8. Insect pests and diseases of rainforest timber species grown in plantations

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Abstract

The Community Rainforest Reforestation Program (CRRP) and other planting programs included in their aims the long-term expansion of forest industries in north Queensland with the production of high quality rainforest timbers in plantations. Plantation productivity (survival, growth rate, form and yield) and quality of the timber product are influenced in part by plantation health which can be adversely affected by insect pests and diseases.

Plantation development planning should include an assessment of the potential risks due to pests and diseases and site-related problems, facilitating appropriate species choice. Once established, regular plantation health surveillance should be incorporated into the management program, enabling early intervention where appropriate. A plantation health surveillance program: identifies pathogens, insect pests and their parasites and predators; enables early recognition of health change; identifies predictive patterns of pest and disease activity; facilitates the correlation between plantation productivity and pests and diseases; and contributes to a valuable bank of knowledge.

Hardwood plantation research has recognised serious pests such as tip moths of the Meliaceae family as well as wood boring beetles and moths, sap sucking bugs and beetle defoliators associated with several tropical and subtropical eucalypts. Diseases such as Cylindrocladium *leaf blight,* Phellinus noxius *and phytophthora root rot are also potential threats to rainforest replantings.*

Risk assessments and health surveillance were not conducted in the CRRP plantings, missing an opportunity to identify and manage the threat of pests and diseases in rainforest reforestation programs. Examples of appropriate risk assessment and health monitoring in hardwood plantation programs are the Department of Primary Industries' Joint Venture scheme and Hardwoods Queensland project.

Introduction

The Community Rainforest Reforestation Program (CRRP) was one of a number of federal and state government initiatives for tree planting, founded on economic, environmental, and social considerations. Others included the Joint Venture Scheme (Department of Primary Industries (DPI), Forestry) and Hardwoods Queensland project (DPI, Agency for Food and Fibre Sciences, Forestry Research).

The CRRP, which began in 1993, included in its aims the growing of high value cabinet woods and hardwoods to provide a sustainable timber industry, and support for the development of a private plantation industry. This industry would provide employment and future growth in areas where logging of native forests ceased.

The development of a private plantation industry requires high-level, long-term investment. To secure such a commitment of funds, potential investors must be certain of a reasonable return on capital, and the value of the return in part, is directly related to the productivity of the plantations and the quality of the end product. To achieve this, plantations should include species best suited to the site (and to the market), and should be managed to provide optimum growing conditions for the selected species, so that the end product meets market expectations in minimum time.

Pests and diseases, and their effect on tree health, can be major limiting factors influencing plantation productivity and the quality of the end product, especially where native or endemic species are to be grown.

Tree health

Tree health is dependent on many factors, including: the genotype of the tree, which determines whether it is vigorous or weak stock; environmental and climatic influences at the planting site; competition with weeds and direct losses due to pests and diseases. Accurate matching of tree species to site promotes tree vigour, and so enhances tree tolerance and resistance to pest and disease attack. In plantations where tree species are well matched to the site, weed competition and pests and diseases can be the most important determinants of plantation health and productivity. If trees are not matched to the site pest and disease effects may be exacerbated.

Previous experience in Queensland has shown that pests and diseases can have major impacts on the health of individual trees and plantations (Heather and Schaumberg 1966; Wylie and Peters 1993; Speight and Wylie 2000; Griffiths *et al.* 2001). When trees are being chewed, sucked on, bored into, defoliated or decayed by pests and diseases they will not grow well, and the end product will be of a low standard, or non-existent. Incorporating pest and disease considerations into the planning of plantation projects is essential to obtaining successful long-term outcomes (see Speight and Wylie 2000). However, during the planning and implementation stages of the CRRP the potential effects of pests and diseases on the required outcomes of the project were not recognised, and entomologists and pathologists were not consulted.

Effects of pests and diseases on tree health

Pests and diseases can affect tree survival, growth rate, form and yield:

Survival – Severe and/or repeated damage caused by insects or diseases can kill trees, or can weaken them sufficiently to make them much more susceptible to adverse abiotic factors.

