WESTERN AUSTRALIA

Richard Robinson **(Compiler)**
Science Division
Department of Environment and Conservation (DEC)
Brain Street
Manjimup, WA 6258

PLANTATIONS

Pinus radiata

Diseases

No major problems reported.

Eucalyptus globulus

Diseases

No major problems reported. Research at Universities continues on *Mycosphaerella* leaf blights (MLB) in *Eucalyptus globulus* plantations (see Research and Development). Research has also commenced on the potential risks posed by MLB and associated pathogens in plantations to native remnants.

Phaeophleospora eppicocoides, a common pathogen causing leaf blight on eucalypts in the Eastern states and elsewhere in the world has been reported for the first time in western Australia (Sarah Jackson, Murdoch University)

MANAGED NATURAL FORESTS

Jarrah forest (*Eucalyptus marginata)*

Diseases

No new major pathological problems reported, but severe frost damage was reported at several locations (see Urban and Rural). Management and survey of *Phytophthora* root disease in jarrah (*Eucalyptus marginata*) forests continues to command attention (see Forest Health Surveillance and Diagnosis, and Research and Development).

Karri forest (*Eucalyptus diversicolor*)

Diseases

No new major pathological problems reported. Management of *Armillaria* root disease in karri (*Eucalyptus diversicolor*) continues to command attention.

NURSERIES

No major problems have been reported in either hardwood or conifer seedlings in nurseries.

NATIVE PLANT COMMUNITIES

Diseases

250 hectares sprayed in the South Coast Region (near Albany, in the Stirling Ranges, at Esperance), 15 hectares at Mt Lindesay, and about 50 hectares near Busselton. Targets included the critically endangered species *Banksia brownii*, *Dryandra montana* and *Andersonia axilliflora* in the Stirling Ranges, and *Lambertia echinata ssp. occidentalis* at Busselton (R. Smith, DEC)

URBAN AND RURAL

Diseases

Mundulla Yellows: Monitoring of the occurrence and symptom development of Mundulla Yellows (MY) in WA has continued. Symptomatic eucalypts (both planted trees and remnant native trees) have been observed in several additional locations. Spread of symptoms within affected sites appears generally to be slow. The observed distribution of MY symptoms in the south of the state is from north of Geraldton to Esperance, and it occurs on alkaline coastal sands as well as on acid soils including laterites. As in South Australia, MY is only seen in vegetation in disturbed sites or modified landscapes such as road verges and medians, parks and gardens, and in parkland or paddock remnant stands. Symptoms have not been observed within undisturbed native forest or woodland stands in WA. CALM is an Industry Partner in a three-year ARC Linkage project at The University of Adelaide, "A comparative study of the distribution and spread of potential molecular markers for Mundulla Yellows disease." (M.Stukely, DEC).

Tuart Decline: In recent years, tuart (*Eucalyptus gomphocephala*) woodland within Yalgorup National Park, south of Mandurah has suffered a severe decline in health. Research carried out by The Tuart Health Research Group (THRG) has shown from surveys of tuart across the range, that the major decline syndrome is confined to Yalgorup N.P. These sites show a high correlation with higher rainfall, finer and shallower soils, higher groundwater alkalinity and salinity, and a greater rate of groundwater salinity increase (T. Edwards - Edith Cowan University). Critical water potentials for loss of xylem function were rarely breached in any size class or location

within YNP over the past 20 months (P. Drake - Edith Cowan University). Fine feeder root necrosis has been observed on trees showing decline and a number of *Peronospora-like* and *Pythium* spp. have been isolated from these roots (P. Scott, Murdoch University). There have been fewer mycorrhizal pads associated with fine roots of declining trees c.f. healthy trees and foliar analysis has shown that tuart within Yalgorup NP have low levels of trace elements such as Zinc (H. Eslick - Murdoch University). Studies on the role of fire and competition indicate tuart seedlings growing on ashbeds exhibit greater rates of survival and growth compared to those grown off ashbeds. Canopy health of the majority of tuart has increased following a controlled burn within Yalgorup NP (R. Archibald, Murdoch University). Trunk injections of a complete nutrient formula have shown promising results in a trial established within the national park and monitored over the previous 12 months (P. Barber, Murdoch University).

