

Forest health guide:

**symptoms of insect
and fungal damage
on trees**



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Compiled by Ross Wylie, Janet McDonald, Tim Wardlaw and Simon Lawson



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The *Forest health guide: symptoms of insect and fungal damage on trees* is intended to help forestry and quarantine staff undertake tree health assessments, in both forest and urban environments. The guide is designed to be used as a quick reference to common symptoms of damage, not as an identification guide to particular insect pests and pathogens.

Readers should seek independent expert advice before making management decisions based on information from the guide.

What to do if you find damage

If you find evidence of insect or fungal damage:

Record details of the damage—its type, severity and locality—on a Forest Health Field Form, an example of which is provided at the end of this guide. Additional copies can be downloaded from the ACIAR project page on the Secretariat of the Pacific Community Plant Protection Services website (www.spc.int/pps/ACIAR/aciар_project.htm).

Send the form, along with digital photos and damage samples or specimens, to a specialist for identification in the laboratory. Contact your local forestry/agriculture agency or quarantine service for more information on where to send your sample.

If the problem is identified as being caused by a native pest and the damage is minor, it may be appropriate to monitor the situation and look for evidence that damage is intensifying before taking action.

If an exotic insect or disease is suspected, then an immediate response is required. Follow your local contingency plan for dealing with pest incursions. Usually, the first response will be to contact the nearest quarantine office or forestry agency to seek advice.

Insects



Image courtesy R Heu, Hawaii Department of Agriculture

Insects

Leaf eating
Sap sucking
Gall forming
Root feeding

A range of defoliating insects feed on leaf tissue. Some consume the leaf entirely, some make characteristic holes or tracks or scallop the leaf margins, while others tunnel beneath the surface of the leaf or skeletonise the leaf, removing all tissue except the veins.



Photo 1: Mining on a leaf caused by the caterpillar of a small moth.



Photo 2: Upper crown defoliation (leaf loss) caused by larvae and adults of leaf beetles. This type of damage is known as *broom topping*.



Photo 3: Larvae of a leaf beetle feeding on foliage. These larvae usually cluster together and feed from the leaf margins inwards, often consuming the whole leaf (image courtesy of D. de Little).



Photo 4: Typical scalloping of a leaf margin caused by an adult scarab beetle.



Photo 5: Leaf mine or blister caused by the larva (immature or juvenile stage) of a small beetle.



Photo 6: Holes cut in leaves by caterpillars of a small moth in the process of making a pupal chamber (where the caterpillar will change into an adult moth).



Photo 7: Close-up of leaf cutting by a moth caterpillar as it constructs a pupal chamber.



*Photo 8: Leaf skeletonising by moth caterpillars.
Most leaf tissue has been removed leaving only
the veins of the leaf.*



Sap feeding insects have sucking mouth parts that allow them to draw liquid from the host plant. Feeding can occur on most parts of the plant including leaves, stems, roots, fruits, flowers or even seeds. When feeding, these insects may inject toxins to help break down plant tissue. As a result, the plant tissue surrounding the feeding point may die. Feeding on tender shoots may cause the shoots to wilt and die.



Photo 1: Aphid infestation on shoots of a pine tree. These aphids produce a white waxy secretion which is easily recognised.



Photo 2: A small sap sucking bug feeding on the shoots of this young tree has caused shoot dieback and subsequent crown *bushing*.



Photo 3: Scale insects and ants on a twig. The ants protect the scale and feed on the scale's sugary excretions.



Photo 4: Massive infestation of gum tree scale insects on the stem of a eucalypt. Black sooty mould grows on the sugary excretions produced by these insects as they feed (image courtesy of D. de Little).



Photo 5: Feeding by this adult bug has caused wilting and death of the shoot.



Photo 6: Lerps (shelters) of a psyllid insect on a eucalypt leaf. Notice the purple blotches and necrosis (death of leaf tissue) caused by these insects' feeding.

Wood, bark and shoot feeding insects have well-developed mouth parts that allow them to tunnel in or chew woody tissue. Some feed on the outer surface of the bark, some tunnel in the cambial region beneath the bark or in shoots, while others tunnel deeply into the sapwood and heartwood. Common stem borers include beetles, moths, termites and wood wasps. Damage is often characteristic of particular insect groups and can be recognised by the type of tunnelling, frass (insect excreta and chewed wood particles) or webbing and staining.



Photo 1: Characteristic swelling associated with tunnelling by the larva of a jewel beetle beneath the bark. The beetle is commonly called the varicose borer because of the raised, vein-like welts on the stem.



Photo 2: Mud galleries of subterranean termites on the stem of a mahogany tree.



Photo 3: Larva of the mahogany shoot borer or tip moth (*Hypsipyla robusta*) in the shoot of a red cedar tree. The blue colour is typical of the late larval stage of this insect (image courtesy of A. Noskoff).