Growth rate – Defoliation and loss of growing points reduces the tree's ability to photosynthesise, and reserves are depleted in producing a new crown. Subsequent defoliations can compound the problem and stop growth. Some examples of defoliators are:

- Sap-suckers, such as psyllids which suck sap from leaves and soft stems or form galls, causing chlorosis, necrotic patches on the leaves, distortion and leaf fall;
- Leaf chewers that singly, in groups or swarms chew off leaves and growing tips. These include sawfly larvae, adults and larvae of leaf-eating beetles and various caterpillars. Leaf chewers in this case includes leaf miners, tiers, etc, many ways of chewing on a leaf;
- Leaf and shoot blight diseases that cause necrosis of leaf tissues, shrivelling and distortion of twigs and growing points; and
- Root rots, which slowly destroy the root system and starve the tree, causing chlorosis, defoliation and often tree death.

Form – Loss of leaders and growing tips, and damage to the stems of young trees, can lead to development of multiple growth points, bushy form and distorted stems, instead of a single, straight trunk which will later yield a high quality saw log. Some examples are:

- Tip and shoot moths that chew out growing tips;
- Tip-sucking bugs which pierce and suck sap from just behind the growing tips and cause them to shrivel;
- Longicorn beetles, either stem borers or branch pruners, and wood moths that kill off branches; and

- Diseases, including cankers, stem and leaf blights and bacterial wilts that can have a detrimental effect on form.

Quality and value of timber produced - These are directly affected by pests and diseases in the trunk. Some examples include:

- Branch-pruning longicorn beetles that also prune young stems, often close to ground level, resulting in loss of growth increment or multiple leaders;
- Longicorn borers and wood moths which leave tunnels filled with frass, gum veins and/or large holes;
- Bark and ambrosia beetles that colonise wound sites and stain the timber; and
- Termites, root rots and heart rots that are associated with cavities, pipes and decaying wood.

Pests and diseases can be a primary cause of poor health, but they can also be secondary agents, 'taking advantage of' and compounding an existing problem. For example trees which are stressed by competition with weeds, or have suffered storm damage, may be more susceptible to, and less able to recover from a subsequent insect or disease infestation.

Often more than one pest or disease or other stress factor can be active at one time. Emergence of holes in the trunk can act as entry points for fungal diseases; dead, ring-barked branches can be infested by termites and the damp 'mudguts' surrounding their nests facilitates decay in the branches and trunk. As a field example a *Eucalyptus urophylla* plantation near Cardwell suffered storm damage, then was trampled by cows and then defoliated by caterpillars (probably *Doratifera* sp. cup moths) and the disease Cylindrocladium leaf blight (Pomeroy pers. comm.).

CRRP plantations

CRRP plantations were often established on cleared agricultural land that was originally rainforest and so could be considered extremely vulnerable to attack by a wide range of tree pests and diseases. These sites were spread over a wide geographic and climatic range. Extensive plantings of mixed species were made in an area that has a high level of biodiversity, especially rich with regard to herbivorous insects and fungal pathogens, and where there was comparatively little recorded information on health problems of some of the rainforest species to be planted. From entomological and pathological perspectives the project would have been an opportunity to increase our knowledge of pest and disease interactions with trees in northern Queensland, particularly in plantation situations.

Cameron and Jermyn (1991), in their review of the performance of rainforest species, recommended future directions for research and testing to improve the performance of selected species in plantations. In their list of 'High Priority' recommendations, which should be addressed early in any program of growing high value rainforest trees, they included research into pests and diseases. They acknowledged the lack of information on health problems of these trees, and made particular mention of problems with *Hypsipyla robusta* in *Toona ciliata* and *Cedrela odorata*, and pests and diseases of *Gmelina arborea*.

In their list of 'Low Priority' recommendations they included long-term experiments monitored by multidisciplinary teams as one of the 'key ingredients' for successful plantation trials. Based on their 'High priority' recommendations, monitoring teams should have included forest health specialists in entomology and pathology.

Plantation health risks in the CRRP

The CRRP would have benefited from the inclusion of pest and disease specialists as permanent members of the project team. During the planning stages entomologists and pathologists would have provided valuable input into species selection and species/site matching by identifying some potential and actual threats to tree health from existing information. Information on potential pest and disease problems of some of the species and sites selected for the CRRP was available from previous trials, specific research projects and field experience. Some of these previously described problems did then occur in the CRRP and other plantations may have been preventable. Consideration of potential problems could have saved time and money either by a decision not to plant particular high-risk species, or by regular monitoring and early intervention. Examples of previously recognised problems include the following:

Cedar Tip Moth

Red cedar, *Toona ciliata*, is attacked by the cedar tip moth, *Hypsipyla robusta.* There have been several unsuccessful attempts to grow Queensland red cedar in plantations in northern and southeast Queensland (Cameron and Jermyn 1991; DPI Forestry records), and in New South Wales (Griffiths *et al* 2001). All trials failed because the trees were attacked by the cedar tip moth, resulting in multi stemming, bushy growth and sometimes tree death. Yet red cedar was planted in several places, with predictable results; in one plantation near Mackay all the trees were severely affected, none were of any value and many died (see Figure 1).