Wandoo Decline: In recent years the health of Wandoo (*Eucalyptus wandoo*) woodland has been affected by crown decline, sometimes resulting in the death of declining trees. The Wandoo Recovery Group was established in 2003, and a Wandoo Strategy and Action Plan developed. Insects and fungal pathogens are associated with the decline, but rainfall deficit, salinity, waterlogging, altered fire regimes and agricultural practices are also thought to be contributing to the decline. Government and community based action is underway to map the extent of decline, and monitor trends in the health and condition of wandoo forests (Wandoo Recovery Group, Bulletin No.2, March 2005). Evidence from recent research shows cankers are more severe on declining trees and suggests an interaction between borers and decay-fungi is causing the decline of canopies (Hooper and Sivasithamparam. Can J For. Res. 35 (2005): 2589-2602).

Rudis decline: Rudis (*E. rudis*) has shown varying degrees of symptoms of crown decline throughout its range for many years. Collaborative research between Murdoch University, Serpentine-Jarrahdale Local Council and ALCOA has been initiated to investigate the efficacy of trunk injections to reverse canopy decline. Trials include treatments of phosphite, complete nutrient and also an insecticide. A trial established in spring 2005 at Pinjarra is currently in progress. Assessments of canopy health are focusing at the canopy, branch and leaf scale and the incidence and severity of a range of insect and fungal pests. Results will be available later this year (2006) (P. Barber, Murdoch University).

Foliar and stem pathogens: Post-fire regenerating tuart has been severely defoliated by *M. cryptica* in Yalgorup National Park, Ludlow State Forest and Yanchep National Park and has contributed to tree deaths in Yalgorup National Park. Trials monitoring the incidence and severity of *M. cryptica* and insect pests on regenerating seedlings of *E. gomphocephala* have been in progress over the last 12 months. These are being combined with growth data and soil characteristics (P. Barber, Murdoch University). A study (by K. Taylor, Murdoch University) investigating the diversity of *Botryosphaeria* spp. in tuart woodlands has identified 5 new species on a range of hosts, including tuart, jarrah, acacia, quandong and banksia. These fungi are currently being described. It is

thought that one of these species may be responsible for the 'top-down' deaths of ***B. grandis*** in the Yalgorup N.P. Pathogenicity trials will commence shortly to determine whether this is the case (P. Barber, Murdoch University). An increased occurrence of 'flagging' and thinning of the crowns of ***Agonis flexuosa*** has also been noticed within Yalgorup N.P. and near the Busselton region over the past 12 months. An unknown fungus has been isolated from symptomatic tissue within the national park. Studies are underway to determine the identity and pathogenicity of this fungus (P. Barber, Murdoch University).

Frost Damage: In mid-June 2006, extensive frost damage has occurred throughout the SW of WA. Damage resulted from a combination of low temperatures and low humidity. On the coastal plain south of Perth temperatures in mid-June dropped to -3°C at Busselton and to -5°C and -6°C inland at Collie and Wandering, and record low rainfall was recorded for June throughout the SW. At Lake Clifton, in Yalgorup NP, the damage was confined to peppermint (***Agonis flexuosa***), and on the Albany Hwy at Glen Eagles and the Brookton Hwy at Dale both mature and juvenile jarrah was affected. Minor damage to marri at Mt Cooke and wandoo at Glen Eagles was also reported. Reports so far have been ***ad hoc*** and further surveillance and monitoring is necessary to determine the full extent and range of damage, but damage so far appears to be restricted to foliage and no deaths have been reported (R. Robinson and A. Wills, DEC).

Frost Damage to ***Agonis flexuosa*** (peppermint) at Lake Clifton, June 2006 (A. Wills, DEC).