Photo 4: Typical frass and webbing associated with tunnelling by the mahogany shoot borer.



Photo 5: Tunnelling by the mahogany shoot borer can result in death of shoots and multiple branching.



Photo 6: Swelling of tree stem and frass associated with feeding by the larva of a giant wood moth.



Photo 7: Tunnelling beneath the bark of *Pinus* sp. by the larvae of the five-spined bark beetle (*Ips grandicollis*). Feeding by the larvae and its associated pathogenic fungi can result in the death of the tree.



Photo 8: Tunnelling by the larva of a longicorn (long-horn) beetle has girdled the stem of this young tree, causing it to break (image courtesy of D. de Little).



Photo 9: Characteristic galleries in a mahogany stem caused by dampwood termites.



Photo 10: Resinosis (sap bleeding) on the stem of a tree caused by tunnelling of an adult ambrosia beetle.



Photo 11: Dieback and mortality of mahogany seedlings due to attack by a scolytid beetle stem borer.

Galls are abnormal plant growths formed in response to infestation by insects or fungal pathogens. They may occur on leaves, shoots, branches and stems and come in many different shapes, sizes and colours. They are sometimes typical of particular agents.



Photo 1: Typical leaf gall caused by a small sap sucking scale insect.



Photo 2: Severe damage caused by the erythrina gall wasp to leaflets of *Erythrina* sp. (image courtesy of R. Heu, Hawaii Department of Agriculture).



Photo 3: Leaf gall caused by a rust fungus.



Photo 4: Galls on a eucalypt leaf caused by small wasp larvae feeding.



Photo 5: Galls along the midrib of a eucalypt leaf caused by small wasp larvae.





Several insect groups feed on roots of trees. Some, like white grubs (the larvae of scarab beetles) and cutworms (moth caterpillars), can sever the stems of young plants below ground. Others such as termites and scarab beetle adults chew away the root surface resulting in tree death. The larvae of cossid moths as well as termites can tunnel in the below-ground stem.



Photo 1: Girdling of a young tree below ground by termites.



Photo 2: Larva of a scarab beetle (white grub) and severed roots of a young eucalypt.

Pathogens



Image courtesy J.A. Rocabado, Darcy Ribeiro State University of North Fluminense, Campos-RJ, Brazil

Pathogens

Leaf spots
Shoot blights
Rusts
Moulds and mildews
Cankers
Root, collar and stem rots

Leaf spots are patches of dead tissue (also called necrotic lesions) that are commonly caused by fungal pathogens but may also be the result of injury. Leaf spots can display a variety of textures, shapes and sizes and may be characteristic of a particular type of pathogen. In older leaf spots, fruiting bodies of the fungus may be seen as small, often dark, spots within the dead leaf tissue.



Photo 1: Necrotic and chlorotic (yellow) lesions on eucalypt leaves caused by leaf spot fungi.



Photo 2: Fungal leaf spot on leaf of an ebony tree.



Photo 3: Necrotic (dead) spots on foliage caused by a fungal leaf spot.



Photo 4: Fungal leaf spot.



Photo 5: Fungal leaf spot showing black fruiting bodies.



Shoot blight is the rapid wilting and death of the soft leaves, stems and buds at the end of shoots caused by fungal pathogens that can infect and kill the soft shoot tissue during humid weather. These symptoms can also be caused by insect and vertebrate pests but in these cases there will be visible evidence at the site of the attack (for example puncture wounds, frass, bark stripping).

To diagnose blight caused by pathogens, the shoots must be examined to find the region where the tissue has been killed, causing it to darken. Fruiting bodies of the pathogen can sometimes be seen within the killed tissue either as pimples (often darkly coloured) or wefts of fungal threads producing clusters of spores.



Photo 1: Shoot blight on *Pinus* sp. caused by *Diplodia*.



Photo 2: Leaf distortion and tissue death caused by a fungal shoot blight.



Photo 3: Death of leaf tissue caused by a fungal blight.

A specialised group of fungi cause rust diseases, so-called because of the blister-like pustules on the leaves and stems from which masses of brightly coloured (commonly yellow, orange or brown) spores erupt.



Photo 1: Symptoms of eucalyptus rust (also called guava rust, *Puccinia psidii*) on the leaf of guava (image courtesy of J.A. Rocabado, Darcy Ribeiro State University of North Fluminense, Campos-RJ, Brazil).



Photo 2: Symptoms of eucalyptus rust on leaves of *Syzygium* sp. (image courtesy of S.F. da Silveira, Darcy Ribeiro State University of North Fluminense, Campos-RJ, Brazil).



Photo 3: Yellow spores of eucalyptus rust covering fruits of guava (image courtesy of Marli F.S. Papa. Reproduced with permission from The American Phytopathological Society, St. Paul, MN).