Figure 1 Red cedar severely damaged by *Hypsipyla robusta*.

White cedar moth

Similarly, white cedar, *Melia azedarach* L.*,* is frequently defoliated by caterpillars of the white cedar moth (*Leptocneria reducta* (Walker)). Caterpillars of this moth cluster together at the base of the tree or on the lower trunk during the day and move into the crown at night to feed. They are voracious feeders, and when all the leaves have been eaten they will move in procession from the defoliated

tree to a new tree. This pest reached such high numbers in some areas that eggs were being deposited on seedlings in the nursery. White cedar moth is usually not found in nurseries of north Queensland.

Eucalypt pests and diseases

Several pests and diseases of eucalypts and acacias were recorded during a series of hardwood taxa trials in northern and south eastern Queensland in the late 1980's. During these trials the devastating disease Cylindrocladium leaf blight (*Cylindrocladium quinqueseptatum* Boedijn and Reitsma), which defoliates eucalypts, was recorded on *Eucalyptus pellita* F. Muell. at Lannercost and Murray Upper (see Figure 2).

Figure 2 Cylindricladium leaf blight causing leaf and stem distortion and defoliation of *Eucalyptus*.

Also recorded were longicorn borers (including *Penthea macularis*) and wood moths tunnelling in trunks of some eucalypts and acacias (see Figures 3 and 4), sap sucking bugs and scarab beetle defoliators (see Figure 5) of some eucalypts (Wylie and Peters 1993).

Yet some of the species severely damaged in these trials (e.g. *E. urophylla* and *E. grandis*), were subsequently used in CRRP plantings and other north Queensland plantations.

Other diseases

Research on the fungus *Phellinus noxius* (Corner) G. Gunn., a lethal pathogen of many tree species, has shown that it can persist in infected stumps and roots in cleared rainforest sites for many years and can infect new hosts through root contact (see Figure 6) (Bolland 1984, Ivory 1996).

The fungus is endemic to rainforests in tropical and subtropical Queensland, and has long been recognized as a serious disease of hoop pines and other rainforest species (Bolland 1984, Ivory 1996). Another well-researched lethal fungus with a wide range of hosts is *Phytophthora cinnamomi* Rands, phytophthora root rot (Keane *et al.* 2000). An initial assessment of sites by a pathologist

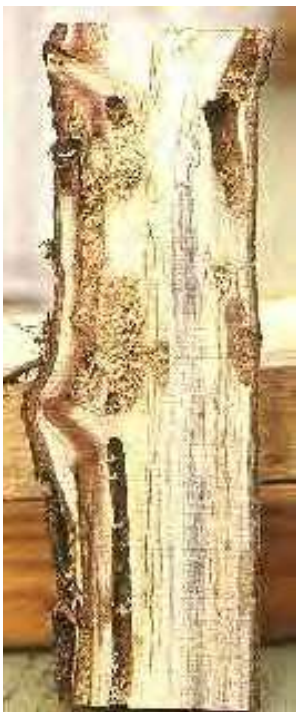

Figure 3 *Acacia aulacocarpa* stem extensively damaged by longicorn borer *Penthea macularis.*

Figure 4 *Acacia mangium*, Kuranda seed orchard, with wood moth damage. Growth rate and form are affected, the trees will not produce marketable timber.

Figure 5 *Epholcis bilobiceps*, a swarming scarab beetle which can defoliate some eucalypts.

Figure 6 *Phellinus* root rot 'stocking' on the trunk of *Argyrodendron* sp. The tree will die and timber will be affected by decay.

would have indicated whether these diseases were likely to be present at the sites, and the likely long-term effects and planting options. This was not done.

These pests and diseases, and others subsequently recognised as potentially serious problems, are included in Table 1 at Appendix One.

