

Biosecurity Manual for the Plantation Timber Industry

Reducing the risk of new pests impacting your production

Version 1.0 June 2015





Plant Health Australia (PHA) is the national coordinator of the government-industry partnership for plant biosecurity in Australia. As a not-for-profit company, PHA services the needs of Members and independently advocates on behalf of the national plant biosecurity system. PHA's efforts help minimise plant pest impacts, enhance Australia's plant health status, assist trade, safeguard the livelihood of producers, support the sustainability and profitability of plant industries and the communities that rely upon them, and preserve environmental health and amenity.
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Introduction

This manual is designed to be used by foresters, contractors, forest managers and consultants. It highlights the basic biosecurity activities that can minimise the risk of introducing and spreading weeds, pests and diseases.

Simple plantation biosecurity practices are highlighted that will help you to keep your property or plantation free from new pests and diseases.



It is likely that some of the recommended biosecurity practices in this manual are already part of your routine management activities, such as pest surveillance and monitoring.

Every plantation is different, so the recommended general principles in this manual will need to be tailored to your needs. The practices you choose will vary from site to site, depending on factors such as the size of your plantation(s), the facilities available, risks and day-to-day management of operations.

By implementing the recommended measures in your day-to-day operations, you will improve your individual plantation's biosecurity and that of your whole region, while minimising losses and unnecessary costs.

Although weeds are not specifically covered in this document, implementation of the recommended practices will also help to protect plantations from the entry and spread of weeds.

In the event that an exotic pest or disease is found, and the decision is made to attempt to eradicate it, there will likely be enforced restrictions put in place to limit the spread of the pest or disease. However, there are systems in place to ensure that your business is not worse off for reporting an exotic pest or disease (see page 11 for further information).

The symptoms and appearance of some exotic pest threats to the forest industry are described so that any incursion into Australia can be detected quickly and controlled.

On page 21 there is a Biosecurity Checklist that will help you to safeguard your plantation. It is recommended that you assess the strengths and weaknesses of your current arrangements against this checklist and address any gaps that might leave you at risk.

An electronic copy of this manual is available from the Plant Health Australia website planthealthaustralia.com.au and the Farm Biosecurity website farmbiosecurity.com.au.



Simple preventative measures, together with monitoring and quick reporting of anything unusual, will help reduce the risk of a new pest or disease establishing in your plantation

A vertical photograph of a forest. In the foreground, a tree trunk with rough, textured bark is visible on the left side. The background is a blurred forest with many vertical tree trunks and some green foliage, creating a bokeh effect.

Biosecurity overview

Foresters can play a key role in protecting their plantation and the Australian forest industry from new pests or diseases by implementing effective plantation biosecurity.

What is biosecurity?

Biosecurity is the management of risks to the economy, the environment and the community, from new weeds, pests and diseases entering, establishing and spreading in your area.

Biosecurity is a national priority, implemented off-shore, at national and state borders and on your plantation. Biosecurity is a shared responsibility.

Due to Australia's geographic isolation we have relatively few of the pests and diseases that affect plant industries overseas. Freedom from these exotic pests and diseases is a vital part of the future profitability and sustainability of Australia's plant industries. Biosecurity allows us to preserve existing trade opportunities and provide evidence to support new market negotiations.

What is plantation biosecurity?

Plantation biosecurity is a set of management practices and activities used to protect a property from the entry and spread of weeds, pests and diseases.

Plantation biosecurity makes good business sense. If a new pest becomes established in your plantation, costs will increase due to:

- increased mortality
- increased management costs
- reduced growth rates
- reduced productivity in terms of yield, quality or both
- potential loss of access to some markets.

Biosecurity practices will help to protect your plantation from established pests and diseases as well as from exotic pests and diseases in the event of an incursion.

General information on biosecurity can be found online at farmbiosecurity.com.au. Specific information on biosecurity requirements in your state can be found on page 59.



Good plantation pest and disease management practices support biosecurity and help detect new pests and diseases quickly, improving the chances of successful eradication.

Regional biosecurity

Pests and diseases do not respect plantation boundaries or state borders. Biosecurity threats can be introduced from neighbouring areas including native or private forests, nurseries, amenity trees or gardens.

You can further strengthen biosecurity for your enterprise by collaborating with others in your area. Consider starting biosecurity meetings and activities to promote biosecurity at the regional level to reduce biosecurity threats to all local properties.

Promotion of biosecurity practices at the regional level is enhanced through understanding the local environment (such as local climate, soil types, drainage, facilities etc), the source and nature of potential threats, and having knowledge of the expertise and resources available in the region. This is supported by a commitment from everyone to implement biosecurity measures, carry out surveillance and report suspect pests, diseases or unusual symptoms.

The definition of a **pest** used in this manual covers all insects, mites, snails, nematodes, pathogens (diseases) and weeds that may harm plants or plant products. **Exotic** pests are those not currently present in Australia. **Established** pests are those present within Australia.

Easy ways to protect your plantation

Pests and diseases can severely affect your plantation. It makes good business sense to take measures to improve biosecurity.

Here are some simple practices that can reduce the possibility of pests or diseases entering and establishing in your plantation. Each practice should be embedded in everyday management activities.

Monitor plantations for pests and diseases

Check plantations regularly for pests and diseases. Record the results of monitoring, even if you don't find anything. Become familiar with the endemic pests and diseases in your area and be vigilant for anything unusual. Be aware of the symptoms that could indicate the presence of exotic pests and diseases on your trees (factsheets are provided in the back of this manual). Keep written and photographic records of all unusual observations. Constant vigilance is vital for early detection of any exotic plant pest or disease.

Be aware

Any time you visit a plantation is an opportunity to monitor for pests or diseases. Whenever you are working in a plantation keep an eye out for anything unusual, signs of new pests, diseases or poorly performing trees.

Report anything unusual

If you suspect a new pest or disease may be present, report it immediately to the Exotic Plant Pest Hotline. Early detection provides the best chance of eradication.

Use pest-free propagation material

Ensure planting material is purchased from reputable sources, and is free of pests and diseases. Request and maintain records that state the source and testing history of planting material to allow the origin of pests or diseases to be traced.

Biosecurity signs and people movement

People can inadvertently carry pests and diseases. The use of biosecurity signs can help to inform visitors and contractors of any biosecurity measures that are in place in the plantation.

Reduce risks posed by vehicles and equipment

Moving machinery between plantations can spread pests and diseases. Ensure that staff and contractors comply with your biosecurity requirements.

Abide by the law

Be aware of and support laws and regulations established to protect the plantation timber industry.

If you see anything unusual, call the Exotic Plant Pest Hotline



Looking for exotic pests during your routine monitoring for pests and diseases will enhance plantation biosecurity.



Biosecurity practices

The following pages detail biosecurity practices for aspects of plantation operations. Assess the strengths and weaknesses of your current arrangements using the Biosecurity Checklist on page 21 and make a biosecurity plan to address any gaps that might leave you at risk.

Plantation monitoring for the early detection of pests and diseases

Monitoring your plantation provides the best protection against new pests and diseases. Any new pests or unusual symptoms should be reported.



Biosecurity awareness

Training should be provided to staff to increase their level of biosecurity awareness, including the ability to recognise high priority exotic pests and diseases and who to report possible sightings to.

Early detection is important for controlling pests

Monitoring the health of your plantation is a fundamental part of plantation management and gives the best chance of spotting a new pest or disease soon after it arrives. You, your workers, contractors or consultants should be looking over your plantation on a regular basis.

Pay particular attention to high risk areas where pests are most likely to enter and establish on your property such as along public roads and around depots.

Keep records of monitoring activity

Surveillance involves looking for pests and diseases, any symptoms, or plant health issues in your plantation, and recording their presence and population levels or their absence. If your company employs forest health professionals these records will already be maintained; otherwise you

are responsible for maintaining your own records. An example of a pest surveillance record sheet is provided on page 61.

In addition to assisting with plantation management, pest and disease surveillance is important for maintaining the biosecurity status of the Australian plantation forest industry.

Maintaining market access

Export destinations often require 'evidence of absence' data for particular exotic and established pests and diseases. Your regular pest and disease surveillance activities can assist in providing evidence of absence and potentially help to keep trade markets open.

Ongoing surveillance

Pest and disease surveillance increases the chances that a new pest or disease is detected early and can be contained and eradicated. A new pest or disease in your plantation might also be new to the region or even the country.

Importance of reporting

Along with plantation monitoring and pest and disease surveillance, prompt reporting is vital to minimise the long-term impact of exotic pests or diseases in your plantation and the forest industry as a whole.

While Australia has one of the strictest border control systems in the world, there is always the chance that an exotic pest or disease will make it into the country. The number of passengers and imported goods is increasing, and a serious exotic pest or disease of the forest industry might only be a day's flight away.

Reporting unusual pests or diseases

If you see unusual disease symptoms or a plant pest, report it to your plantation manager, who will take the following precautions to contain the pest and protect other parts of your plantation:

- Report to local forest health or biosecurity expert, or call the Exotic Plant Pest Hotline.
- Do not touch, move, or transport potentially affected plant material unless instructed by forest health or biosecurity expert.
- Mark the site, record the location and limit access to the area.
- Take a photo and note any symptoms.
- Limit or restrict operations in the area while waiting for identification.

Do not send samples until you have received advice on the correct protocol for sampling, packaging, handling and transport to the laboratory assigned for diagnosis.

The Exotic Plant Pest Hotline

Reporting of unusual pests is mandatory in Australia under the national agreement for dealing with Emergency Plant Pest incursions, the Emergency Plant Pest Response Deed.

If you see anything unusual, call the Exotic Plant Pest Hotline



Calls to the Exotic Plant Pest Hotline are confidential. Your call will be forwarded to an experienced person in your state or territory government, who will ask some questions and arrange for an assessment of what you've found.

If the hotline in your state operates only during business hours, leave your full contact information and a brief description of the issue and your call will be followed up as soon as possible.



If you see anything unusual call the Exotic Plant Pest Hotline

What happens if an exotic pest or disease is confirmed

Within 24 hours of the initial identification of an exotic pest or disease, the relevant state agency, through the State Chief Plant Health Manager, will inform the Australian Chief Plant Protection Office who will notify all state agencies, relevant industry representatives and Plant Health Australia.

The relevant state or territory agriculture agency will seek a confirmatory diagnosis from another laboratory, usually within a different jurisdiction.

If the pest or disease is considered potentially serious and/or suspected to be an Emergency Plant Pest (EPP), the relevant state or territory agriculture department will usually adopt precautionary emergency containment measures. These measures, depending on the pest, may include:

- restricted access to the area
- restriction of operations in the area
- withdrawal of people, vehicles and machinery from the area
- control or containment measures.

If an EPP is confirmed, technical and economic considerations are reviewed, and a decision made whether to:

- attempt to eradicate, which would be managed under the Emergency Plant Pest Response Deed (EPPRD) and a Response Plan
- take another course of action, such as to contain or do nothing and accept potential long-term management of the pest.

Incorrect handling could spread the pest or disease further or render the samples unfit for diagnosis so always speak to an expert before taking a sample.

Emergency responses

In Australia, both industry and governments have a role to play in managing and funding emergency responses aimed at eradicating exotic pests and diseases.

Incursions by pests and diseases that are deemed to be Emergency Plant Pests (EPPs) are dealt with under the terms of the Emergency Plant Pest Response Deed (EPPRD).

The Australian Government, all state and territory governments and the major plant industry bodies have signed the EPPRD, along with Plant Health Australia, the organisation that has custodianship of the agreement.

Under the EPPRD all decisions are made by committees that include government and industry representatives. The decisions of the Consultative Committee on Emergency Plant Pests (CCEPP) relate to the technical feasibility of eradication of the pest in question. Decisions of the National Management Group (NMG) are made on technical advice from the CCEPP and financial considerations.

