolations of *P. cinnamomi* and *P. citricola* (Figure 5.1) have greatly extended the known distribution of these *Phytophthora* species.

North of Perth, the occurrence of dieback disease caused by *Phytophthora* species is consistently associated with sites near roads which are prone to seasonally wet conditions (Department of Conservation and Land Management 1990; Hill 1990). This suggests that *Phytophthora* species are probably recent introductions into the area. Infected soil and gravel carried by vehicles and machinery would be the main source of introduction. Seasonally wet sites are usually the first infected because of high soil moisture conditions which are favourable for survival, sporulation and dispersal of the pathogens and infection of host tissue.

Once established in the most susceptible sites, *Phytophthora* species have the potential to infect neighbouring areas. At Wanneroo and in the Moore River National Park, infection by *P. cinnamomi* has spread from seasonally wet locations and is now destroying the surrounding *Banksia* woodlands (Hill 1990; Shearer and Hill 1989). The current distribution and impact could therefore underestimate the potential impact of the *Phytophthora* species north of Perth. Protection of healthy areas from *Phytophthora* infection must therefore have a high priority.

5.22 Disease caused by *Armillaria*.

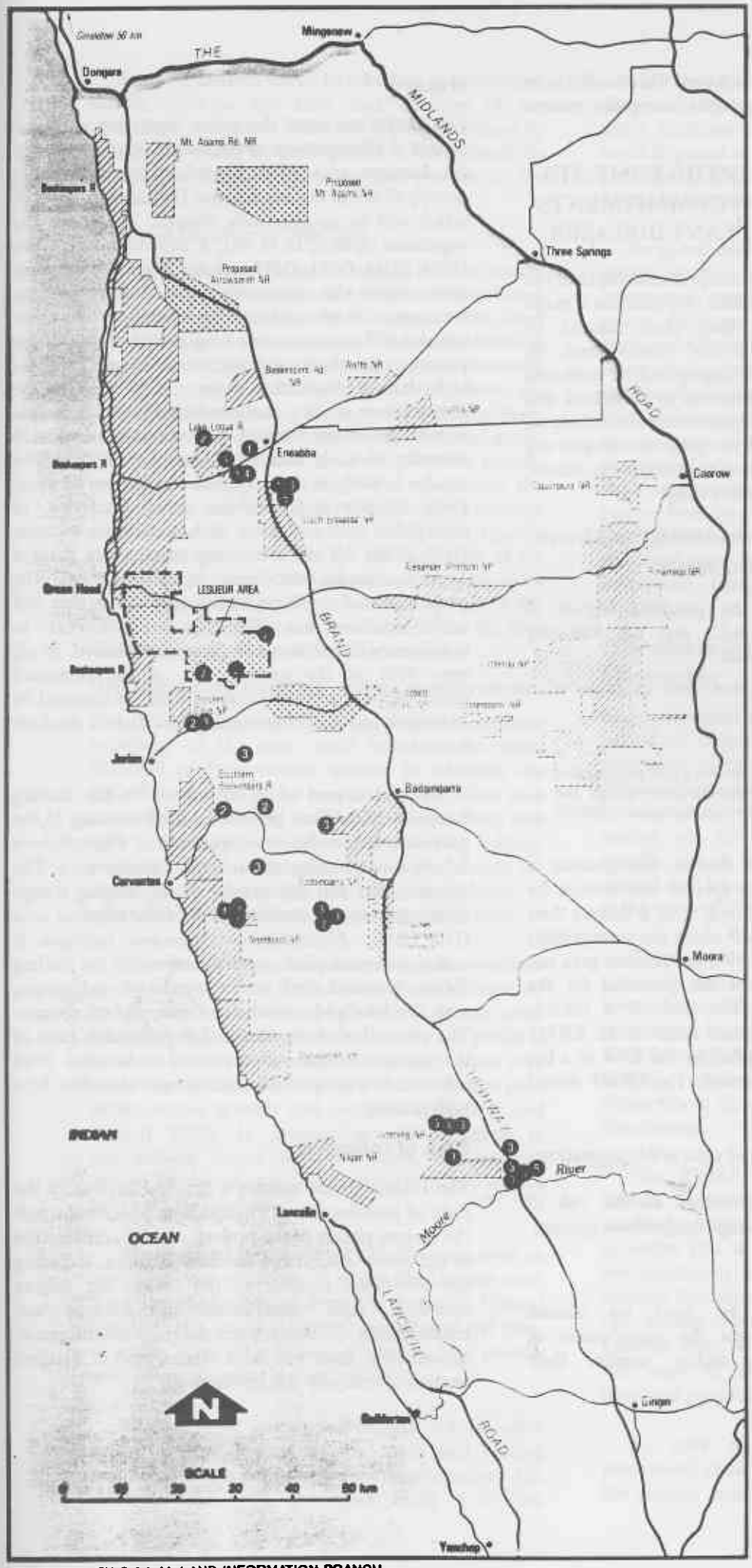
Armillaria luteobubalina is a widespread primary pathogen occurring in native plant communities throughout south-western Australia. This native pathogen has not been found north of Yanchep. However, the present northern limit for *A. luteobubalina* is probably more a reflection of the limited number of surveys than of the true distribution of the pathogen. *Eucalyptus wandoo* is very susceptible to infection and dies once the pathogen reaches the collar (Shearer and Tippett 1988). This species is a major component of the woodland vegetation associations present within the Lesueur area and is an important source of nesting hollows for a variety of bird species, including Carnaby's Black-Cockatoo.