Plantation health

During the life of the CRRP, entomologists and pathologists were not asked to inspect the trees until damage and disease were obvious and/or severe. They visited only a few of the plots, although many other plots were affected by pests and diseases (P. Pomeroy, G. Sexton, M. Bristow, A. Sturrie pers. comm.). This is sometimes referred to as the 'fire fighting' approach to pest and disease management, whereby control measures are undertaken once visible symptoms are severe, rather than sampling for pests and diseases before they reach critical levels. A health surveillance program would have facilitated early recognition of health problems and significantly increased knowledge of pests and diseases, knowledge which could be utilised in planning and managing future plantations. In addition, field staff who travelled with the surveillance team would have increased their knowledge and awareness of this aspect of plantation development.

Health Surveillance.

A regular health surveillance program, with frequent inspections and meticulous record keeping, should be an integral part of plantation management (e.g. Stone *et al.* 2001, Candy and Zalucki 2002).

Benefits of health surveillance include:

- Identification of pests and diseases;
- Identification of parasites and predators of insect pests - these may be useful pest controllers;
- Standardised and consistent methods of measuring and expressing damage and effects;
- Early recognition of developing problems and changes in health. This will allow timely remedial action to be taken if such action is appropriate or possible. For example, remedial measures such as weed control and fertilizer application can significantly improve tree health following pest or disease damage episodes (Stone and Birk 2001, Wardlaw pers. comm.);
- Recognition of patterns of pest and disease activity. This can have predictive value for some pests and diseases, once activity patterns have been determined. For example, some scarab beetle species swarm in the spring, often following storm rain, and defoliate some eucalypt species. If those beetles are known to be present, extra surveillance at the appropriate time, and early intervention, can reduce or prevent damage. As well, the grower learns which pests and diseases are always present, and can select tree species with low susceptibility to pests and diseases for future planting;
- Development of a database. A database of information on pests and diseases is crucial for planning future plantations, eg. matching species to site: a eucalypt species devastated by leaf blights in some locations would not be replanted and would not be planted in other sites with similar parameters;
- Potential for regular exchange of information with colleagues, widening the knowledge and experience base; and
- The creation/development of a known source of assistance and information as needed.

A health surveillance program should include nursery inspections and nursery staff should be trained to be aware of problems so that recognised nursery pests and diseases can be managed effectively. Nurseries also need to ensure that healthy seedlings are supplied for planting out and that high populations of pests and diseases are not introduced into the plantation at this early stage. High economic costs can be associated with treatment or replacement of unhealthy stock once planted out. Quarantine is also an issue – nurseries from one region supplying plants for another region (e.g. north Queensland nurseries supplying plants for southeast Queensland) can spread pests and diseases into areas where they previously did not occur.

A final inspection of standing trees and some destructive sampling at the end of the CRRP would have provided information on the longer-term effects of damage to trees previously inspected – did they survive, if they survived how well did they recover, what were the outcomes for each

plantation? As well, overall health, and the effects of pests and diseases on stand quality across sites could have been assessed.

Hardwoods Queensland – A case study

An example of a planned health research and development program for plantations is provided by the Hardwoods Queensland project (www.dpi.qld.gov.au/hardwoodsqld). This project represented an integrated, multidisciplinary approach to research and development in support of a new plantation industry. This project focused upon eucalypt plantations in southeast Queensland which comprised part of the South East Queensland Forests Agreement (SEQFA) of 1999. From the conception of this project, pests and diseases were recognised as key limiting factors in plantation productivity, and research into their management was appropriately funded and resourced for the four years of the project. Additionally, systematised health surveillance has been a part of the operational plantation program since 1999 and has contributed much to our understanding of the distribution and impact of pests and diseases in eucalypt plantations, as well as providing early warning of new problems when they arise and assisting in targeting research into the most needed areas. This close linkage between surveillance and research should be an essential part of any plantation program.

From its inception, forest health specialists contributed to the selection process for species to be used in the planting program, with some species (notably *Eucalyptus grandis*) being rejected and cautions given for others with known problems. Because these plantations are being established mainly for solid timber values, *E. grandis* was excluded due to its extremely high susceptibility to stem borers such as *Endoxyla cinerea* (the giant wood moth) and longicorn beetles (*Phoracantha* spp.), which have rendered timber from older plantations of this species virtually valueless from a solid timber point of view. From previous experience plantation managers were advised of the possible impact of *Quambalaria pitereka* (J. Walker and Bertus) J.A. Simpson (Ramularia shoot blight) on *Corymbia citriodora* ssp. *variegata* (spotted gum) based on plantings in northern New South Wales. When problems did occur, provenance trials of this species had been established from which more tolerant genotypes could be selected and then used in the plantation program.