A variety of fungal pathogens can grow on or in leaf tissue without causing the death of the infected tissue. Many of these fungi are true parasites that infect leaf cells to obtain their nutrition. Others do not infect the leaf cells but instead live superficially on the leaf surface and obtain their nutrition from other sources. Commonly encountered moulds and mildews are sooty mould, which grows on the sugary excretion of sap-sucking insects, and powdery mildew, which parasitises the leaves on which it grows.



Photo 1: Black mould infection of a *Flueggea* leaf.



Photo 2: Powdery mildew on an acacia leaf.

Canker pathogens infect and colonise the bark and may spread inwards to kill the cambium in the stem, resulting in localised wounds or more extensive damage that can effectively girdle the tree. Signs to look for are sunken areas that may contain pimple-like fruiting bodies of the canker fungus erupting through the bark; stem lesions indicated by the discolouration (darkening) of the inner bark/cambium, particularly at the boundary with healthy tissue; and separation of the bark from the cambium. Cankers are often associated with wounds or borer damage, or with branch stubs.



Photo 1: Sunken lesion caused by fungal canker on a young eucalypt stem.



Photo 2: Resinosis on a *Pinus* sp. stem caused by pine pitch canker.



Photo 3: Fungal canker on a eucalypt stem showing swelling and splitting bark.

Root and collar rot pathogens infect and kill the phloem, cambium and sapwood in the roots and/or at the root collar (ground level) and the stem. Infected wood is usually darkly discoloured. Trees with root or collar rot often die very quickly with the foliage of the entire crown rapidly wilting and drying (blight).

Some root and collar rot pathogens provide characteristic signs, which can be helpful in diagnosis. For example, trees killed by species of *Armillaria* will usually have a felt-like mat of white mycelium (fungal filaments) growing underneath the bark. Trees killed by *Phellinus noxius* have a dark brown crust spreading up the outside of the stem.

Decay of above-ground and below-ground woody tissues may reduce the tree's growth rate, diminish the amount and quality of products that can be obtained from discoloured or decayed wood, and shorten the life span of the tree.



Photo 1: Typical crust or stocking of the root rot fungus *Phellinus noxius* on a stem.



Photo 2: Fruiting bodies of *Phellinus noxius*.



Photo 3: Close-up of a fungal fruiting body.



Photo 4: Characteristic mat of white mycelium (fungal filaments) of *Armillaria* sp. growing under the bark.



Photo 5: Collar rot of a young tree caused by the root rot fungus *Phytophthora cinnamomi*.



Photo 6: Fungal decay associated with a stem wound.

- *Forest health guide: symptoms of insect and fungal damage on trees*
- Waterproof and alcohol-proof pens, permanent markers (but not ballpoint pens) and moderately soft lead pencils (HB, B or 2B)
- Forest Health Field Forms and field notebook
- Waterproof paper to write on when it is raining
- Collector's tags, acid-free paper if possible
- Plastic (zip-lock) and paper bags
- A magnifying glass or hand lens on a cord
- Specimen tubes (screw-top vials), various sizes
- Preserving alcohol, well sealed (typically 70–90% ethanol)
- Forceps (especially lightweight for delicate insect specimens such as termites)
- Scalpel
- Digital camera
- Small pair of binoculars
- Secateurs
- Small combination pick/mattock for examining roots of trees
- Pruning saw (ideally folding type) for trimming specimens
- Hand-held GPS unit
- Maps
- Compass
- Penknife
- Machete, small axe or hammer and chisel for extracting small blocks of wood/bark from the stem/roots
- Gardening gloves
- Disinfectant wipes (for cleaning tools to avoid cross-contamination)
- Measuring tape
- Brightly coloured tape/ribbons (e.g. flagging tape) or spray paint for marking trees
- Insect net
- Beating trays

Accompanying equipment (in vehicle)

- Portable icebox for transport of specimens
- Chainsaw for felling trees and collecting wood billets

ACIAR Project FST2001/045, Development of forest health surveillance systems for South Pacific countries and Australia.

[http://www.spc.int/pps/ACIAR/aciar_project.htm]

Australian Government and Museum Victoria, Pests and Diseases Image Library (PaDIL).