The EPPRD sets out arrangements that automatically activate when a suspected EPP is detected in Australia, allowing swift and effective action. The fast response time is required to provide an opportunity to eradicate the pest or disease.

The Australian Forest Products Association has signed the EPPRD, giving the industry a seat at the decision making table in the event of an incursion that affects the plantation forest industry.

Since the industry benefits from a response to eradicate any new pest or disease that would compromise production, Australian Forest Products Association covers a proportion of the costs of an approved Response Plan by having appropriate levy arrangements in place.

Also under the conditions of the EPPRD, the forest industry (including members of AFPA) has a responsibility to report suspect pests or diseases.

For more information on the EPPRD and emergency responses, go to planthealthaustralia.com.au/epprd.

Owner Reimbursement Costs

Without early reporting, eradication efforts can be futile as the pest or disease is too widespread and established in the environment. In these cases, the growers then have to manage the pest or disease as endemic, leading to permanent increases in production costs.

To encourage early reporting and improve the chance of successful eradication, the Emergency Plant Pest Response Deed (EPPRD) allows for payments to growers who can demonstrate financial losses or costs incurred as a result of an effort to eradicate an Emergency Plant Pest. Owner Reimbursement Costs (ORCs) may cover costs associated with Response Plan actions, such as the destruction of trees, enforced fallow periods and additional chemical treatments. Their purpose is to reduce the financial impact of the eradication response.

ORCs apply only to approved Response Plans aimed at eradication, and only to industries that are signatories to the EPPRD, like the plantation forest industry.

ORC Evidence Frameworks are developed for each cropping sector to provide extra guidance and a hierarchy of evidence is used to determine specific ORC valuations. Approved ORC Evidence Frameworks can be found at planthealthaustralia.com.au/orc



Industry and government have a role to play in managing emergency responses

Hypothetical exotic bark beetle incursion and response

This is an example scenario of an exotic pest detection and emergency response that is relevant to the plantation industry. It indicates actions that could occur during a response, and the potential impacts on a business.



Mountain pine beetle (*Dendroctonus ponderosae*)

Detection

An exotic bark beetle was detected in drought stressed Radiata pine (*Pinus radiata*) during routine forest health surveys in a regional plantation during late August and was reported to the Exotic Plant Pest Hotline.

The beetle was identified as Mountain pine beetle (*Dendroctonus ponderosae*). In the past, this insect pest has caused massive damage to Ponderosa pine (*Pinus ponderosa*) in North American forests www.nrcan.gc.ca/forests/insects-diseases/13381. Under conditions that lead to an outbreak, it can kill healthy trees across a wide area, including Loblolly pine (*P. taeda*) and Slash pine (*P. elliottii*).

A meeting of the Consultative Committee on Emergency Plant Pests (CCEPP) was convened, which included plant biosecurity experts, forest health experts and industry representatives. The committee agreed that this pest was an Emergency Plant Pest, that it was a significant threat to the forest industry, and an attempt should be made to eradicate it under the terms of the Emergency Plant Pest Response Deed.

Operations

A Control Centre was established in the local forestry office in the region where the beetles were detected. This was staffed by state biosecurity officers, emergency response teams, forest health experts, and staff from the forest industry and local state government who assisted in the emergency response. A total of 150 people were involved over the next nine months, with a skeleton staff thereafter for the next two years.

The Control Centre managed the surveillance activities, quarantine area, tracing, and destruction and fumigation operations. A small laboratory was also set-up in the Control Centre to identify beetles collected during the campaign. Contractors were required for some of this work. The Control Centre also liaised with the CCEPP and industry.

Quarantine

Mountain pine beetles are known to disperse over relatively long distances, but can travel further distances via infested material such as bark and logs. Therefore, quarantine restrictions were immediately enforced on the affected and adjacent plantations. This included:

- no removal of logs from the area
- restricted vehicle movement into and out of the quarantine zone
- inspection and removal of all plant material from vehicles using wash-down facilities.
- strict movement controls were also put in place for other plantations in the region.

The restrictions were in place for an initial three month period while surveillance determined the distribution of the pest. These restrictions were ongoing for a further two years to ensure that the pest was not spread by the movement of people.

Surveillance

The initial aim of surveys was to determine the distribution of the beetle. Insect traps containing lures for Mountain pine beetle were placed at strategic points within the immediate area of the detection, in the adjacent plantations, and in plantations throughout the region.

Beetles begin to emerge from logs in early spring, and will breed and continue to fly through to late summer. It was essential to determine the extent of the beetle infestation early on, prior to build-up of populations and further spread. Ground surveillance of these areas, together with inspection of dead and dying trees and slash, also occurred.

Tracing

The origin of the pest and whether it had moved further afield was essential information to decide on the feasibility of eradication.

At the time of the detection, harvesting had just begun in the affected plantation, and some unbarked logs had been trucked to a port for export. The port facilities and logs awaiting shipment were inspected for Mountain pine beetle. Insect traps were also set in the port and surrounding area, where amenity pine trees were growing.

Fumigation and destruction of logs

No logs had been exported that year. Methyl-bromide was used to fumigate all of the log stacks at the port facility, and logs remaining in the affected and adjacent plantations. Following fumigation, they were chipped and left on site.

Slash within the affected and adjacent plantations was chopper-rolled to break up plant material that could feed and harbour the beetle. Beetles captured in insect traps placed around the port and within the plantations were killed.

A non-commercial thinning operation in a nearby plantation had attracted many beetles (these were detected during the first month of the emergency response surveys). Because of the amount of beetles in the felled trees in this compartment, and the large amount of susceptible material, the entire compartment was felled and burnt.



Mountain pine beetle has caused massive damage to Ponderosa pine in North American

Outcome

After three months of trapping and surveillance, it was found that beetles had established in a five kilometre area surrounding the initial detection.

Within six months of detection, all slash and logs in the area, including a two kilometre buffer zone, had been either fumigated or destroyed, significantly reducing material on which the beetles could feed and breed.

Trapping and supplementary surveillance continued in the region for a further two flight seasons. No forest operations were permitted in the quarantine zone during this time.

Mountain pine beetles were caught in traps in the port facility only during the initial flight season following detection.

When no Mountain pine beetles were detected in the third flight season following detection, it was considered to be eradicated from the region, and quarantine restrictions were lifted, allowing normal forestry operations to resume.

Cost

In an emergency response, the leading state agency and relevant industry(s) provide in-kind support from their staff.

Additional costs include travel, contractors, chemicals, consumables and vehicles. During the three years of the response, these additional costs amounted to \$5 million. Not included in this amount is the costs incurred by the grower for lost production due to restrictions on harvesting within the quarantine zone, nor the financial impact of losing the overseas contract to supply logs.

Planting and propagating material

Always source planting material from reputable nurseries. Inspect material on arrival to reduce the risk of pests and diseases from entering and establishing in your plantation.



Infected, infested or contaminated propagation material is a source of pests and diseases, allowing them to enter your plantation. It can be difficult to accurately assess the quality of propagation material just by sight as it can appear clean and healthy at the time of purchase. Pathogens may require certain environmental conditions or extended periods of time before they show obvious symptoms.

Plantation managers should ensure that they use reputable nurseries that have systems in place to ensure the supply of high quality, pest and disease free material. Material should also be checked thoroughly on arrival for pests and diseases.

Supplying nurseries should ensure propagation material is sourced from reputable suppliers who maintain records of where material was sourced and grown.

Plantation managers should maintain a register of their propagation material to allow products to be fully traced. Information recorded should include the source of the material and contact details, variety/provenance, number of plants obtained, areas on the property where the material was planted and the planting date.

Never use poor quality or pest/disease-affected planting material, as it has the potential to infect your entire plantation.



Always inspect propagation material before planting to ensure it is free of pests and diseases.



Managing people and machinery movement

People, vehicles and machinery can carry pests and diseases onto and around your plantation.



Pests and diseases can be spread in soil and on plant material that adheres to vehicles, equipment, footwear and clothing. Anyone visiting your plantation or property is a potential biosecurity threat.

Not all plantation owners will be able to implement all of these suggestions. However, where feasible these recommendations will assist in managing biosecurity risks.



Biosecurity signs

Well-designed signs demonstrate your commitment to plantation biosecurity. They also serve to alert people to the potential impact of their visit, and remind them that they share responsibility for maintaining biosecurity.

Signs should be placed at the main external entrances, in visitor parking areas and at any wash-down facilities.

Managing people movement

If possible, direct all visitors (such as utility providers and contractors) to a designated area and ask them to notify you of their presence. Ask that people stay to paths and designated roadways as much as possible when moving around the plantation.

Controlling and limiting access to production areas will assist in minimising biosecurity risks.

Some people pose an increased biosecurity risk to your plantation and need to be managed. High risk people include anyone who travels from plantation-to-plantation or from one region to another. Notable examples are contractors, workers, earthmoving companies, fire fighters, utility providers (such as power, water, gas and communications employees), research personnel, consultants and mining operators, any of whom might enter properties in their day-to-day operations.



Make sure workers know about any biosecurity risks in the region or specific issues in the plantation

Inform workers or contractors of your biosecurity requirements

Make sure that staff, contractors, consultants and anyone entering your plantation knows about your biosecurity requirements. These messages could be included in visitor induction sessions, handout material or operating procedures (where applicable).

Make sure workers know about any biosecurity risks in the region or specific issues in the plantation. They should also be familiar with common pests or diseases in the plantation and know how to report anything unusual.

Keep a record of visitors

It is good practice to maintain a visitor register to document who has been on your property, where they have come from and where they are going in the plantation and after they leave. A suitable recording sheet is on page 60.

Visitor/contractor records are one of the most useful tools in the event of a serious pest or disease incursion. These records allow investigators to trace the origin and spread of any incursion.



Each state has legislation and/or codes of practice in place governing the movement of machinery and equipment

Reducing risks posed by machinery and equipment

Any machinery coming onto your property poses a risk of spreading pests and diseases between plantations.

It is important to keep all equipment clean and ensure that any machinery brought into the plantation does not pose a risk. Follow appropriate hygiene practices. As an example, if the vehicle has been operating in a high risk area, adopt more stringent measures, such as vehicle wash-down.

Each state has legislation and/or codes of practice in place governing the movement of machinery, equipment and other potential sources of pest or disease contamination.

Further information about state codes of practice is available on page 19.

The Quarantine Domestic website **quarantinedomestic.gov.au** provides information about domestic quarantine.

The website of the Subcommittee on Domestic Quarantine and Market Access, **domesticquarantine.org.au**, lists the Interstate Certificates of Assurance that relate to moving commercial consignments of products between states.

While it may seem like a lot of effort, inspecting and cleaning vehicles and machinery is more time and cost effective than managing a new pest or disease.

Biosecurity and Quality Assurance

The biosecurity practices described in this manual will assist you in achieving accreditation under Industry Best Management Practice (IBMP) and Quality Assurance (QA) schemes.



These schemes strengthen the forest industry's potential to detect, control and eradicate plant pest or disease outbreaks rapidly, before extensive damage occurs. IBMP and QA schemes that cover some of the suggested biosecurity measures include:

ISO 14001

www.iso.org/iso/iso14000

ISO 14001 is an international standard that describes the specifications and requirements for an Environment Management System.

Australian Forest Certification Scheme

www.forestrystandard.org.au

The Australian Forest Certification Scheme, which includes the Australian Standard for Sustainable Forest Management (SFM), sets out the requirements for forest owners seeking SFM certification. It includes requirements for the management of pests and diseases.

Forest Stewardship Council

www.fscus.org

Forest Stewardship Council is another SFM certification scheme. It also includes requirements for the management of pests and diseases within forests/plantations.



Codes of Practice

Each state has recommended codes of practice. These codes of practice provide information on a range of forest activities. Links are provided below for further information.