Several other projects such as the Department of Primary Industries' (DPI) Forestry Joint Ventures scheme and the Australian Centre for International Agricultural Research (ACIAR) and Shell trials of the 1980's included pest and disease specialists in their planning and management programs such that many emerging pests and diseases were identified early on, such as *Epholcis bilobiceps* swarming scarabs, Cylindrocladium leaf blight, stem borers such as giant wood moths (*Endoxyla* spp.) and *Phoracantha* spp. longicorn beetles, and Ramularia shoot blight. Where possible, remedial action could then be taken (Wylie and Peters 1993).

Harvest and post-harvest health

For future projects some consideration should be given to health issues during and after harvest. Problems are caused almost exclusively by insect pests. Primary fungal infestations in newly felled logs are prevented by rapid harvesting and processing.

Of greatest concern are ambrosia beetles, which are major timber pests world wide. Ambrosia beetles are pests of unseasoned timber. Adults bore in the sapwood and heartwood of unhealthy, wounded, dying or recently dead trees, freshly felled logs or, occasionally, newly sawn timber. Their tunnels and the associated fungal staining of the wood can rapidly and severely degrade the timber (Peters *et al*. 1996).

Disinfestation of borer-affected logs is extremely difficult. Therefore, for high value logs the emphasis should be on:

- Care in logging - to prevent wounding and infestation of remaining trees;

- Rapid processing - logs taken to the mill and processed as soon as possible, not left lying in the bush, at the logging ramp or in the mill yard; and
- Kiln or air drying - sawn product should be kiln dried where possible, or air dried in a protected environment.

Conclusions

Long-term management of pests and diseases in plantations of native species should be an integral part of a project from planning to harvest. It is a complex issue demanding tailored rather than 'broad brush' measures. This is because the pests and diseases are already present and large-scale planting, either mixed or monoculture, provides substantial new habitats and resources.

Good plantation health management practice is about:

- identifying the end-use of each species, including sawlogs, cabinet timber, veneer, pulp, environmental restoration (biological damage is much less significant for some uses); and
- having knowledge of: the potential pest organisms and an understanding of their biology; the effects of these organisms on the host tree in relation to the end-use; and whether effective and appropriate management (for example natural enemies, pheromone trapping) is practically and economically possible.

Where available, all this information should be incorporated into plantation project planning by pest and disease specialists. Where information is not available it should be collected. An informed decision can then be made about which species to include.

After planting, trees should be inspected regularly (at least twice a year) for pest and disease problems by experienced personnel, and appropriate remedial action should be taken as necessary.

The CRRP plantings would have been an opportunity for entomologists and pathologists to increase the knowledge bank of pests and diseases of trees in north Queensland, as well as providing an opportunity for CRRP staff and other stakeholders to access knowledge and information needed to execute sound plantation health management practices, as achieved by Hardwoods Queensland and the Joint Venture scheme where immediate benefits for growers and the collection of information for the long-term benefit of an expanding industry resulted.

Recommendations

Several principles of sound plantation health management can be recommended for future planting programs for rainforest timbers:

- Forest health specialists need to be involved in any planting program from its inception to advise on the health risk aspects of species selection and to have inputs in planning the management of known pests and diseases;
- A systematised health surveillance of plantations must be put in place. This is essential to assess the incidence and severity of pests and diseases over time and to evaluate the impacts on plantation productivity;
- Field staff should be trained to recognise and record health problems, and request assistance as necessary between scheduled health surveillance visits from specialists;
- Our current knowledge of pests and diseases in north Queensland should be reviewed, and a comprehensive health data base developed to record pests, diseases, impacts, geographic and temporal occurrence and other factors in relation to the tree species grown in plantations;
- A final inspection of at least some of the CRRP plantations should be conducted to assess and record the outcomes of the project; and
- Harvest and post-harvest pest problems of logs for cabinet timbers and veneers require greater recognition in the overall health risk to timber production in native hardwood plantations.

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Appendix One

Table 1 Some insects and diseases causing severe damage to trees in north Queensland. Note: pest and disease occurrence and effects differ at different localities.