Forest health surveillance and diagnosis

Dieback mapping and management

To assist the planning of roading and harvesting operations undertaken by the FPC on DEC managed lands, a total area of 24,686 ha was mapped by accredited DEC interpreters for the presence of symptoms of dieback disease, caused by *Phytophthora cinnamomi*. This included 11,969 ha of previous mapping that was rechecked for further spread. Mapping and hygiene planning was also undertaken on a further 5,970 ha for the Parks and Visitor Services, Nature Conservation and Sustainable Forest Management Services, and 3,108 ha for external requests. Mapping for external clients included assistance to determine the current extent and model predicted future spread of dieback from point infestations in the Fitzgerald River National Park (Bell Track Project), and in the implementation of phosphite application trials (M. Rayner, DEC).

A major project to undertake dieback threat assessment and risk analyses for vegetation on the South Coast continued with the SCRIPT (South Coast Regional Initiative Planning Team) natural resource management group. This work has included the collation of biological assets, strategic disease mapping, predictive modelling of future disease spread, and estimation of threat and risk categories within a target area of approximately 1.9 million ha. (M.Rayner, DEC).

In the year to June 2006, a total of 1,475 samples were processed for *Phytophthora* identification by DEC's Vegetation Health Service (VHS). DNA sequencing has led to the identification of *Phytophthora inundata* which was isolated from a sample collected beneath a dead *Xanthorrhoea preissii* in the Southern Jarrah Forest in 2005. Further work is being done to test and identify various recent and historical isolates of unidentified *Phytophthora* from a range of locations and ecosystems. A small number of other tree health and nursery problems were investigated (M.Stukely, DEC).

A Forest Health and Vitality Surveillance and Monitoring program is in the initial stages of planning. An options paper has been prepared and submitted to the DEC Sustainable Forest Management Division for consideration (R. Robinson and J. Farr, DEC).

Research and Development

PLANTATIONS

Eucalyptus globulus

Forest health surveillance

Several projects at Murdoch University are focusing on eucalypt plantation health and risks to biodiversity of native forests in Australia. In the past 3 years, surveys have been

conducted in collaboration with State departments and private forestry companies in eucalypt plantations in QLD and NT. The surveys provide a framework for a database on disease already present in Australia. Several new fungal species have been found causing leaf diseases and these are currently being described. A database of exotic eucalypt diseases and their proximity to Australia and the risk they pose to Australia's forests and industry is being compiled. A number of diseases are of particular interest, *Phaeophleospora destructans*, *Coniothyrium zuluense* and *Cryphonectria cubensis*. Molecular markers have been developed for *P. destructans* and are already in existence for *C. zuluense* and *C. cubensis* (through collaboration with the Forestry and Agriculture Biotechnology institute in South Africa). These markers will be used to determine the origin, diversity and movement of potentially destructive eucalypt diseases. A project has been funded to test the susceptibility (in trials in Asia) of several tropical and sub-tropical eucalypt species to *P. destructans* and *C. zuluense* (T. Burgess, Murdoch University)

Study on the exchange of pathogens between native forests and bluegum plantations in Western Australia continued at Murdoch University and the new forestry CRC is studying the movement of Mycosphaerella spp. into WA and between forests and plantations. Several *Botryosphaeria* spp., endemic to WA have moved into the plantations. (T. Burgess, Murdoch University).

Kate Taylor (MU) completed an honours thesis on Botryosphaeria spp. associated with trees in healthy and declining tuart stands; identification, pathogenicity and potential role in decline. She found that *B. australis* was widespread and very pathogenic on most hosts. Several new endophytic species were also found and these are currently being described (T. Burgess, Murdoch University).

Diseases

Work under the following grants is in progress at Murdoch University (MU).

Collaborative Project - Murdoch University and the Tree Pathology Cooperative Program (TPCP - Sth Africa). The project 'New and emerging pathogens threatening the biodiversity of Australia's eucalypts' continues, and concentrats on some of the major eucalypt pathogens worldwide (*Phaeophleospora* spp. *Mycosphaerella* spp., *Botryosphaeria* spp. *Cryphonectria* spp.). The aim is to determine their origin, movement and the risk they pose to Australia's eucalypts (T. Burgess, MU and M. Wingfield, TPCP).