5.23 Diseases caused by canker fungi

The major canker-causing fungus in Western Australia is *Botryosphaeria ribis*. This fungus is an aggressive pathogen causing cankering of the aerial parts of a wide range of woody plants in the Northern Hemisphere. In native communities of south-western Australia, *B. ribis* causes cankers in *Eucalyptus* and *Banksia* species, and a wide range of other woody plants. The spores are air-borne and hosts can be predisposed to infection by water stress and air pollutants. Shearer *et al.* (1987) suggest that environmental stress is also a factor favouring infection of some plant species by *B. ribis*.

The fungus *B. ribis* has been isolated from cankers associated with branch dieback of *Banksia attenuata*

Figure 5.1
PHYTOPHTHORA SPECIES NORTH OF GUILDERTON

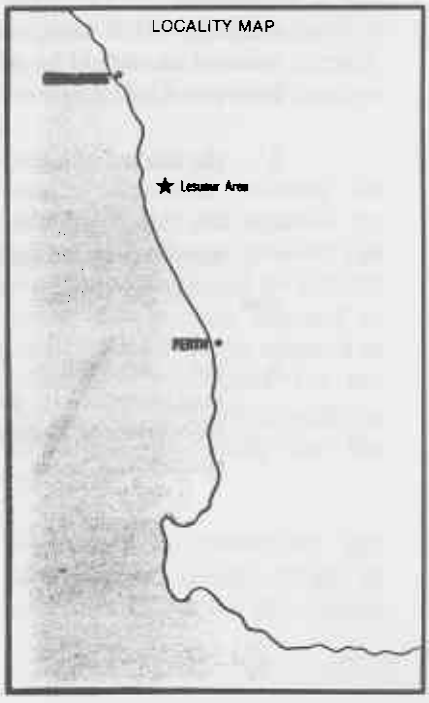


LEGEND

- Major Road
- Minor Road
- Study Area
- Existing National Park, Nature Reserve
- Existing "other" Conservation Reserve
- Proposed National Park, Nature Reserve
- Lesueur Area

Occurrence/Species

1. *Phytophthora cinnamomi*
2. *Phytophthora citricola*
3. *Phytophthora megasperma var megasperma*
4. *Phytophthora megasperma var sojae*
5. *Phytophthora dreschleri*
6. *Phytophthora nicotianae var parasitica*



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and *B. menziesii* on Banovich Road. This locality is on the eastern edge of the proposed conservation reserve at Lesueur.

5.3 ASSESSMENT OF THE ERMP, ITS CONCLUSIONS AND COMMITMENTS IN RELATION TO PLANT DISEASES

The ERMP does not assess the potential effect of the Hill River Project plant diseases. No mention is made of plant diseases other than those caused by *Phytophthora* species. Stress factors such as disturbance, drought, waterlogging and air pollution can predispose plants to infection by *Armillaria* and canker fungi. Disease management should include an evaluation of the effects of the proposed project not only on *Phytophthora* caused disease but on disease caused by *Armillaria* and canker fungi.