Tree species	Insect	Type of Damage
Acacia aulacocarpa Cunn. ex Benth.	*Calomela crassicornis* Fabricius. Coleoptera	Leaf chewer
	Cryptocephalus iridipennis Chiapuis. Coleoptera	Leaf chewer
	Cryptocephalus gracilior Chiapuis. Coleoptera	Leaf chewer
	Rhyparida discopunctulata Blackburn. Coleoptera	Leaf chewer
	Penthea pardalis (Newman). Coleoptera	Tunnels in trunk
	Dicranosterna sp..Coleoptera	Ring bark branches,
	Xyloryctidae, unidentified species. Lepidoptera	Stem and branch borer
A. auriculiformis Cunn. ex Benth.	*Calomela crassicornis*	Leaf chewer
	Cryptocephalus speciosus Guerin. Coleoptera	Leaf chewer
	Dicranosterna sp.	Ring bark branches
	Mictis profana (Fabricius). Hemiptera	Tip sucker: shoot dieback, stunting, bushy growth
A. mangium Willd.	*Calomela crassicornis*	Leaf chewer
	Cryptocephalus iridipennis	Leaf chewer
	Cryptocephalus gracilior	Leaf chewer
	Dicranosterna sp.	Ring bark branches
	Platyomopsis sp. Coleoptera	Ring bark branches
	Calcarifera sp. Lepidoptera	Leaf chewer
	Xyloryctidae, unidentified species	Stem and branch borer
	Cryptophlebia sp. Lepidoptera	Tip borer: shoot dieback, stunting, bushy growth
Agathis robusta (C. Moore ex F. Muell.) Bailey	*Geloptera miracula* Lea. Coleoptera	Leaf chewer, surface and margins
	Conifericoccus agathidis *Brimblecombe* Hemiptera	Sap sucker
Alphitonia petrei	No information	
Blepharocarya involucrigera	No information	
Cardwellia sublimes F. Muell.	No information	
Castanospermum australe Cunn. ex C. Fraser ex Hook	No information	
Cedrela odorata L	*Hypsipyla robusta* (Moore). Lepidoptera	Tip and stem borer: shoot dieback, stunting, bushy growth

Tree species	Insect	Type of Damage
Corymbia citriodora (Hook.) K.D. Hill and L.A.S. Johnson	*Cryptocephalus speciosus*	Leaf chewer
	Phoracantha acanthocera (Macleay). Coleoptera	Tunnels in trunk
	Phoracantha solida (Blackburn). Coleoptera	Tunnels in trunk
Corymbia torelliana	*Monolepta australis* (Jacoby) Coleoptera	Defoliator
Elaeocarpus grandis F. Muell.	Unidentified processionary caterpillars. Lepidoptera	Defoliator
Eucalyptus acmenoides Schauer	*Epholcis bilobiceps* (Fairmaire). Coleoptera	Defoliator
Eucalyptus camaldulensis Dehn.	*Epholcis bilobiceps*	Defoliator
	Liparetrus discipennis (Guerin-Meneeville). Coleoptera	Defoliator
	Hyalarcta huebneri (Westwood). Lepidoptera	Defoliator
	Endoxyla cinerea (Tepper) Lepidoptera	Tunnels in trunk
Eucalyptus cloeziana F. Muell.	*Paropsis atomaria* Olivier Coleoptera	Defoliator
	Liparetrus sp. Coleoptera	Defoliator
	Hyalarcta huebneri	Defoliator
	Phoracantha solida	Tunnels in trunk
Eucalyptus drepanophylla F. Muell. ex Benth.	*Epholcis bilobiceps*	Defoliator
Eucalyptus dunnii Maiden	*Chrysophtharta cloelia* Stal. Coleoptera	Leaf chewer
	Paropsis atomaria	Defoliator
	Xylotrupes gideon (L). Coleoptera	Bark chewer
	Creiis lituratus (Froggatt) Hemiptera	Defoliator
	Endoxyla cinerea	Tunnels in trunk
	Phoracantha solida	Tunnels in trunk
E. grandis W. Hill ex Maiden	*Epholcis bilobiceps*	Defoliator
	Endoxyla cinerea	Tunnels in trunk
	Phoracantha acanthocera	Tunnels in trunk
	Phoracantha solida	Tunnels in trunk
	Cossidae, unidentified species. Lepidoptera	Tunnels in trunk
	Eriococcus coriaceus Maskell. Hemiptera	Damage and distortion of small branches and twigs, chlorosis.
	Chrysophtharta cloelia	Leaf chewer
	Cardiaspina fiscella Taylor Hemiptera	Defoliator
	Cardiaspina maniformis Taylor. Hemiptera	Defoliator