State	Link to code of practice
New South Wales	www.forestrycorporation.com.au/resources/pubs
Northern Territory	www.planningplantations.com.au/assets/content/plantation_management/regulation_planning/nt4.html
Queensland	www.business.qld.gov.au/industry/forests-and-wood/regulation-legislation
South Australia	http://www.pir.sa.gov.au/__data/assets/pdf_file/0011/254765/guidelines_for_plantation_forestry_in_sa_web.pdf
Tasmania	www.fpa.tas.gov.au/forest_practices_system/elements_of_the_forest_practices_system
Victoria	www.depi.vic.gov.au/forestry-and-land-use/timber-production/timber-harvesting-regulation/code-of-practice-for-timber-production
Western Australia	www.forestindustries.com.au/upload/Code%20of%20Practice%20for%20Timber%20Plantations%20in%20WA%202014.pdf



Biosecurity checklist for forest managers

Biosecurity practices help to protect your plantation from pests and diseases. The following checklist can be used to identify the strengths and weaknesses of your plantation biosecurity activities.



To ensure your plantation has the best protection against the introduction and spread of new pests and diseases, use the following self-assessment questions to identify the strengths and weaknesses of your plantation activities.

Date of biosecurity check: _____

RECOMMENDED PRACTICES	ASSESSMENT	ACTION REQUIRED
Pests and diseases		
Staff and contractors are familiar with common established and high priority exotic pests and diseases		
Staff and contractors know how to report unusual pests, diseases or symptoms		
Forest health surveillance is regularly conducted, with activities and results recorded, even when nothing is found		
Biosecurity awareness material and training is available to staff and contractors		
Planting and propagating material		
The origin of planting or propagation material is known and is sourced from reputable suppliers		
The health status of propagation material is thoroughly checked upon arrival		
Records of planting material and its source are maintained		
Equipment used to store or transport propagation material is cleaned on arrival, and exit from the plantation		
Forest nursery staff are familiar with exotic and established forest pests and diseases		
People and machinery movement		
Biosecurity signs with contact details at strategic locations		
Biosecurity messages incorporated into visitor and contractor induction material		
The manager/owner collaborates with neighbours to reduce biosecurity threats and to promote biosecurity at a regional level		
Managers know where high risk areas are to inform hygiene procedures		
Appropriate procedures in place to manage the risks posed by machinery entering the plantation		

Pests and diseases

High priority exotic pests and diseases pose a major threat to the Australian forest industry. The climate of Australia's plantation forest production regions would allow each of these pests and diseases to survive, spread and establish, should they be introduced into these regions.

High priority exotic pest and disease threats of the forest industry

Make sure that you, your staff and your contractors are familiar with these pests and diseases, any of which would have serious consequences should they make it through border controls.

Any suspicious pests or symptoms should be reported to the Exotic Plant Pest Hotline on 1800 084 881 or to your state or territory department of agriculture.

Additional information on many of these pests and diseases is included on the Plant Health Australia website planthealthaustralia.com.au/industries/plantation-forestry/.

Remain vigilant for anything unusual in your plantation.

If a pest, disease or unusual symptom is found that is not normally present in your plantation, it should be reported as it may be new not only to your plantation, but to the region, state or even Australia.

Report anything unusual to the Exotic Plant Pest Hotline 1800 084 881

The pest fact sheets in this manual have been sorted according to their hosts. However, several species of moth have very wide host ranges and feed on both softwood and hardwood species. These include:

- White spotted tussock moth (*Orgyia thyellina*) page 34
- Nun moth (*Lymantria monacha*) page 36
- Gypsy moth (*Lymantria dispar*) page 38

Factsheets for these species are included in the softwood section of this manual.



Giant pine scale

Description

Giant pine scale (*Marchalina hellenica*) is a large scale insect that reaches a length of 8–19 mm and 3–5 mm wide. The pest feeds on the sap of various conifers and, while feeding, secretes a white waxy substance.

The insect feeds mostly on the lower trunk of infested trees but will also feed on branches or, in some cases, above ground roots.

This species originates from the Mediterranean but has recently been detected in Australia in Melbourne and Adelaide, where an eradication effort is underway.

Primary hosts

Giant pine scale feeds exclusively on plants of the family Pinaceae. Overseas host records include the following genera and species:

- **Firs:** Greek fir (*Abies cephalonica*), Caucasian fir (*A. nordmanniana*),
- **Spruces:** Engelmann spruce (*Picea engelmannii*), Oriental spruce (*P. orientalis*)
- **Pines:** Turkish pine (*Pinus brutia*), Aleppo pine (*P. halepensis*), Caucasian pine (*P. kochiana*, *P. sosnowskyi*), Corsican pine (*P. laricio*), Black pine (*P. nigra*), Stone pine (*P. pinea*), Scots pine (*P. sylvestris*).

In Victoria and South Australia, Giant pine scale has been found on Aleppo pine (*Pinus halapensis*), Stone pine (*Pinus pinea*), Radiata pine (*Pinus radiata*) and Blue spruce (*Picea pungens*) (the last record is yet to be confirmed by Melbourne Herbarium; the last two represent new host records for the pest).

Symptoms

Giant pine scale produces a distinctive white, cotton-like, wax secretion, which stands out within the cracks of the dark trunks and branches of host trees. The insect prefers the lower part of the tree and mainly occurs on the trunk, but it may also be found on branches well up in the canopy, and even on exposed roots.

Giant pine scale attacks the tree from the base to the top. In heavily infested trees, there is gradual desiccation, causing drained needles and branch dieback which can eventually kill the tree.



Waxy secretions caused by the Giant pine scale



Adult Giant pine scale



What it can be confused with

Early symptoms could be confused with Pine woolly aphid (*Pineus pin*) but a significant infestation is unlikely to be confused with other organisms. Any unusual symptoms should be reported to the Exotic Plant Pest Hotline on 1800 084 881.

Plant part affected

Giant pine scale typically affects the lower part of the tree, mainly occurring on the trunk, but it may also be found on branches well up in the canopy, and even on exposed roots.

Age of plant

All ages of tree are susceptible.

Time of year pest is most likely to be seen

Early infestations will be most prevalent during spring and summer. Heavy infestations can be observed throughout the year as the old scale covering remains on the tree even when the insect has died.

Further information

Victorian Department of Economic Development Giant pine scale: A new insect pest of pine, spruce and fir trees. Available from www.depi.vic.gov.au/__data/assets/pdf_file/0010/290746/Giant-pine-scale-a-new-insect-pest_final-A4.pdf.

PIRSA Exotic Pest Alert: look out for Giant pine scale (*Marchalina hellenica*). Available from www.pir.sa.gov.au/__data/assets/pdf_file/0003/230844/Pest_Alert_-_Marchalina_hellenica.pdf.

NSW DPI Exotic Pest Alert Giant pine scale. Available from www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/542365/Exotic-Pest-Alert-Giant-pine-scale.pdf.

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Mountain pine beetle

Description

The Mountain pine beetle (*Dendroctonus ponderosae*) is considered the most destructive bark beetle pest native to western North America. The adults are stout, cylindrical, typically dark brown or black coloured beetles, ranging from 4–7.5 mm in length. There are four larval instars and a pupa. The larvae are white, without legs and look very similar to other bark beetle larvae. The mated females produce relatively straight, vertical egg galleries from which the developing larvae form perpendicular galleries. When mature, larvae construct oval pupation cells at the end of their tunnels before emerging through small exit holes as adults.



Lateral view of adult beetle

Pest and Diseases Image Library, Bugwood.org

Primary hosts

It is estimated that this bark beetle has affected several million hectares of forest in north western USA and south western Canada, predominantly killing Lodgepole (*Pinus contorta*) and Ponderosa pine (*P. ponderosa*). Under normal conditions, attacks are generally restricted to senescent, stressed or damaged trees. However, under ideal conditions, more pine species become susceptible, including Loblolly (*P. taeda*), Slash (*P. elliotii*) and Caribbean (*P. caribaea*) pine, and healthy trees become vulnerable to attack.

Symptoms

A large number of adult beetles can attack a single tree. The joint action of larval feeding and cambial colonisation by fungal species associated with the beetles can rapidly kill a host tree. Initially the crown remains green, then fades as the needles wilt and turn orange-red in colour. This distinctive crown colour can remain for many months before fading to brown-grey and then the needles fall to the ground.

Numerous small pitch tubes form on the bark of infected trees at the entrances to the beetle's tunnels. The pitch tubes consist of a mixture of resin and frass and vary in colour dependent on the host. Pitch tubes are typically found low on the tree.

Mountain pine beetles commonly transmit Blue stain fungi (e.g. *Ceratocystis* and *Ophiostoma* spp.) which invade the sapwood, affecting the value and aesthetic qualities of milled timber.



Larval form of Mountain pine beetle

Scott Turnock, USDA Forest Service, Bugwood.org



Small resin 'pitch tubes'

Kenneth E. Gibson, USDA Forest Service, Bugwood.org



What it can be confused with

Adult Mountain pine beetles are similar in appearance to Ips species, including the Five-spined bark beetle (*Ips grandicollis*). These can be distinguished by the shape of their elytra (wing covers). The Five-spined bark beetle has small spines on their elytra while Mountain pine beetles do not have spines.

Plant part affected

Successful galleries are usually found along the main trunk within a metre of the ground up to the middle branches.

Age of plant

Under normal conditions large diameter trees are preferred, but during outbreaks the beetles will attack smaller trees from approximately 12 cm DBH and larger.

Time of year pest is most likely to be seen

The overwintering adults emerge in warm conditions and fly to nearby un-infested trees. However, the adults are capable of flying up to 100 km under ideal conditions.

Further information

Pest and Disease Image Library (PaDIL) Mountain pine beetle. Available from www.padil.gov.au/pests-and-diseases/pest/main/135643.

Letherman DA, Aguayo I, Mehall TM (2014) Mountain pine beetle. Colorado State University. Available from www.ext.colostate.edu/pubs/insect/05528.html

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Small resin 'pitch tubes' on spruce



Larval feeding galleries



Infected trees showing leaf symptoms

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Red turpentine beetle

Description

Adult Red turpentine beetles (*Dendroctonus valens*) are relatively large (6–10 mm long) beetles, which have brown to black bodies with reddish-brown elytra (wing coverings). The larvae are C-shaped, legless and mainly white, with a distinct, dark head capsule, small dark patch at the tip of the abdomen and, in older larvae, a line of small darker tubercles (look like small spots) along the body.

A pair of adult beetles will feed on the phloem, forming an egg gallery. Up to one hundred eggs are laid in an elongated mass along the side of the galleries. Unlike other species of *Dendroctonus* and *Ips*, the larvae are gregarious, living in communal chambers within the phloem, often forming fan shapes with irregular margins as the larvae feed side by side in an irregular line. The galleries are not clean: they are usually packed with boring dust or frass.

Primary hosts

This species is a widespread forest pest in Northern and Central America and was introduced into China in the late 1980s, presumably on unprocessed logs. It has been recorded on at least 40 species of conifer including species of Pine (*Pinus*), Larch (*Larix*), Fir (*Abies*), and Douglas fir (*Pseudotsuga menziesii*). In North America, Ponderosa pine (*Pinus ponderosa*) is the species most frequently attacked, but Radiata pine (*P. radiata*) is the species most frequently killed.

In North America, the adults primarily attack freshly cut stumps or the bases of dying or stressed trees (e.g. pest, drought or fire affected trees). However, in China both stressed and healthy trees are attacked.

Symptoms

Early symptoms include the presence of red boring dust and frass which collects in the bark crevices or drops to the base of the tree. Pitch tubes (resin mixed with frass) also form on infected trees. The pitch tubes are usually found up to a height of three metres above the ground and can vary in size, texture and colour depending on the host species.

Infested trees will have entire crowns or individual branches presenting symptoms. The foliage of infected trees becomes pale green then turns orange-red before being shed months later.