5.31 Dieback diseases caused by soil-borne *Phytophthora* species

The ERMP considered the potential impact of *Phytophthora* in Section 6.2.3 and the following general statements are relevant:

> "The potential for spread from these infestations is recognized." (ERMP p. 6-3)

and

> "Vegetation of the Hill River area has a high proportion of the most susceptible and sensitive plant groups and Phytophthora is widely distributed in the region." (ERMP p. 6-3)

ERMP Section 6.3 on disease management is vague and generally lacking specific information for the type of operations proposed. This is despite their own statements in the ERMP about the susceptibility and sensitivity of the flora within the Lesueur area and despite their recognition of the potential for the spread of this disease. This lack of a suitable treatment for the plant disease issue in the ERMP conflicts with it being identified by the EPA as a key issue which should be addressed. The ERMP should have provided details on:

1. the hazard of infection of susceptible vegetation;
2. the affect of the operations on the risk of introducing and spreading *Phytophthora* species;

and

3. the procedures to be used for disease management to prevent the introduction of *Phytophthora* species and/or monitor their spread.

Hazard

Hill (1990) has rated the major vegetation types for hazard if *Phytophthora* species were introduced into the Lesueur area. High hazard plant communities occupy 40.8% of the impact zone (Figure 1.1), some of which will be progressively cleared. These are the vegetation types C, D, H, M1, X and the mosaic types DEH, FGH, DFH, DFG and AE. High hazard plant communities also occur adjacent to and down-slope from areas where earth-moving machinery and other vehicles will operate over a long period of time if the project proceeds. Susceptible species dominate these high hazard vegetation types, and infection by *Phytophthora* species characteristically results in loss of over 50% of the biomass and irreversible decline in diversity of such areas. Infection by *Phytophthora* species is likely to cause localised extinction of many plant species and, perhaps, total extinction of susceptible local endemics, such as *Banksia tricuspis* (Hill 1990). All the other vegetation types (except Type K, wandoo woodland) in the area near the project are of medium hazard and these also will suffer significant loss of species and a decrease in biodiversity if the disease becomes established. In all, over 90% of the eastern end of the proposed conservation reserve at Lesueur, that was mapped by Martinick and Associates (1988) is of high or medium hazard.

Current impact of *P. cinnamomi* in the Stirling Range National Park provides a stark warning of the potential deleterious consequences of *Phytophthora* infection on the vegetation of the Lesueur area. The climate, soils and topography of the Stirling Range National Park are similar to that of the Lesueur area (Hill 1990). *Phytophthora cinnamomi* infection is reducing diverse plant communities within the Stirling Range National Park to impoverished sedgelands, with the localised extinction of many plant species. The protection of the diverse, but vulnerable flora of the proposed conservation reserve at Lesueur from infection by *Phytophthora* species must therefore be a high priority.

Risk of Infection

The ERMP should contain a detailed analysis of the risks of introduction of *Phytophthora* species through the various phases of the project, such as construction of the power station and ancillary facilities, including the blowdown pipeline to the ocean, the mining operation, road construction and haulage and rehabilitation. Similarly, when the route for the power transmission lines has been determined a detailed analysis of risks will also be required.

Such an analysis needs to take into consideration factors such as the scale and duration of the operation, changes to the local hydrology caused by the operation and the areas placed at risk through the interactions between hydrology and position in the landscape.

Scale and Duration of Operation

The construction of the power station and the mining operations will result in massive disturbance associated with the movement of large amounts of soil and continual extensive use of large earthmoving machinery. Experience in south-western Australia and in other parts of Australia has already shown the high risk of introducing and spreading *Phytophthora* species associated with these types of disturbances. The proponents need to clearly outline the specific procedures they plan to implement to prevent the introduction and spread of *Phytophthora*. Particular attention needs to be given as to how the specific procedures will be effective for the large scale of the operations proposed. Consideration also needs to be given to how the specific procedures to reduce the risk of infection will operate over the 30 year life time of the mine and when it is decommissioned.