Tree species	Insect	Type of Damage
E. microcorys F. Muell.	*Phoracantha acanthocera* *Phoracantha solida* Scarabaeidae, unidentified species. Coleoptera *Pergagrapta polita* (Leach) *Hymenoptera*	Tunnels in trunk Tunnels in trunk Defoliator Leaf chewer
Eucalyptus pellita F. Muell.	*Chrysophtharta cloelia* *Epholcis bilobiceps* *Geloptera miracula* *Phoracantha acanthocera* *Phoracantha solida* *Pergagrapta polita*	Defoliator Defoliator Leaf chewer, surface and margins Tunnels in trunk Tunnels in trunk Leaf chewer
Eucalyptus pilularis Smith	*Cryptocephalus speciosus* *Epholcis bilobiceps* *Hyalarcta huebneri* *Phoracantha solida* *Paropsis atomaria*	Leaf chewer Defoliator Defoliator Tunnels in trunk Defoliator
Eucalyptus resinifera Smith	*Phoracantha acanthocera* *Phoracantha solida*	Tunnels in trunk Tunnels in trunk
Eucalyptus robusta Smith	*Epholcis bilobiceps* *Phoracantha acanthocera* *Phoracantha solida*	Defoliator Tunnels in trunk Tunnels in trunk
Eucalyptus tereticornis Smith	*Endoxyla cinerea* *Phoracantha solida* *Chrysophtharta cloelia* *Glycaspis* sp. Hemiptera	Tunnels in trunk Tunnels in trunk Defoliator Sap-sucker
Eucalyptus tetradonta F. Muell.	No information	
Eucalyptus urophylla S.T. Blake	*Epholcis bilobiceps* *Phoracantha acanthocera* *Phoracantha solida* *Doratifera* sp. Lepidoptera	Defoliator Tunnels in trunk Tunnels in trunk Defoliator
Eucalyptus spp., specific name not recorded	*Cardiaspina* sp. Hemiptera *Amorbus* sp. Hemiptera Microhymenoptera, Hymenoptera *Perga* sp., *Pergagrapta* sp., Hymenoptera	Sap sucker: leaf necrosis, defoliation Tip sucker: shoot dieback, stunting, bushy growth Galls on leaves and stems, distortion, stunting Defoliators
Flindersia spp	*Strongylurus thoracicus* (Pascoe). Coleoptera	Branch girdler

Tree species	Insect	Type of Damage
Grevillea robusta Cunn. Ex R. Br.	No information	
Khaya spp.	No information	
Melia azedarach L.	*Strongylurus thoracicus* (Pascoe) *Leptocneria reducta* (Walker).Lepidoptera	Branch girdler Defoliator
Nauclea orientalis (L.)	No information	
Paraserianthes toona	No information	
Tectona grandis	*Hyblaea puera* Cramer Lepidoptera	Leaf chewer
Terminalia sericocarpa F. Muell.	No information	
Toona ciliata M. Roemer	*Hypsipyla robusta*	Tip and stem borer: shoot dieback, stunting, bushy growth
Araucaria cunninghamii Aiton ex D. Don	*Phellinus noxius* (Corner) G. Gunn	Root decay, death
Acacia mangium	*Ganoderma sp.* *Atelocauda digitata (G. Wint.) Cummins and Y. Hiratsuka*	Root decay, death Leaf and stem galls, distortion, leaf loss
Most rainforest species	*Phellinus noxius*	Root decay, death
Many hardwoods and softwoods	*Phytophthora cinnamomi* Rands	Root decay, poor growth or death
Eucalyptus spp.	*Cylindrocladium quinqueseptatum* Boedijn & Reitsma *Mycosphaerella* sp.	Defoliation, shoot, branch and stem damage in young trees and nursery stock Shriveled leaves, defoliation.
Corymbia spp.	*Quambalaria pitereka* (J. Walker & Bertus) J.A. Simpson	Shoot distortion, dieback, bushy growth.