Lateral view of adult beetle



Larval form of Red turpentine beetle



Red boring dust/frass at the base of an infested tree



What it can be confused with

Red turpentine beetles can potentially be confused with the Five-spined bark beetle (*Ips grandicollis*) which occurs in Australia. The two species can be separated by their size (Red turpentine beetles are larger) and the shape of their wing covers.

Black pine beetle (*Hylastes ater*) and Golden-haired bark beetle (*Hylurgus ligniperda*) occur in Australia and also form galleries beneath the bark of stumps or the lower stems of weak, dying trees. However, the adults of both species are smaller than the Red turpentine beetle.

Plant part affected

Attacks on standing trees are concentrated on the lower trunk and exposed roots. When attacks are made just above the ground, the galleries may extend below the ground, along the larger roots.

Age of plant

This species does not attack seedlings or small trees. Trees usually require a stem of more than 20 cm DBH.

Time of year pest is most likely to be seen

During warmer conditions the adults will emerge, commonly from recently cut stumps or stressed/dying trees.

Further information

Pest and Disease Image Library (PaDIL) Red turpentine beetle. Available from www.padil.gov.au/pests-and-diseases/pest/main/135644

Global Invasive Species Database. *Dendroctonus valens* (insect). Available from issg.org/database/species/ecology.asp?si=1405&fr=1&sts=&lang=EN

Diagnostic protocol for the identification and detection of *Dendroctonus valens* LeConte (Red Turpentine Beetle). Prepared for the Subcommittee on Plant Health Diagnostic Standards. Available from plantbiosecuritydiagnostics.net.au/wordpress/wp-content/uploads/2015/03/NDP-24-Red-turpentine-beetle-Dendroctonus-valens-V1.2.pdf

Zhengliang Y, Jiangha S, Owen D and Zhongning Z (2005) The red turpentine beetle, *Dendroctonus valens* Le Conte (Scolytidae): an exotic invasive pest of pine in China. *Biodiversity and Conservation* 14: 1735–1760.

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Pitch tubes on Ponderosa pine



Gregarious larval feeding chamber

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European spruce bark beetle

Description

Adults of the European spruce bark beetle (*Ips typographus*) are small (4.0–5.5 mm) cylindrical beetles, dark brown to black in colour. The eggs, larvae and pupae are very similar in appearance to other species of *Ips*.

Male beetles bore into the inner bark and construct a nuptial chamber and emit pheromones that attract from one to four females. Each female then bores an egg gallery out from the nuptial chamber and lays approximately 50 eggs. After the eggs hatch, the larvae feed in galleries which radiate at right angles to the egg gallery. The newly emerged adults feed for a short time under the bark before emerging through small (2–3 mm) round exit holes. The young adults may swarm en-mass to locate new hosts. Alternatively, under cold conditions, they will overwinter in litter or under the bark.

Primary hosts

The European spruce bark beetle is one of the most damaging insect pests of Spruce (*Picea*) in Europe and Asia. It normally infests diseased, damaged or recently fallen trees, including windthrow, harvest slash or logs. With high population levels in an outbreak, it can colonise and kill apparently healthy trees, including species of Pine (*Pinus*), Fir (*Abies*) and Larch (*Larix*).

In Europe, outbreaks can be caused by disturbances such as fire or in areas presenting large volumes of harvesting residue. Stands that have been stressed by extreme weather conditions, including periods of drought, are also susceptible.

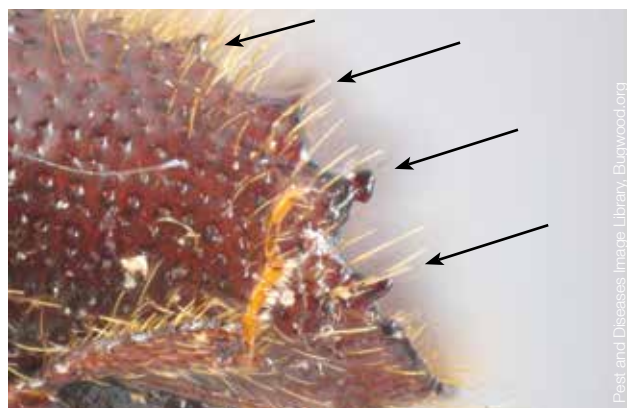
Symptoms

As with most bark beetles, it transmits Blue stain fungi (e.g. *Ceratocystis* and *Ophiostoma* spp.) which interfere with water translocation and prevent water transport to the foliage. Blue stain fungi also invade the sapwood, affecting the value and aesthetic qualities of milled timber.

Under low population levels, the crowns can appear a lighter green colour, and green needles can often be seen on the ground. In a mass attack the needles can turn reddish-brown in colour as a result of desiccation caused by the rapid spread of Blue stain fungi.



Lateral view of adult beetle



Elytral spines of European spruce bark beetle. Note 4 spines and club shaped third spine (arrows)



Elytral spines of European spruce bark beetle



Other symptoms of bark beetle attack include the presence of red-brown borer dust in bark crevices or at the base of the trunk and small pitch (resin) tubes extruding from the bark.

What it can be confused with

The *Ips* genus has more than 30 species and distinguishing between them can be difficult. The number and shape of the spines on their elytral declivity (the steeply sloped section at the back of their wing covers) is an important feature to distinguish between species of *Ips*. The third spine on each side of the elytral declivity of European spruce bark beetles is the largest one, and is club like on the tip. The Five-spined bark beetle (*Ips grandicollis*), which is established in Australia, has five of these spines.

Plant part affected

European spruce bark beetles prefer mature trees and usually infest the lower and middle parts of the trunk.

Time of year pest is most likely to be seen

In Europe, depending on the temperature, young adults normally emerge in spring and are capable of flying tens of kilometres to locate suitable host material.

Further information

Wermelinger B (2004) Ecology and management of the spruce bark beetle *Ips typographus* – a review of recent research. *Forest Ecology and Management* 202: 67–82.

Kimoto T and Duthie-Holt M (2006) *Exotic Forest Insect Guidebook 2006*. Canadian Food Inspection Agency. Available from www.inspection.gc.ca/plants/plant-protection/insects/eng/1307077188885/1307078272806

European spruce bark beetle. Pest and Disease Image Library (PaDIL). Available from www.padil.gov.au/pests-and-diseases/pest/main/135618



Larval galleries

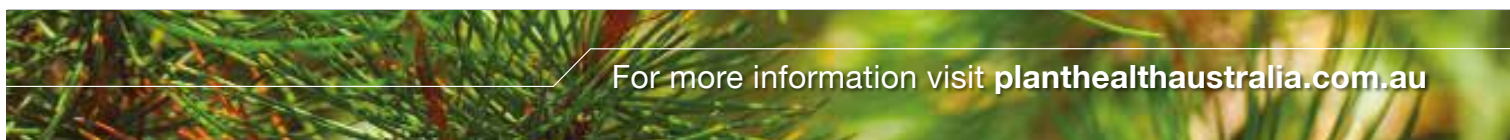


External symptoms of attack (red-brown frass)

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Giant wood wasp

Description

The Giant wood wasp (*Urocerus gigas*) is a large (10–40 mm long) black and yellow coloured wasp with a black and yellow head, black thorax and a yellow and black abdomen. This species of wood wasp occurs widely in North America, Europe and Asia as well as in parts of South America and northern Africa, attacking members of the Pinaceae family of trees, particularly Pines, Firs and Spruce.

The 30 mm long larvae are a cream-white colour and cause extensive boring damage while feeding. Larvae spend between one and three years feeding before pupating. They usually attack stressed, dying or damaged pine trees, but relatively healthy trees can be attacked when large populations of wasps develop. Timber in service cannot be re-infested, though live adults can complete development in such timber. A pathogenic fungus is also spread by these wasps and can cause serious damage to pine plantations.

Primary hosts

The larvae of Giant wood wasps feed on fungi contained in the sapwood and heartwood of:

- a range of conifers including Pine (*Pinus*), Fir (*Abies*), Cedar (*Cedrus*) and Spruce (*Picea*)
- some broad leaf species such as Ash (*Fraxinus*) and Willow (*Salix*).

Symptoms

Eggs are laid on the lower three metres of the trunk of damaged or weakened trees in spring and summer. The larvae hatch and develop inside the host plant, creating feeding galleries. Females have also been reported to lay eggs on logs and sawn timber. When larvae exit the host they create round 3–8 mm diameter exit holes.

What it can be confused with

At first glance this species is similar to the naturalised *Sirex* wood wasp (*Sirex noctilio*). Males of the two species are very similar and require close examination to be identified. A distinguishing feature is that male Giant wood wasps have some yellow on the sides of



Adult female. Note black stripe on abdomen



Adult female ovipositing



Adult male. Note yellow on head and abdomen



their heads, unlike the completely black head of the male *Sirex* wood wasp. Females of the two species are more easily separated. Female Giant wood wasps have a yellow abdomen with a black stripe; while the female *Sirex* wood wasp has a completely black abdomen.

Plant part affected

The Giant wood wasp attacks the trunk of damaged or weakened trees.

Age of plant

This species typically prefers to attack larger, often damaged trees.

Time of year pest is most likely to be seen

Overseas, adults typically emerge during late spring and early summer. Damage caused by larvae can be detected at any time of the year.

Further information

Davis EE and Venette RC (2005) Mini risk assessment. Giant wood wasp, *Urocetus gigas* L. [Hymenoptera: Siricidae]. US Department of Agriculture, Animal and Plant Health Inspection Service. Available from extension.entm.purdue.edu/CAPS/pdf/datasheets/GiantWoodwasp.pdf

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Female (left) and male (right) *Sirex* wood wasp. Note colouration



Larval form of Giant wood wasp



Damage (pupal galleries) caused by Giant wood wasp

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White spotted tussock moth

Description

White spotted tussock moths (*Orgyia thyellina*) are medium sized with a 25–40 mm wingspan. In the female the forewing colour is dirty white with distinctive wavy brown and black markings, while in the male the forewings are brown with a wavy, mottled pattern. Females produced late in the season only have vestigial wings.

Eggs are white to buff in colour and are laid in clusters about the size of a 10 cent coin.

Young larvae are black and very hairy; mature larvae are about 30 mm long with four distinctive white tufts of hair, an orange stripe down each side and two yellow spots on the rear.

The white spotted tussock moth is found in China, Korea, Japan, Far Eastern Russia, and Taiwan. The first known record outside of its native range was in Auckland, New Zealand, in 1996, but this was subsequently eradicated with a spraying program.

Primary hosts

White spotted tussock moths are a pest of many forest and horticultural trees. The larvae feed on a wide range of hosts including Rose (*Rosa*), Birch (*Betula*), Ebony (*Diospyros*), Elm (*Ulmus*), Maple (*Acer*), Mulberry (*Morus*), Oak (*Quercus*), Willow (*Salix*), Douglas fir (*Pseudotsuga menziesii*) and Pine (*Pinus*).

Symptoms

At first larvae skeletonise leaves, but as they grow the larvae devour all but the main vein and petiole.

What it can be confused with

There are native moths with similar larvae. These include the Painted pine moth (*Orgyia australis*) which also has a wide host range. Larvae need be reared through to adult moths to enable specialist diagnosis. Any suspect larvae or adults should be reported.



Female moth



Male moth



Larval form of White spotted tussock moth



Plant part affected

Larvae feed on the foliage of a range of species.

Age of plant

Outbreaks of white spotted tussock moth are driven more by the prevalence of susceptible species in the landscape than by tree age.

Time of year pest is most likely to be seen

Larvae and adults are present during spring and summer months. In Japan, there are two or three generations per year in which females show wing dimorphism. The spring or summer generation(s) are fully winged and capable of flight, but the autumn generation is wingless and mainly sedentary.

