ABSTRACT

In a survey of rehabilitated bauxite mines in south-west Western Australia, *Phytophthora cinnamomi* was isolated from the collar, but not from the root system of dead and dying *Eucalyptus marginata* (jarrah) seedlings. Surface water ponding occurs in rehabilitated mines from autumn through to spring, and infected collars were commonly associated with ponding. This suggested that *P. cinnamomi* infects seedlings directly through periderm at the collar. The objective of this project was to ascertain whether infection by *P. cinnamomi* through periderm was possible, to study the disease in seedlings infected in this manner, and the methods by which *P. cinnamomi* circumvented the periderm to infect the seedlings.

An inoculum receptacle was designed to simulate water ponding around the main stem of jarrah seedlings, and into which zoospores could be introduced. Under controlled glasshouse conditions in December (early summer) it was demonstrated that zoospores can infect through the stems of non-wounded and wounded jarrah seedlings. This was confirmed in a rehabilitated bauxite mine in May/June (late autumn/early winter), when ponding is most prevalent and sustained. In the field trial, *P. cinnamomi* was isolated from stems of non-wounded and wounded seedlings 3 weeks after inoculation. However, lesions did not develop in the non-wounded seedlings, or in most of the wounded seedlings.

Another field trial examined the long-term prognosis for jarrah seedlings infected by zoospores at the collar. Within 3-6 months of either winter or spring inoculations, 7% of the seedlings died. In a further 6% of seedlings, the inoculated shoot died but the seedling survived through coppice growth from the lignotuber. As time from inoculation increased the reisolation of the pathogen from surviving seedlings decreased. Seedlings were severely water stressed during the summer with pre-dawn
xylem pressure potentials as low as -1.5 MPa. In two post-summer harvests an intensive baiting and wetting regime was required to reisolate the pathogen from inoculated seedlings.

Histological studies were undertaken to investigate: the origin and nature of jarrah periderm; the effects of ponding on jarrah tissue; and the methods by which *P. cinnamomi* invades jarrah through periderm.

The production of periderm was described from its origin in the pericycle of the roots in 4-week old jarrah seedlings, through to rhytidome production in lignotuberous seedlings and 3- to 4-year old saplings. The first periderm in jarrah stems occurred internal to the primary phloem tissue, but it eventually migrated to a more superficial position in the stem. The first periderm consisted of phellogen, phelloderm, and a single type of phellem which was thin-walled and suberised. Between sequent periderms a second type of phellem formed, the cells of which were thick-walled and lignified. The formation of spongy rhytidome occurred when secondary phloem tissue underwent gross expansion after isolation between layers of periderm.

Jarrah stems took up water in the region of inundation, and there was an increase in the frequency, but not size, of intercellular spaces after 5 weeks of localised ponding. There was also an increase in size of non-tanniferous parenchyma cells, but no overall increase in stem diameter. There was a measurable quantity of soluble carbohydrates in the pond liquid after 1 week, which had significantly increased after 5 weeks.

Zoospores of *P. cinnamomi* were attracted primarily to sites of axillary shoot emergence in jarrah stems. Rapid and extensive infection and colonisation occurred through the new tissue of the emerging axillary shoots. Zoospores also bound randomly to other parts of the stem and were occasionally observed to attempt intercellular
penetration of thin-walled suberised phellem, but extensive infection and colonisation was not observed as a result of such interactions. Zoospores were not preferentially attracted to either stem or leaf stomata, although penetration was occasionally observed through stem stomata. Zoospores were not attracted to lenticels and there was no evidence of infection through lenticels.

The results of the project are discussed in the light of a ‘disease tetrahedron’, where mining and rehabilitation have resulted in a highly altered environment in which the host and pathogen operate. Conditions peculiar to rehabilitated sites are discussed in terms of their ability to exacerbate or reduce disease severity.