[<http://www.padil.gov.au>]

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[http://www.spc.int/pps/ACIAR/aciar_project.htm]
Forest Health Field Form

Form number	Location/geographical	
Pest/disease	Country	
Host	State, island, province	
Date	Lat X:	Long Y:
Collector's name	Local identifier	
Local collection number		
Host situation (native forest, plantation, agroforestry, amenity, port surrounds, nursery, quarantine)		

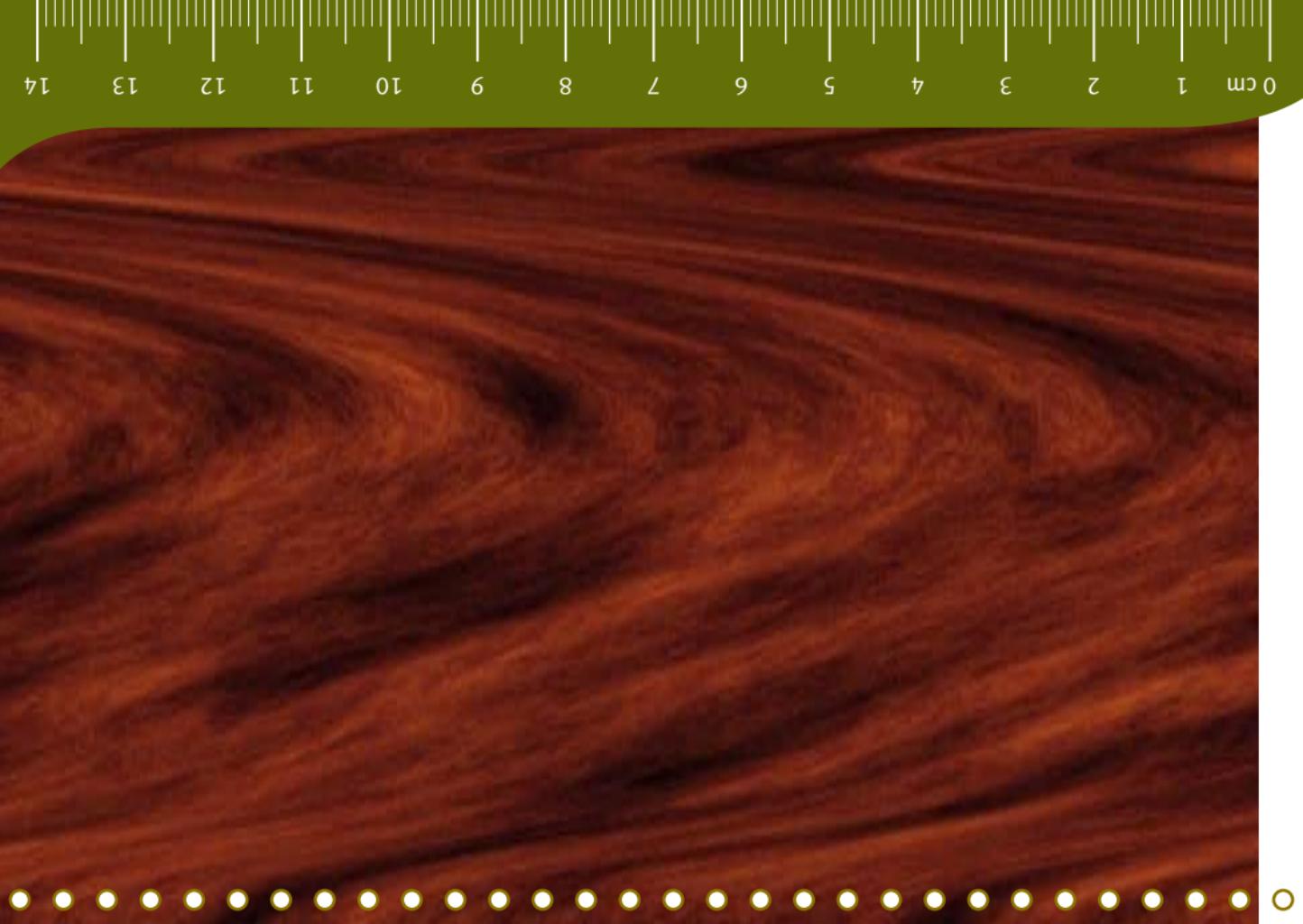


Plant parts infested			
Bark	Cambium	Foliage	Sapwood
Base of trunk	Cone/Fruit	Heartwood	Seed
Branch	Entire tree	Leading shoot	Stem
Bud	Flower	Root	Twig
Symptom/s			
Blight	Distortion	Resinosis	Suppressed
Chewing	Epicormic shoots	Ringbarking/girdle	Swelling
Chlorosis	Frass	Scale	Tunnelling
Chlorosis interveinal	Fruiting body	Severing	Tying/rolling
Chlorosis marginal	Gall	Skeletonising	Webbing
Dead crown	Mining	Spot	Wilt
Decay/stain	Mortality	Stem canker	Other
Dieback	Mottling	Sucking	

Occurrence comments	
Host age (years or seedling, sapling, pole, mature, over mature)	Severity (minor, moderate, severe)
Host status (living, dead, fallen, other)	Distribution (patch, widespread, scattered, single)
Notes	

Copies of this form may be downloaded from the ACIAR project web page: http://www.spc.int/pps/ACIAR/aciar_project.htm





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