Further information

Field guide to exotic pests and diseases: White spotted tussock moth. Department of Agriculture. Available from <http://www.agriculture.gov.au/pests-diseases-weeds/plant/forestry/forests-timber>

Pest and Disease Image Library (PaDIL) White-spotted tussock moth. Available from www.padil.gov.au/pests-and-diseases/pest/main/136273

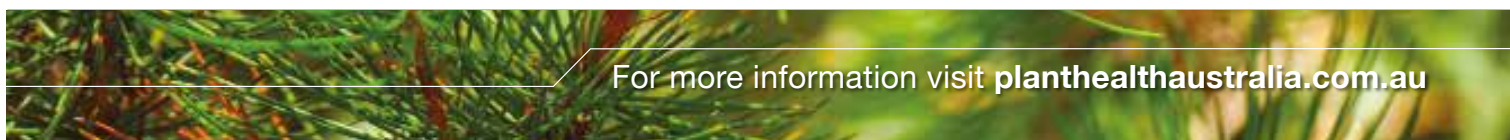
White-Spotted Tussock Moth. Ministry for Primary Industries. Available from www.biosecurity.govt.nz/pests-diseases/forests/white-spotted-tussock-moth/

Hosking G, Clearwater J, Handiside J, Kay M, Ray J and Simmons N (2003) Tussock moth eradication – a success story from New Zealand. *International Journal of Pest Management* 49: 17–24.

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Nun moth

Description

Nun moths (*Lymantria monacha*) are medium-sized moths with a wingspan of 35–55 mm. The forewings of both sexes are white with wavy dark bands. Wing colour can vary greatly with white and dark forms being present. Nun moths are widespread in Europe and Asia.

Eggs are dark grey and are laid in masses of 20 to 100 in bark crevices or under bark scales or lichen.

Larvae are up to 35 mm long with a grey-yellow body and with tufts of hair of various lengths along the sides of the body. The first four abdominal segments have a dorsal pair of bluish spots; the sixth and seventh segments have dorsal orange lumps. The head is pale brown with dense black markings.

Primary hosts

Hosts include a wide range of broad-leaved trees such as Oak (*Quercus*), Maple (*Acer*), Ash (*Fraxinus*), Birch (*Betula*), Apple (*Malus*), other fruit trees, and conifers such as Pine (*Pinus*), Spruce (*Picea*), Fir (*Abies*) and Larch (*Larix*).

Outbreaks of the Nun moth are often observed in Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*) stands in central Europe.

Symptoms

Defoliation of leaves or needles. Complete defoliation of stands is observed during outbreaks.

What it can be confused with

The most likely stages to be observed in a plantation are the larvae. There are a number of other hairy lepidopteran caterpillars, native and exotic, that can resemble Nun moth larvae, including some native *Lymantria* species. Larvae need to be reared through to adult moths to enable specialist diagnosis. Any suspect moths or larvae should be reported.

Plant part affected

Leaves of both broadleaved and conifer tree species are affected.



Adult female (L) and male (R)



Eggs under bark scales



Larval form of Nun moth



Age of plant

Outbreaks of Nun moth are driven more by the prevalence of susceptible species in the landscape than by tree age. Infestations appear to be more frequent in monocultures growing on poor sites.

Time of year pest is most likely to be seen

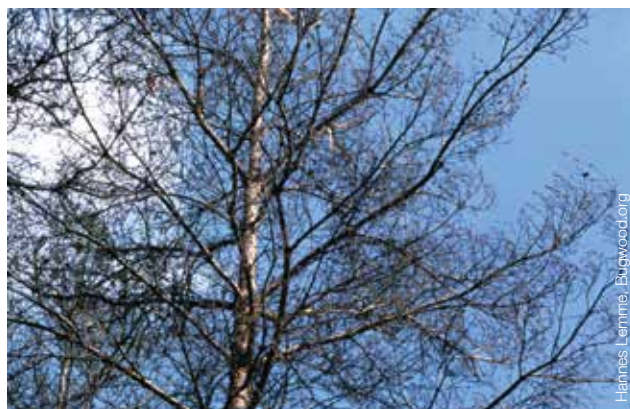
In the northern hemisphere, eggs hatch in spring and caterpillars develop through to pupation in 40–80 days. Pupation occurs on tree trunks or in crowns, or occasionally on surrounding vegetation cover. Flights by adult moths occur from mid-summer to early autumn.

For further information

Nun moth (*Lymantria monacha*), bugwood wiki.
Available from wiki.bugwood.org/Archive:Atlas/Lymantria_monacha

Michigan State University's invasive species factsheets:
Nun moth *Lymantria monacha*. Available from
www.ipm.msu.edu/uploads/files/Forecasting_invasion_risks/nunMoth.pdf

Pests and Diseases Image Library (PaDIL) Nun moth *Lymantria monacha* (Linnaeus) (Lepidoptera: Lymantriidae). Available from www.padil.gov.au/pests-and-diseases/pest/main/136274

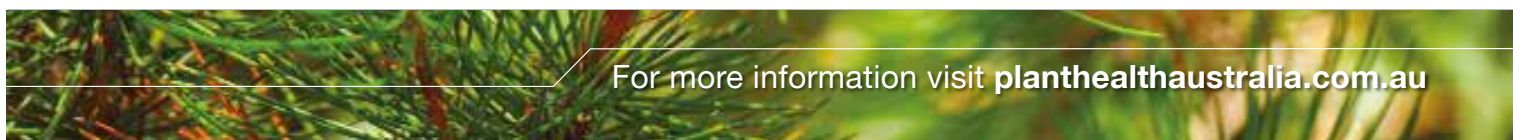


Defoliation by Nun moth larvae on Scots Pine (*Pinus sylvestris*)

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Gypsy moth

Description

There are two main biotypes of Gypsy moth (*Lymantria dispar*): the Asian gypsy moth (*L. dispar asiatica*) and the European gypsy moth (*L. dispar dispar*). Their appearance is similar, although the female European gypsy moth is usually flightless. This species complex occurs in regions of northern Africa, Asia, Europe, and North America.

The female moth is a large (40–70 mm wingspan), distinctive moth with wavy, dark-coloured bands across the forewings. Males are smaller (30–40 mm wingspan) and brown with darker brown patterns on the wings.

Egg masses contain 100–1000 eggs and are covered with yellowish coloured scales from the female moth. Laying of eggs on vehicles, cargo containers and ships provides a highly effective method of dispersal.

Larvae can grow to 70 mm in length, are dark, hairy and in the later instars have a characteristic double row of dots along the back: five pairs of blue followed by six pairs of red dots.

Primary hosts

The Gypsy moth is an extreme generalist herbivore and is known to complete development on more than 650 species of plants from at least 24 families, including forest, orchard and ornamental trees. This host range includes both Eucalypts (*Eucalyptus*) and Pines (*Pinus*).

Symptoms

Damage from early instar larvae appears as small holes in the leaf. As the larvae grow, the holes become larger and feeding occurs along the leaf margin. In the final instar stage the larvae consume the entire leaf. Large, eruptive populations occur in cycles and appear to be more frequent in the Asian biotype. Generally, larvae feed by day in the early instars and at night from the fourth instar onwards. However, at high population densities, larvae feed continuously, day and night, until the host's foliage is completely removed. Repeated defoliations can cause tree death. Tree mortality also occurs if Gypsy moth defoliation coincides with another stress, like drought. The larval hairs cause allergies in some people.



Male (L) and female (R) adult Gypsy moths



Gypsy moth egg masses on a tree trunk



Larval stage of Gypsy moth



What can it be confused with

The most likely stages to be observed in a plantation are the larvae. There are a number of other hairy lepidopteran caterpillars, native and exotic, that can resemble Gypsy moth larvae, including some native *Lymantria* species. However, the distinctive patterning of the double row of dots along the back of larvae is reasonably diagnostic. Larvae need to be reared through to adult moths to enable specialist diagnosis. Any suspect moths or larvae should be reported.

Plant part affected

Leaves of both broad-leaved and conifer species are affected.

Age of plant

Outbreaks of Gypsy moth are more driven by the prevalence of susceptible species in the landscape than by tree age.

Time of year pest is most likely to be seen

In the northern hemisphere, eggs are laid from late summer to early autumn and hatch in the following spring.

Further information

Threat specific Contingency Plan for the Nursery and Garden Industry. Gypsy Moth – (Asian and European Strains) *Lymantria dispar dispar*. (2009) Plant Health Australia. www.planthealthaustralia.com.au/wp-content/uploads/2013/03/Gypsy-moth-CP-2009.pdf.

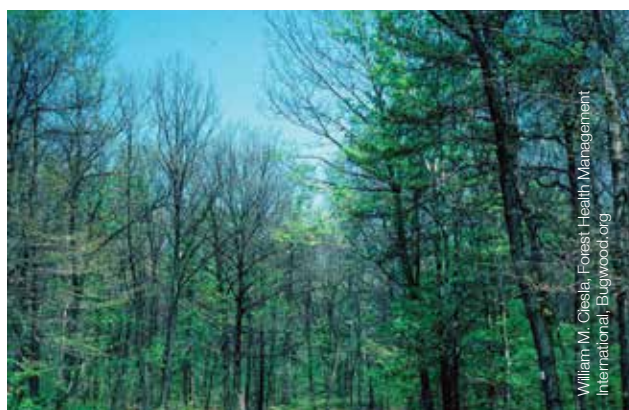
US Forest Service. Gypsy moth in North America. www.fs.fed.us (search for gypsy moth).

Pests and Diseases Image Library (PaDIL) Asian gypsy moth *Lymantria dispar dispar* race Asian. Available from www.padil.gov.au/pests-and-diseases/pest/main/136285

Pests and Diseases Image Library (PaDIL) European gypsy moth (*Lymantria dispar dispar* race European). Available from www.padil.gov.au/pests-and-diseases/pest/main/136283



Larval stage. Note colouration



Defoliation of broadleaved forest by Gypsy moth

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Pine pitch canker

Description

Pine pitch canker is a disease of Pines which follows infection by the fungal pathogen *Fusarium circinatum*. This fungus is thought to have originated in Mexico. In the United States the disease was first recorded in 1946 and has also been recorded in Japan, South Africa, Chile, Spain and Italy. It can infect the vegetative and reproductive parts of susceptible trees of all ages. The disease is associated with reduced wood production and can result in high levels of mortality causing substantial economic losses.

Primary hosts

Some 57 species of *Pinus* are considered susceptible to *F. circinatum* as well as Douglas fir. Research suggests Radiata pine is likely to be the most susceptible species.

Symptoms

Wilting and yellow-green discolouration of needles are usually the first symptoms of Pine pitch canker. Affected needles subsequently turn red, shoots droop and branch dieback occurs away from the point of infection. Branch dieback progresses throughout the crown. Copious resin typically bleeds from infection sites resulting in a characteristic honey-coloured appearance. In young trees infection can occur close to ground level, causing stem girdling and subsequent mortality. In older trees large, sunken stem lesions can develop where the bark has been killed. Small, salmon pink fruiting structures called sporodochia may sometimes be observed on the bark of affected stems.

What it can be confused with

Pitch canker can be confused with Shoot wilt caused by *Diplodia sapinea*, due to the general appearance of shoot blight and needle discolouration. However, *Diplodia* infection causes a characteristic blue stain in affected wood, and fruiting bodies are black.

Fusarium lateritium has been observed to cause similar symptoms in Radiata pine in Tasmania, including shoot dieback, resinosis and visually identical sporodochia. It can only be distinguished from *F. circinatum* by DNA analysis. Any suspect symptoms should be reported.



Needle discolouration and shoot dieback caused by Pine pitch canker on Radiata pine



Resin soaked tissue



Copious resin bleeding at infection site



Plant part showing symptoms

Needles and shoots typically show symptoms, but as the disease reaches an advanced state the main stem in older trees can become infected. The disease can infect all vegetative and reproductive parts including shoots, branches, cones, seeds, stems and exposed roots.

Age of plant

Seedling to mature trees can be infected.