PhD Theses in progress at Murdoch University

Sarah Jackson: Taxonomy and biology of *Mycosphaerella* species found on *E. globulus*. (Supervisors: G. Hardy and B. Dell, MU)

Fransisco (Paco) Tovar: The cause of basal stem rot in second rotation *Eucalyptus globulus* plantations (Supervisors: T. Burgess, G. Hardy, MU and R. Robinson, DEC).

In 2005 a large-scale survey of the *E. globulus* 2nd rotation estate of WA was conducted to establish the incidence and likely causal agents of observed basal stem rots. Three main wood decay fungi were identified as possible causal agents of observed rots; *Trametes versicolor*, *Stereum hirsutum* and *Pycnoporus coccineus*. Additionaly, 2 commercial scale trials were set up to investigate the efficacy of a variety of fungal rot preventative treatments. In 2006 further surveys will be conducted, a pathogenicity trial will be set up, a population genetics survey of *T.versicolor* will be conducted and data from 2005 trials collated (F. Tovar, MU).

Stereum hirsutum fruiting on stump (left) and resulting basal rot in stump and coppice (right) of *E. globulus* (R. Robinson, DEC).

Vera Andjic: The movement of *Phaeophleospora destructans* throughout Asia, a potential threat to Australias forests and plantations (Supervisors: T. Burgess and G. Hardy, MU and M.Wingfield, TPCP).

Katherine Taylor: A detailed study of *Mycosphaerella cryptica* and *Mycosphaerella nubilosa* in Western Australia, focusing on the threat to native remnants. (Supervisors: T. Burgess, G. Hardy and P. Barber, MU, C. Mohammad, Forestry CRC and A. Carnegie, SF NSW).

Diseases of Boabs

In collaboration with Mike Winfield in South Africa Murdoch University has conducted a survey of fungi associated with boab (*Adansonia gregorii*) in Western Australia that will have a matching project in South Africa. Monique Sakalidis (PhD, MU) is taking on this work as part of her thesis.

Paulownia Plantations

Diseases of *Pawlonia.* (K. Bayliss, Postdoc MU). Funded by ARC LINKAGE.

MANAGED NATURAL FORESTS

Corymbia calophylla

Diseases

PhD Theses in progress at Murdoch University

Trudy Paap. (PhD submitted 2006). Canker fungi associated with deaths of *Corymbia calophylla* (marri) (Supervisors: G. Hardy, MU, B. Shearer, CALM and J. McComb, MU). Part funded by Forest and Wood Products Scholarship.

The impact of a canker disease of *Corymbia calophylla* (marri) in the southwest of Western Australia (WA) has been increasing since it was first observed causing decline and death of this species in the 1970s. Despite increasing concern, there has been very little research into the disease. This study examined the range of fungal species associated with healthy and diseased *C. calophylla,* and the pathogenicity of isolates obtained from these surveys. DNA sequencing confirmed that *Quambalaria cyanescens* and *Q. pitereka* are present in southwest WA, with the latter associated with leaf and shoot disease. A third group isolated from cankers represented a new species of *Quambalaria.* Comparisons of disease symptoms and conidiogenesis indicate this species is synonymous with *Sporotrichum destructor,* a fungus historically implicated in the canker disease described in the 1920s on amenity planted *C. ficifolia,* and the species is formally described as *Q. coyrecup*. Pathogenicity trials show *Q. coyrecup* is capable of causing significant lesions similar to those observed in natural infections, confirming it is the fungus responsible for the current canker disease. *Endothiella eucalypti* also caused significant lesions, though these were not typical of natural infections, which together with its frequent isolation from both healthy and diseased trees suggests it is an

opportunistic pathogen. The current cause of cankers in *C. calophylla* is the same as the fungus historically implicated in the canker disease described in the 1920s on amenity planted *C. ficifolia.* At that time it was described as an endophyte doing little or no damage in *C. calophylla.* It is of immediate importance to determine the factors potentially driving this decline, and develop control and management options (T. Paap, MU).

Jarrah forest (Eucalyptus marginata)

Diseases

Dieback-resistant jarrah (*Eucalyptus marginata*): Field trials of jarrah clones selected for resistance to *Phytophthora cinnamomi* are being written up. Trials of site preparation procedures for re-establishment of jarrah in dieback "graveyard" sites commenced in 2003 with further trials established in 2004, and promising levels of survival have been recorded in the critical first and second years. Final planting of a production seed orchard of dieback resistant jarrah clones at the Forests Products Commission's Plant Propagation Centre near Manjimup has been deferred pending the availability of clones. (M.Stukely, DEC).