Hydrological and landscape position considerations

The ERMP does not discuss how the surface hydrology of the area could influence the rapid dispersal of *Phytophthora* species. In addition, the ERMP does not consider how various operations such as roading, mining and overburden dumps along with their subsequent rehabilitation and the holding, evaporation and sedimentation ponds may change the surface and near-surface hydrological balance to affect site susceptibility to *Phytophthora* infestation.

Dispersal of *Phytophthora* species in near-surface seepage and overland flow of water would be favoured by the soils and topography of the Lesueur area. Dispersal of *Phytophthora* at depth in the soil profile is favoured by lateral near-surface seepage of water over impeding layers of duricrust, clay, rock or gravel pans within course gravelly and sandy soils (Shearer and Tippett 1989). In conjunction with dispersal in near-surface lateral flows of water, *Phytophthora* species can be active in the water table up to 5 metres below the soil surface.

As described in the ERMP, shallow soils over an impeding layer predominate within the Lesueur area. Even the sands that occur on the Banovich Upland landform unit are underlain by impeding gravel pans. In addition, the steep slopes and shallow hard gravelly soils favour dispersal in overland flow.

Changes in the hydrological balance in areas below active pits, overburden dumps, roads and holding ponds can favour near-surface seepage of water. The shallower the soils, the more likely it is that near-surface seepage will be increased below the proposed activity. Enhanced near-surface seepage of water increases site susceptibility to infection and rapid dispersal of *Phytophthora* species should they be introduced. The wetter soil environment can also favour host infection and disease intensification.

Proposed mining areas and roads occupy elevated points in the landscape, providing high risk of infection in overland and near-surface seepage of water. Proposed mining activities would directly impinge on three major catchments (Coomallo Creek, Cockleshell Gully and Munbinia Creek), which together drain the bulk of the area containing rare and vulnerable vegetation. A fourth catchment present in the proposed conservation reserve at Lesueur, Stockyard Gully, will also be affected by the proposed mine sites on private land to the north of the proposed reserve boundary. Every opportunity, therefore, exists for *Phytophthora* species to rapidly contaminate the heart of the proposed conservation reserve if introduced, particularly if Cockleshell Gully were infected.

Procedures for Disease Management and Monitoring

General statements in the ERMP recognize the high hazard of *Phytophthora* infection to the vulnerable vegetation of the Lesueur area, the occurrence of *Phythophthora* species in the area and the potential for the spread of infection. Despite this, the short section on disease management fails to provide specific details on how effective monitoring and control can be accomplished, particularly in relation to the size and duration of the proposed project.

There is no assessment of the research and resources needed for effective disease management for the large scale and duration of the operation. The proponents have made no firm commitment in the ERMP to undertake or fund the required research to develop procedures to control and monitor *Phytophthora* diseases, especially in areas of massive disturbance.

The ERMP places considerable reliance on CALM to provide the necessary information on monitoring and disease control. The proponents fail to realise that the procedures developed by CALM are specifically for native communities exposed to minimal disturbance and cannot be simply adapted to the massive scale disturbance proposed for the Lesueur area. New disease management procedures will need to be developed specifically for the proposed project if it proceeds.

As part of the evaluation procedure, the proponents should have provided specific details of the disease management procedures for the various

phases of the operation together with the likely consequences should infections occur and control measures fail.

In the ERMP the proponents have stated that: "Disease management procedures are in place, and have been followed during exploration work" (Section 6.2.3). It has been documented by CALM, however, that on one occasion the proponents' disease management procedures failed. This breakdown occurred when commercially grown potted seedlings were used in an attempt to rehabilitate an old drill pad. The seedlings and potting medium were not screened to determine if dieback disease was present.

This breakdown in disease management occurred during the relatively short exploration phase and we are concerned at the possibility of future breakdowns occurring during the life of the project (30 years). This incident highlights the problems that the proponents face in implementing an adequate disease management and monitoring program and how easily such a program can break down, no matter how genuine the intentions of the proponents may be.

In relatively undisturbed situations, accurate monitoring of disease occurrence depends on a complexity of many factors. Accurate monitoring over large, highly disturbed areas over long periods of time is extremely difficult. The proponents have failed to provide details on how accurate monitoring can be accomplished, and what procedures will be followed should plant diseases be detected.