Time of year pest is most likely to be seen

In southeast United States symptoms appear in autumn, and continue through winter and spring. In the Mediterranean climate of California, branch tip cankers tend to progress faster in spring than in autumn. Temperature and moisture both affect spore germination and infection. Ideal temperatures appear to be between 20–25°C, and high ambient humidity is generally more conducive to infection. Various stress factors can predispose trees to infection. In Australia, disease expression is likely to be more pronounced in warm, moist climates.



Symptoms of Pine pitch canker

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Further information

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Hammerbacher A (2006) Biology and epidemiology of *Fusarium circinatum*. Master of Science dissertation, Department of Microbiology and Plant Pathology, University of Pretoria, Pretoria. Available from
<http://repository.up.ac.za/bitstream/handle/2263/25707/dissertation.pdf?sequence=1>

Wingfield MJ, Hammerbracher A, Ganley RJ, Steenkamp ET, Gordon TR, Wingfield BD and Coutinho TA (2008) Pitch canker caused by *Fusarium circinatum* – a growing threat to pine plantations and forests worldwide. *Australasian Plant Pathology* 37: 319–334.

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Daño foliar de pino

Description

Daño foliar del pino (*Phytophthora pinifolia*) was first observed in Radiata pine (*Pinus radiata*) plantations in Chile in 2004. It is characterised by the appearance (in late autumn and early winter) of translucent bands – seen at first glance as black bands – on pine needles, and later as a generalised discoloration of foliage (initially golden and brown), resulting in a greyish aspect of the crown. The crown turns reddish brown by the end of spring as a consequence of necrosis of affected foliage, eventually leading to defoliation. Repeated infection causes growth loss of mature trees, while severe infection can kill young (1–2 years old) trees.

Primary hosts

Radiata pine (*P. radiata*) is the main species affected.

Symptoms

Initial symptoms are a pale area at the base of needles and dark resinous bands on green needles, which at first glance appear as black bands. The bands appear translucent when held to the light. The most obvious signs of infection are a chlorosis and reddening of the past year's needles, which eventually die and appear grey-red before falling. Often these needles hang on trees for some time. The first needles to display these symptoms are often on the lower side of branches. The current year's needles are not affected. When infection reaches the base of needles, resin exudes from the point of attachment, causing death of cambial cells surrounding the fascicles, resulting in small cankers on the stem. Affected needles often hang at right angles from branches. On younger trees (less than four years old), lesions form on young shoots and needles causing the terminal shoots to wilt and die. Resin can be found exuding profusely from these young tissues.

What it can be confused with

It can be confused with *Dothistroma* needle blight, due to the general appearance of needle blight. Needles infected with *Dothistroma septosporum* can be distinguished by characteristic red-banding. It can also be confused with *Cyclaneusma* needle cast, due to the general appearance of chlorosis and needle blight; but needles infected with *Cyclaneusma minus*



Pale area at base of needles and resinous bands



Grey-red needles in lower crown



Drops of resin at base of infected needles



have a yellow-brown mottled appearance. Symptoms of Daño foliar del pino, *Dothistroma* needle blight and *Cyclaneusma* needle cast may be present on a tree at the same time, and the presence of one may mask low level infection of another.

It can also be confused with the exotic Red needle cast (*Phytophthora pluvialis*), due to general appearance of needle blight, and also black resinous bands. These two *Phytophthora* species require laboratory examination to distinguish. Any suspect symptoms should be reported.

Plant part showing symptoms

Symptoms are apparent on the foliage of infected trees. On mature trees the symptoms usually start lower on the crown and spread upwards. On young trees stems and young shoots are affected.

Age of plant

Seedling to mature trees.

Time of year pest is most likely to be seen

In Chile's Mediterranean climate, symptoms are generally observed from autumn to late spring, during the rainy season. Infection is most severe from winter to early spring, with defoliation mostly during spring. In Australia the disease will be most pronounced during prolonged wet periods.

Further information

Duran A, Gryzenhout M, Slippers B, Ahumada A, Rotella A, Flores F, Wingfield BD and Wingfield MJ (2008) *Phytophthora pinifolia* sp. nov. associated with a serious needle disease of *Pinus radiata* in Chile. *Plant Pathology* 57: 715–727.

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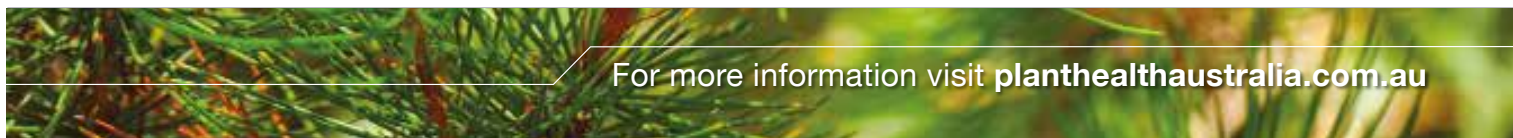


Tissue discoloration on affected branch

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Red needle cast

Description

Red needle cast (*Phytophthora pluvialis*) was first observed in Radiata pine (*Pinus radiata*) plantations in New Zealand in the late 2000s. Although the pathogen is present in Oregon in the United States, the disease it causes is only known to occur in New Zealand. It is characterised by pale-olive or khaki lesions with distinct dark resinous bands. Lesions eventually turn yellow then brown, with trees developing an overall reddish appearance. Symptoms are most common in autumn to late spring (in wet conditions), with defoliation common in late spring. The general appearance of the disease can be confused with *Dothistroma* needle blight, with symptoms and defoliation beginning in the lower crown.

Primary hosts

Radiata pine (*P. radiata*) is the main species affected.

Symptoms

The first obvious symptoms are a pale-olive or khaki colour anywhere on needles, but more common at the base of needles, which usually have small, distinct dark resinous bands. These lesions expand, turning yellow then brown, giving the trees an overall reddish appearance. Infected needles are quickly shed. The disease is more common in the lower crown, but moves up the crown when severe. Severe disease can almost completely defoliate affected trees, but recovery is common and in the following year the one-year foliage is unaffected.

What it can be confused with

It can be confused with *Dothistroma* needle blight, due to the general appearance of needle blight; but needles infected with *Dothistroma septosporum* can be distinguished by characteristic red-banding. It can also be confused with *Cyclaneusma* needle cast, due to general appearance of chlorosis and needle blight; but needles infected with *Cyclaneusma minus* have a yellow-brown mottled appearance. Symptoms of Red needle cast, *Dothistroma* needle blight and *Cyclaneusma* needle cast may be present on a tree at the same time, and the presence of one may mask low level infection of another.



Red needle cast lesions on needles showing the pale-olive or khaki regions with the small, distinct dark resinous bands



Early symptoms of red needle cast. Needles are turning a dull green, reddish colour but are still attached to the tree.



Symptoms of red needle cast are similar to those of *Dothistroma* needle blight. However, the needles of red needle cast are easily shed from the tree, unlike those of *dothistroma* needle blight.



Symptoms are also similar to the exotic Daño foliar del pino, with the pale coloured lesions on needles and the dark resinous bands as well as overall reddish colour to trees. However, Red needle cast does not cause resin bleeding or lesions on woody tissues. Laboratory examination is required to distinguish between these two *Phytophthora* species. Any suspect symptoms should be reported.

Plant part showing symptoms

Symptoms are visible on pine needles.

Age of plant

Symptoms are more common on trees greater than four years old. Trees less than four years old can be infected but this usually happens when they are adjacent to heavily infected stands.

Time of year pest is most likely to be seen

In New Zealand, Red needle cast generally occurs between autumn and spring in areas experiencing prolonged wet conditions. Once early needle lesions have been observed, the progression to reddening and defoliation tends to occur rapidly, within a few weeks. High risk areas tend to be those prone to mist and fog. The timing of disease expression and severity of the disease has differed between regions and years, and is likely dependent on climatic factors.

Further information

Dick MA, Williams NM, Bader MK-F, Gardner JF and Bulman LS (2014) Pathogenicity of *Phytophthora pluvialis* to *Pinus radiata* and its relations with red needle cast disease in New Zealand. *New Zealand Journal of Forestry Science* 44: 6.

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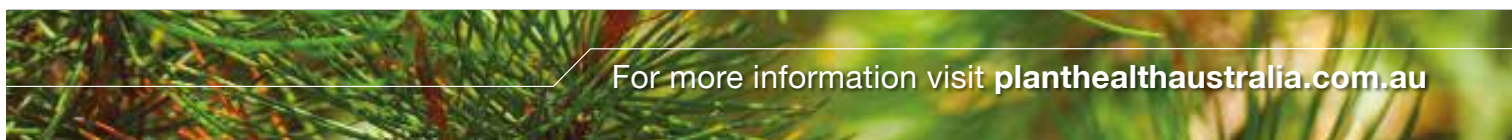


Infected needles are cast from the tree

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Western gall rust

Description

Western gall rust (*Peridermium harknessii*) is a disease of two- and three-needle species of *Pinus*. It is restricted to continental North America. The disease is characterised by the appearance of small hemispherical, cylindrical or globose swellings in one year old stem and branch wood. These swellings develop from infection that took place in the previous year when the soft, new shoots were extending. The swellings enlarge in subsequent years to produce woody galls typically 1–10 cm in diameter, but sometimes up to 30 cm. Young seedlings can rapidly die following infection before any swellings develop. In older plants, galls developing in branches lead to shoot blight and branch dieback, while galls on the main stem result in swollen stem deformities. Heavy gall infestations on individual trees suppress their growth and leads to their premature death.

Primary hosts

Two- and three-needle *Pinus* species, including Radiata pine (*Pinus radiata*).

Symptoms

The site of initial infection in soft, expanding shoots develops localised reddening which may progress to localised tissue death. Needles near the infection site may die. Over the next year globose, hemispherical or spindle-shaped woody swellings develop at the infection site and grow to a diameter of 1–2 cm. These swellings continue to grow in size over successive years to produce woody galls. During the spring and early summer, the bark of galls two years and older sloughs off to expose a mass of yellow-orange spores.

What it can be confused with

Rounded woody swellings morphologically indistinguishable from young (not yet producing spores) Western gall rust galls have been seen on Radiata pine (*P. radiata*) in Australia. DNA testing is necessary to confirm the presence or absence of Western gall rust in such instances. Any suspect symptoms should be reported.

Swellings associated with native Australian mistletoe growing on *Pinus*, although rare, superficially look like those caused by Western gall rust.



Immature gall (less than 2 years old)



Bark splitting to expose yellow-orange spore mass in a mature gall



Mature non-sporulating gall



Plant part showing symptoms

Symptoms are observed on one year and older wood of the stem and branches.

Age of plant

The disease affects all ages from seedlings to mature trees but most new infections occur in trees younger than 15 years of age.

Time of year pest is most likely to be seen

Infection occurs in spring to coincide with shoot extension. However, visibly detectable swelling at the points of infection does not usually appear until the following year. Rupturing of the surface of mature galls (generally two years or more after infection) to expose the underlying mass of orange spores occurs in spring and early summer.

Further information

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Old KM (1981) Western gall rust, a serious disease of *Pinus radiata* in California. *Australian Forestry* 44: 178–184.

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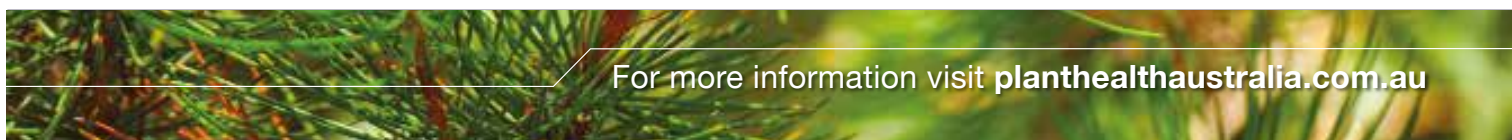


Multiple galls on single tree



Early stages of infection on a Pine

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Pinewood nematode and its beetle vectors

Description

The Pinewood nematode (*Bursaphelenchus xylophilus*) is native to North America but are found in Portugal and parts of Asia (including Japan). The nematode has caused widespread losses to pines and other conifers overseas.