Work under the following grants is in progress at Murdoch University (MU).

PhD Theses in progress at Murdoch University

Sarah Collins (PhD submitted 2006). Long term survival of *Phytophthora cinnamomi* in rehabilitated bauxite mines and adjacent *Eucalyptus marginata* forest. This project is looking at chlamydospore dormancy and saprophytic growth. (Supervisors, G. Hardy, MU and B. Shearer, DEC). Funded by ARC LINKAGE.

Kathryn Smith (PhD received Sept 2006). Saprophytic ability and long-term survival of *Phytophthora cinnamomi* in rehabilitated bauxite mines and adjacent jarrah forest. (Supervisors G. Hardy, J. McComb, MU and I. Colquhoun, Alcoa World Alumina). Funded by ARC LINKAGE.

Arunodini Jayasekera (PhD submitted 2006). Mechanisms of suppression of Acacia species on *Phytophthora cinnamomi* (Supervisors: B. Shearer, DEC, J. McComb and G. Hardy, MU)

Rodney Armistead. The impact of *Phytophthora cinnamomi* on different mammal guilds in the Darling Range of Western Australia (Supervisors: M. Garkaklis, DEC and G. Hardy, MU).

Michaela King . Genomic analysis of phosphite responsive genes from *Phytophthora* cinnamomi (Supervisors: G. Hardy, J. McComb, W. Reeve, P. O'Brien, MU).

Nathan Jardine. Is phosphite accumulation in the plant necessary to induce resistance? (Supervisors: P O'Brien, G. Hardy and J. McComb, MU).

Leila Eshraghi. The role of plant defense pathways in Phosphite induced protection of *Arabidopsis thaliana* from *Phytophthora cinnamomi* infection (Supervisors: P. O'Brien, G. Hardy and J. McComb, MU).

Nari Anderson. DNA based detection of *Phytophthora cinnamomi* from soil samples (Supervisors: P O'Brien, MU and I. Colquhoun, Alcoa World Aluminium).

Masters Theses in progress at Murdoch University

Mee Hua Wong. Characterization of phosphite responsive genes in *Phytophthora cinnamomi* and other *Phytophthora* species (Supervisors: P. O'Brien, G. Hardy, J. McComb, MU).

Honours projects in progress at Murdoch University

Melissa Bexley. Taxonomy, biology, ecology, pathology of *Phytophthora citricola*-like pathogen (Supervisors: K. Bayliss, G. Hardy, MU)

Shannon Dundas. Utilisation of *Phytophthora cinnamomi* infected habitats by honey possums (*Tarsipes rostratus*) in the Cape Riche area, Western Australia (Supervisors: T. Fleming, B.Wilson and G. Hardy, MU).

Chid Gilovitz. Screening *Lambertia* species for susceptibility and resistance to *Phytophthora cinnamomi* to develop a model plant system to examine resistance mechanism (Supervisors: G. Hardy, MU, B. Shearer, DEC, B. Bowen, MU).

Nicole Moore. Interaction of fire and *Phytophthora cinnamomi* on plant communities in the Stirling Range National Park, Western Australia (Supervisors: G. Hardy, B. Bowen, MU, B. Shearer, S. Barrett, DEC).

Department of Environment and Heritage funded projects at Murdoch University.

Enhancing the efficiency of phosphite with the addition/supplementation of other chemicals such as those known to be involved in resistance (Chief Investigators: G. Hardy, B. Dell, B. Bowen, P. O'Brien, M. Calver, J. McComb, Research Officer: J. Ellery).

Defence gene regulation by combined treatments with phosphite and inducers of systemic acquired resistance in the model plant *Arabidopsis thaliana* (PhD student: Patsy Stasikowski).

Does the physiological status of the plant at time of spraying affect the efficiency of phosphite? (Research Associate: D. Huberli).

Eradication of *Phytopohthora cinnamomi* from spot infections in a native plant community in Tasmania (Research Associate: W.Dunstan).

Eradication of *Phytophthora cinnamomi* from spot infections at Cape Riche, Western Australia. (Research Associate: W. Dunstan, Research Officer: N. Moore).

Department of Environment and Heritage Consultancies (MU).

A project to review current best practice approaches to the management of sites in Australia that are or could be threatened by *Phytophthora cinnamomi* (Chief Investigators: G. Hardy, E. O'Gara, B. Wilson, Scientific Advisory Group: K. McDougall, D. Cahill, T, Rudman, I. Smith, P. Gaddek, K. Vear)

Review of National Threat Abatement Plan (E. O'Gara, G. Hardy, K. Howard).

Karri forest (*Eucalyptus diversicolor*)

Diseases

Re-measurement of the impact of Armillaria root disease in the Warren Thinning Experiment, 20 years following treatment, was undertaken in 2005-06. Preliminary indications suggest that singe the last assessment (2000), there has been limited tree mortality and many bole scars have occluded (R. Robinson, DEC).

Wandoo Decline

In recent years the health of Wandoo (*Eucalyptus wandoo*) woodlands has been affected by crown decline, sometimes resulting in the death of declining trees. The Wandoo Recovery Group was established in 2003 and a Wandoo Strategy and Action Plan was developed, which included aims to support research, distribute information in the community and develop partnerships with stakeholders. Research strategies were based on two lines of research; (A) Abiotic factors (i.e. drought) and physiological response of Wandoo are impacting on its health directly; (B) Insect pests and pathogens are more

prevalent in recent years and causing severe damage to Wandoo canopies. The University of Western Australia is pursuing these lines of research. For "A" two projects are currently running: A PhD project is screeningtolerance of Wandoo seedlings from various provenances to abiotic stress factors such as drought and salinity. These provenances are also being characterized genetically (E. Dalmaris, E. Veneklaas, P. Poot, UWA and M. Byrne, DEC). Also, a field study in Julimar state forest is comparing water-use strategies of four co-occurring eucalypts including Wandoo (*E. wandoo, E. marginata, Corymbia calophylla, E. accedens*) (P. Poot and E. Veneklaas, UWA). Preliminary results indicate that Wandoo uses more water and allows its tissues to dry out further. This strategy allows the species to grow in drier soil but could be associated with severe stress when threshold soil water contents are reached after several low-rainfall years. For "B" a PhD project is focussing on the model for Wandoo decline introduced in 2003 (Hooper and Sivasithamparam 2005, Can. J. For. Res. 35: 2589–2602) that proposes an interaction between a wood boring insect (type 1) and decay-causing fungi, and specific site conditions that influence these causal relationships (R. Hooper, K. Sivasithamparam, UWA; B. Shearer, C. Crane and A. Wills, DEC). Tri-annual surveys using a crown assessment method developed by K. Whitford and A. Wills (DEC) for use in community assessment (K. Whitford, DEC), have shown April to May to be the peak period for decline symptoms (R. Hooper, UWA). Comparison of 9 locations (1 sq km each) throughout the Wandoo range has identified two locations as decline "hotspots". By using aerial trapping and branch caging we have shown the "hotspots" to have more current borer galleries and higher populations of type-1 borer, whereas recovering stands have greater mean number of old type-1 galleries. Pathogenicity trials using most frequently isolated fungal species have shown 5 isolates out of 11 to cause significant lesions on healthy Wandoo saplings (R. Hooper, UWA). Molecular work is planned to identify fungal species and elucidate functional relationships between type-1 borer and pathogenic fungal species. All results at this stage are preliminary and further work is being carried out by the research groups. Decline "hotspots" have been identified in two locations, with symptogalleriesms severe throughout autumn and type-1 borer identified as a Buprestid (Jewel) beetle is most active in these areas with close associations with two fungal species. A pathogenicity trial showed significant lesions were formed on healthy Wandoo saplings for 5 of the 16 isolates used in the trial. Molecular work is planned to identify species and investigate the nature of the relationship between the insect and fungi (R. Hooper, UWA).