Nematodes are transmitted by a range of wood boring beetles, but *Bursaphelenchus xylophilus* is primarily spread by large (up to three cm long and approximately one cm wide) mottled, brown–grey coloured beetles with long antennae that belong to the *Monochamus* genus. All of the known vectors are exotic species, including the Japanese Pine sawyer beetle (*Monochamus alternatus*) and the Pine sawyer beetles, *M. galloprovincialis* and *M. carolinensis*.

Pinewood nematodes can be mycophagous (fungus eating) or phytophagous (plant eating). The nematode is mycophagous when it infects weakened or dying trees, which become infected when the nematodes are spread by ovipositing *Monochamus* beetles. Nematodes feed on Blue stain fungi (*Ceratocystis* spp.) within the wood before moving to pupal chambers and attaching to the emerging beetles under the elytra (hardened forewing). The nematode can also be phytophagous when it is introduced to a susceptible host through wounds made by feeding adult *Monochamus* beetles on the small soft branches. The nematodes multiply in the resin canals before moving through the tree. The resin canals of the tree become blocked, resulting in wilting of the affected branches within a few weeks of infection, causing rapid tree death (often only 30–40 days after infection).

Primary hosts

Pinewood nematodes mostly affect *Pinus* but will also attack Spruce (*Picea*), Douglas fir (*Pseudotsuga menziesii*), Larch (*Larix*) and Fir (*Abies*). Only a small number of Pines – including Maritime pine (*P. pinaster*), Black pine (*P. nigra*) and Scots pine (*P. sylvestris*) – are known to be killed by this nematode as mature trees.

Pine sawyer beetles (*Monochamus* spp.) attack a range of conifers including Pine (*Pinus*), Spruce (*Picea*), Larch (*Larix*) and Fir (*Abies*). Pines are the preferred hosts.



Pinewood nematode damage



Pinewood nematode infected Black pine (*P. nigra*)



Japanese pine sawyer beetle, a vector of the Pinewood nematode



Symptoms

When the nematodes infect susceptible trees via wounds caused by feeding beetles, they multiply in the resin canals and cause xylem blockages. This causes yellowing and wilting symptoms of the infected branches, followed by rapid tree death.

Adult *Monochamus* beetles may be seen feeding on the young shoots of various conifers. The larvae are borers and can be detected by the presence of exit holes on weakened or dying trees.

Trees that have low susceptibility can still become infested but may not show symptoms for many years.

What it can be confused with

The long antennae of *Monochamus* beetles makes them fairly distinctive from other beetles likely to be found in pine plantations. When the nematodes infect a susceptible tree they cause yellowing and wilting symptoms that could also be caused by other disorders (e.g. *Sirex* wood wasp, *Diplodia* canker or Five-spined bark beetle (*Ips grandicollis*)), but the rapid onset of symptoms (as short as four weeks) and tree death is unlike other endemic pests or diseases.

Plant part affected

When the Pinewood nematode infects susceptible trees via *Monochamus* beetle feeding wounds, the nematodes cause xylem blockages, resulting in the yellowing and wilting of the affected branches and rapid tree death.

Beetles feed on the young shoots of host plants and breed in weakened or dying trees.

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Feeding Japanese pine sawyer beetle, a vector of the Pinewood nematode

Age of plant

Monochamus beetles prefer to oviposit in weakened or dying trees. However, most damage is caused when the nematodes infect healthy trees via *Monochamus* beetle feeding wounds, which can be seen on trees of any age.

Time of year pest is most likely to be seen

Symptoms of the Pinewood nematode typically develop shortly after *Monochamus* beetles have fed and transmitted the nematode. Adult *Monochamus* beetles emerge in early summer, so symptoms and adult beetles are most likely to be seen at that time. The disease caused by the nematode is also exacerbated by hot, dry weather throughout summer.

Further information

CABI and EPPO Data Sheets on Quarantine Pests: *Bursaphelenchus xylophilus*. Available from www.eppo.int/QUARANTINE/nematodes/Bursaphelenchus_xylophilus/BURXSY_ds.pdf

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Donald PA, Stamps WT and Linit MJ (2003) Pine wilt disease. The Plant Health Instructor. DOI:10.1094/PHI-I-2003-0130-01. Available from www.apsnet.org/edcenter/intropp/lessons/nematodes/pages/pinewilt.aspx.

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Chrysoporthe canker

Description

Chrysoporthe canker of Eucalypts (*Eucalyptus*) in South Africa, Mozambique, Malawi and Zambia is caused by the fungus *Chrysoporthe austroafricana*. The same disease in South America and Asia is caused respectively by *Chr. cubensis* (previously known as *Cryphonectria cubensis*) and *Chr. deuterocubensis* (previously known as *C. cubensis*).

Primary hosts

The pathogen affects Eucalypts (including *Eucalyptus* and *Corymbia* spp.), *Tibouchina* spp. and *Syzygium* spp.

Symptoms

Disease on young trees causes wilt and dieback of foliage relating to the girdling of the stem by the pathogen.

Symptoms on older trees include the swelling, cracking and splitting of the bark at the bases of trees or the formation of sunken, target shaped cankers higher up the stems. These can be associated with branch stubs.

What it can be confused with

The disease can be confused with root diseases in young trees (such as *Phytophthora*) or with genetic/physiological disorders.

Plant part affected

The pathogen affects the stem and branches of infected hosts.

Age of plant

The disease can affect trees of all ages.

Time of year pest is most likely to be seen

The disease can be seen at any time of the year and is more likely to be an issue in subtropical and tropical regions of Australia.



Swelling and cracking at the base of *Eucalyptus* spp. caused by *Chrysoporthe austroafricana* infection



Discolouration of the cambium associated with infection by *Chr. deuterocubensis* on seedlings of *Corymbia* spp.



Further information

Nakabonge G, Roux J, Gryzenhout M, and Wingfield MJ (2006) Distribution of *Chrysosporthe* canker pathogens on *Eucalyptus* and *Syzygium* spp. in eastern and southern Africa. *Plant Disease* 90: 734–740.

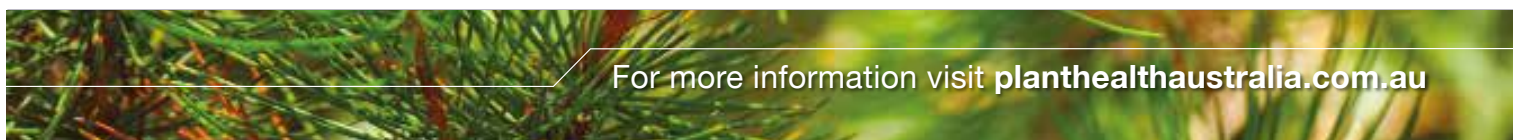
Heath RN, Gryzenhout M, Roux J and Wingfield MJ (2006) Discovery of the canker pathogen *Chrysosporthe austroafricana* on native *Syzygium* spp. in South Africa. *Plant Disease* 90: 433–438.

MC Fan CC, Huang ROC, Huang JS, Tsai SF, Yeh HC and Hong CF (2013) First report of *Chrysosporthe deuterocubensis* causing canker on *Syzygium samarangense* in Taiwan. *Plant Disease* 97: 1508.

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Shoot-borer

Description

Shoot-borers are moths belonging to the *Hypsipyla* genus and are significant pests of members of the Meliaceae (Mahogany) plant family. Attack from the native Cedar tip moth (*Hypsipyla robusta*) has effectively prevented the commercial growth of Australian red cedar (*Toona ciliata*) in Australia.

Plantings of related African mahogany (*Khaya senegalensis*) in northern Australia have remained relatively free of damage despite heavy attack from *Hypsipyla* shoot-borers in its native African range. Previously, it was considered that the same species is present in both Australia and Africa. However recent work has shown there are three African species, none of which are *H. robusta*, explaining the lack of damage in Australia to date. However, it is important to be aware of the biosecurity risks from exotic *Hypsipyla* spp., as well as the risks of local *H. robusta* populations 'host switching' to feed on African mahogany.

The adult moth has brown forewings with a faint zigzag pattern and buff hindwings with a darker margin. Male and female moths are similar in appearance though the female is generally larger (30–35 mm wingspan). Moths are nocturnal and rarely seen during daylight hours.

Eggs are oval and white when first laid, developing distinct red and white banding within 24 hours.

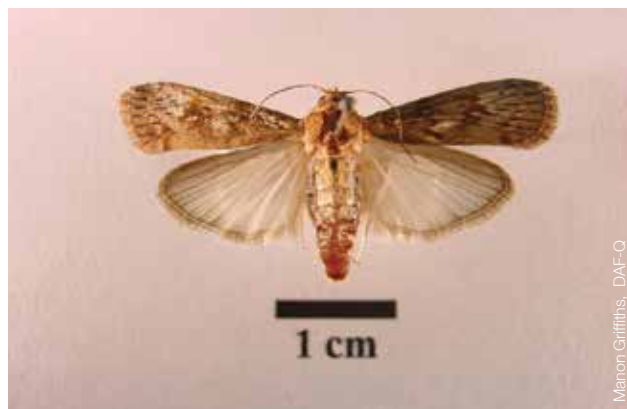
Larvae are reddish-brown in colour initially, turning blue just prior to pupation. Larvae feed within the plant tissue and are concealed for most of their development time. Larvae pupate within cocoons spun in the stem tunnels of young trees, beneath the bark on mature trees, or amongst the leaf litter around the tree base.

Primary hosts

Larvae feed on members of the Meliaceae (Mahogany) plant family. This includes native species such as the Australian red cedar (*T. ciliata*) and mangroves in the *Xylocarpus* genus. African mahoganys (*Khaya* spp.) can also be affected.

Symptoms

Larvae feed in growing tips, resulting in shoot death and loss of apical dominance. Continued damage leads to a stunted, multi-branched tree. Larvae move frequently



Adult female Cedar tip moth



Last instar larva of Cedar tip moth in feeding tunnel



Early instar feeding in growing tip of African mahogany (*Khaya senegalensis*)



in the early instars, initiating feeding at several locations resulting in droplets of sap and wilting of the tip. Older larvae often move down the tree to burrow into older, lignified tissue and can girdle and kill branches or the main stem. Larvae in Nigeria will also feed in the fruits of African mahogany (*K. senegalensis*).

What it can be confused with

Early damage causing wilting of growing tips could be confused with a number of generalist sap sucking Hemiptera, including Fruit spotting bug (*Amblypelta nitida*) and Crusader bug (*Mictis profana*). More advanced tunnelling in shoots is quite distinctive. Any unusual moths or larvae should be reported and investigated further.

Plant part affected

Larvae feed on shoots and fruits of their hosts.

Age of plant

Trees of any age can be attacked, ranging from young seedlings to mature trees.

Time of year pest is most likely to be seen

Larvae of this pest are active and likely to be seen from August–September until April–May when cooler and/or drier conditions limit the availability of young shoots.

Further information

Griffiths MW (2001) The biology and ecology of Hypsipyla shoot borers. In *Proceedings of an International Workshop on Hypsipyla shoot borers in the Meliaceae*, Kandy, Sri Lanka 20–23 August 1996. Hauxwell C and Floyd RB (eds). Australian Centre for International Agricultural Research, Canberra pp 74–80. Available from aciar.gov.au/files/node/2239/pr97chapter3.pdf.



Frass and webbing associated with shoot boring in Lagos mahogany (*Khaya ivorensis*)

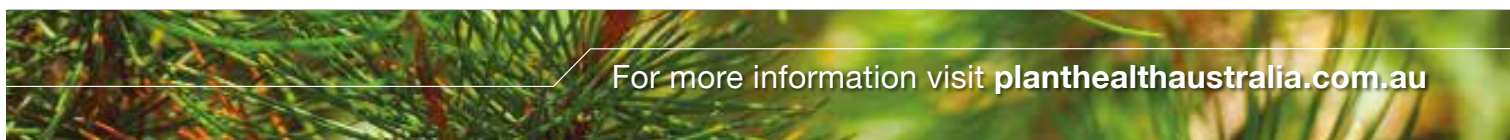


Old shoot damage showing frass and tip death in African mahogany (*Khaya senegalensis*)

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Sudden oak death

Description

Sudden oak death is a serious disease that affects over 100 species of plant. Cool, moist conditions favour the survival, infection and spread of *Phytophthora ramorum*.

Three different disease syndromes can be caused by *P. ramorum*: stem or bole canker (known as Sudden oak death or SOD), leaf blight (known as Ramorum leaf blight) and twig blight/dieback (known as Ramorum shoot dieback). Individual plant species can display more than one syndrome of the disease.

Primary hosts

Susceptible hosts include trees (both hardwood and conifer species), shrubs, herbaceous plants and ferns. Of particular concern to Australia are the field observations and pathogenicity tests that show a number of Australian genera from a range of families are highly susceptible to *P. ramorum*, including species of *Eucalyptus* such as Cider gum (*E. gunnii*) and Mountain ash (*E. regnans*). Radiata pine also appears susceptible to the disease.

Symptoms

Sudden oak death: Symptoms of SOD on large trees include cankers on the lower trunk that have brown or black discoloured outer bark and bleeding sap. Sunken or flattened cankers may occur beneath bleeding areas. When the outer bark is removed from bleeding cankers, mottled areas of necrotic, dead, discoloured inner-bark tissues can be seen. Black 'zone lines' are often present within and around edges of the necrotic areas. Cankers develop before foliar symptoms become evident and crown death appears rapid.

Ramorum shoot dieback and leaf blight: Shoot dieback is characterised by blackened shoots, with or without foliage attached. Symptoms of leaf blight include diffuse brown to dark-brown spots or blotches with fuzzy margins, frequently at the leaf tip (where moisture can accumulate and remain for extended periods encouraging infection). Eventually, entire leaves can turn brown to black and may fall prematurely.



Bleeding canker on Tan oak infected with *Phytophthora ramorum*



Bark removed showing mottled areas of necrotic, dead discoloured inner-bark



Twig dieback on Tan oak



What it can be confused with

Bleeding cankers with dark stained wood under the bark can occur on the trunks of several plant species in Australia caused by other pathogens such as *Botryosphaeria*, other *Phytophthora* species and Chestnut blight (*Cryphonectria parasitica*) (introduced into Victoria in 2010, where efforts to eradicate it are ongoing). However, *P. ramorum* appears to attack only aerial plant parts and disease symptoms have not been detected below the soil-line.

Armillaria species can also cause bleeding cankers, but can be easily distinguished by the white mycelial fans under the bark of infected trees. Other exotic pathogens such as Chrysoporthe canker (*Chrysoporthe cubensis*) and Teratosphaeria stem canker (*Teratosphaeria zuluense*) can also cause bleeding cankers.

Other aerial *Phytophthoras*, *Colletotrichum*, *Botryosphaeria* and *Botrytis* may cause foliar symptoms similar to those of Ramorum dieback. Abiotic factors such as sunburn may also give similar symptoms although in these cases a defined margin is usually expressed.

Plant part affected

The pathogen affects the stem, shoots and leaves of infected hosts.

Age of plant

The size and age of the plant displaying symptoms depends on the host species.

Time of year pest is most likely to be seen

Wet, cool periods support the growth of the pathogen.

If you see anything unusual, call the Exotic Plant Pest Hotline



Further information

Ireland KB, Hueberli D, Dell B, Smith IW, Rizzo DM and Hardy GESJ (2012) Potential susceptibility of Australian flora to a NA2 isolate of *Phytophthora ramorum* and pathogen sporulation potential. *Forest Pathology* 42: 305–320.

Ireland KB, Hueberli D, Dell B, Smith IW, Rizzo DM and Hardy GESJ (2012) Potential susceptibility of Australian native plant species to branch dieback and bole canker diseases caused by *Phytophthora ramorum*. *Plant Pathology* 61: 234–246.

Kliejunas JT (2010) Sudden oak death and *Phytophthora ramorum*: a summary of the literature. General Technical Report. Pacific Southwest Research Station, USDA Forest Service. Available from www.suddenoakdeath.org/wp-content/uploads/2010/03/psw_gtr234.pdf

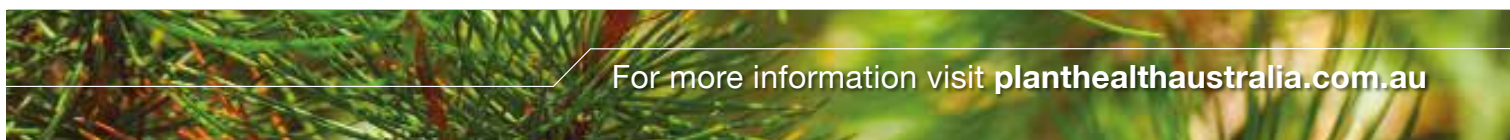


Ramorum leaf blight on California laurel



P. ramorum may be also confused with exotic pathogens that also cause bleeding cankers e.g. *Chrysoporthe* canker (*Chrysoporthe cubensis*)

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Teratosphaeria stem canker

Description

Teratosphaeria stem canker (caused by *Teratosphaeria gauchensis* and *T. zuluensis*) is one of the most important diseases affecting Eucalypts in Africa, Asia and South America. It was previously known as *Coniothyrium* stem canker, *Colletogloeopsis* stem canker and *Kirramyces* stem canker.

The canker was first reported in South Africa in 1987. It has also been reported in Zambia, Malawi, Mozambique, Ethiopia and Uganda. In Asia, it has been reported from China, Vietnam and Thailand. It has also been reported from Mexico.

The origin of *T. gauchensis* is hypothesised to be South American (Cortinas et al. 2011). *T. gauchensis* has been reported from Uruguay and Argentina in South America and Uganda and Ethiopia in Africa.

Primary hosts

These diseases affect *Eucalyptus* species including River red gum (*E. camaldulensis*), Flooded gum (*E. grandis*) and hybrids.

Symptoms

Symptoms caused by *T. zuluensis* and *T. gauchensis* are the same.

Symptoms first appear as small necrotic spots on the young green bark of Eucalypts. These can develop into large, girdling, stem cankers causing death of twigs and branches or young trees.

The disease also causes discrete sunken lesions which may merge to form large necrotic cankers on susceptible trees. The lesions have characteristic parallel cracks which give them a 'cat's eye' appearance. Fruiting bodies (pycnidia) can often be seen on the dead bark between cracks.

Kino (i.e. plant gum or sap) periodically exudes from resulting kino pockets in the wood of infected trees, staining stems and branches.

Epicormic shoots may develop on the stems of severely infected trees, and trees may develop brush-like, flattened crowns.



T. zuluensis lesions on immature stems of Flooded gum (*E. grandis*)



T. zuluensis lesions on mature stems of Flooded gum (*E. grandis*) in South Africa



What it can be confused with

The disease can be confused with *Caliciopsis* stem and branch canker (*Caliciopsis* sp.) or with damage caused by hail stones.

Plant part affected

The stems and branches are affected. On young green stems the disease causes sunken, necrotic lesions, while on older stems and branches the disease causes measles-like spots.

Infected timber is brittle and unsightly, making trees unsuitable for construction and sawn timber.

Age of plant

Trees of any age may be affected. Symptoms are not often seen on trees less than 12 months old.

Time of year pest is most likely to be seen

Symptoms may be seen at any time of the year but can be more severe in hot, humid areas, so it is more likely to be detected in subtropical and tropical regions of Australia.

Further information

Wingfield MJ, Crous PW, Coutinho TA (1997) A serious new canker disease of *Eucalyptus* in South Africa caused by a new species of *Coniothyrium*. *Mycopathologia* 136: 139–145.

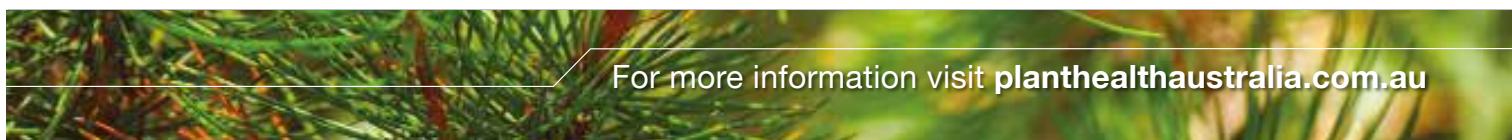
van Zyl LM, Coutinho TA and Wingfield MJ (2002) Morphological, cultural and pathogenic characteristics of *Coniothyrium zuluense* isolates from different plantation regions in South Africa. *Mycopathologia* 155: 149–153.

Cortinas MN, Barnes I, Wingfield BD and Wingfield MJ (2011) Unexpected genetic diversity revealed in the *Eucalyptus* canker pathogen *Teratosphaeria gauchensis*. *Australasian Plant Pathology* 40: 497–503.

If you see anything unusual, call the Exotic Plant Pest Hotline



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Further information

Useful contacts

More information on biosecurity and can be found through the following sources.

Contact details	
ORGANISATION	
Australian Forest Products Association	Phone: 02 6285 3833 Email: enquiries@ausfpa.com.au Website: www.ausfpa.com.au
Forest And Wood Products Australia	Phone: 03 9927 3200 Email: info@fwpa.com.au Website: www.fwpa.com.au
Plant Health Australia	Phone: 02 6215 7700 Email: biosecurity@phau.com.au Website: www.planthealthaustralia.com.au
Farm Biosecurity	Phone: 02 6215 7700 Email: info@farmbiosecurity.com.au Website: farmbiosecurity.com.au
GOVERNMENT	
Australian Government – Department of Agriculture	Phone: 02 6272 3933 Website: www.agriculture.gov.au
New South Wales – Department of Primary Industries	Phone: 1800 808 095 or 02 6391 3100 Website: www.dpi.nsw.gov.au
Northern Territory – Department of Primary Industry and Fisheries	Phone: 1800 808 095 or 08 8999 5511 Website: www.nt.gov.au/d/
Queensland – Department of Agriculture and Fisheries	Phone: 13 25 23 or 07 3404 6999 Website: www.daff.qld.gov.au
South Australia – Department of Primary Industries and Regions SA	Phone: 1300 666 010 or 08 8226 0995 Website: www.pir.sa.gov.au
Tasmania – Department of Primary Industries, Parks, Water and Environment	Phone: 1300 368 550 Website: www.dpipwe.tas.gov.au
Victoria – Department of Economic Development, Jobs, Transport and Resources	Phone: 13 61 86 Website: economicdevelopment.vic.gov.au
Western Australia – Department of Agriculture and Food	Phone: 08 9368 3333 Website: www.agric.wa.gov.au

If you see anything unusual call the Exotic Plant Pest Hotline 1800 084 881



Visitor register

Please enter your details to assist us with our forest biosecurity records

[illegible]

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881

An electronic version of this Visitor register can be downloaded from the Farm Biosecurity website **farmbiosecurity.com.au**

EXOTIC PLANT PEST HOTLINE
1800 084 881

Pest surveillance record

It is important to record both the absence or presence of pests.

Site:

Name of person inspecting:

Date:

		Established pests				Exotic pests*		Other pests found		Comments
Site	No. sites	Pest 1	Pest 2	Pest 3	Pest 4	Pest 1	Pest 2			

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881

* Estimate pest infestation level (e.g. zero/low/med/high or % trees affected) for both endemic and exotic pests and diseases.
An electronic version of this Pest surveillance datasheet can be downloaded from the Farm Biosecurity website farmbiosecurity.com.au



Notes

Notes

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