



Healthy plantations

A field guide to pests and pathogens of
Acacia, *Eucalyptus* and *Pinus* in Vietnam



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A field guide to pests and pathogens of *Acacia*, *Eucalyptus* and *Pinus* in Vietnam

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Foreword

This book has been compiled at a time of three intriguing global and national developments.

Firstly, and on the global scale, data indicating changes in various climatic indicators raise interesting questions about how forests, forest pests and forest diseases might respond to rapid climate change. Furthermore, most discussions of climate change touch upon the possible role of managed forests in any concerted human response to change.

Secondly, also on a global scale, is the now general acceptance that the spread of invasive species is an immense challenge to ecosystems and economies. Related to this development is the growing understanding that the invasive species threat is increasing. Very damaging but previously little-known species are emerging in various parts of the world.

Lastly, on the national scale, Vietnam's forest industry seems on the threshold of striking expansion. Over the past decade there has been a remarkable increase in the number and variety of trees planted for commercial purposes. These plantings have taken place across most of Vietnam's geographical regions; however, few growers are familiar with the pests and diseases now known to attack these trees, and few advisors are prepared to help growers avoid losses caused by these pests and diseases.

Time alone will reveal the eventual outcomes of these three developments, but it is likely that the outcomes will be intertwined.

This book is a resource for those involved ‘on-the-ground’ with the task of growing trees, identifying the pests and diseases that surely will be found on those trees, and managing the unwanted impacts of these organisms. The preparation and publication of this book has been made possible by AusAID’s Vietnam CARD (Collaboration for Agriculture and Rural Development) Program, but the book draws heavily on the collective, long-standing experience of forest health scientists in Vietnam, Australia and South Africa.

The book provides illustrations and information on 23 pests and 25 diseases of *Acacia*, *Eucalyptus* and *Pinus* for Vietnam; four of these species are important biosecurity threats not yet present in Vietnam. I am quite certain that the book will be of interest more widely in South-East Asia and I hope that it is of widespread value.

Ian Naumann

Office of the Chief Plant Protection Officer
Australian Government Department of Agriculture,
Fisheries and Forestry
Canberra

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Dedication

Dedicated to the memory of Dr John Fryer who encouraged and supported this and many other forest health projects in the Asia–Pacific region.





About this guide

Healthy plantations: a field guide to pests and pathogens of Acacia, Eucalyptus and Pinus in Vietnam helps identify common damaging insects and pathogens of Vietnam's principal plantation species.

This guide includes photographs of the agents and the damage they cause, along with a brief description to aid identification. Information on susceptible hosts and the seasonality of the agent is also provided (when known).

Although it is possible to identify insects and fungi from these photographs, laboratory examination is sometimes necessary—for example, microscopes and culturing media might be used to identify fungi.

This guide includes agents already recorded from Vietnam plus a number of potential threats that have not yet been recorded in the country; these are biosecurity threats. Potentially, these would have a severe impact on plantation performance if introduced.

If one of these biosecurity threats is suspected, please contact Forest Science Institute of Vietnam (FSIV) immediately to confirm identification.

To report possible biosecurity threats contact:

Forest Protection Research Division
Forest Science Institute of Vietnam
Dong Ngac - Tu Liem - Hanoi

Ph: 84 4 3836 2376

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Name: *Hypomeces squamosus* (Coleoptera: Curculionidae)

Common name: Gold dust weevil; green weevil

Host: *Acacia mangium*, *A. auriculiformis*, *A. mangium* x *A. auriculiformis* (*Acacia* hybrid) and a wide range of host plants including *Eucalyptus* spp., teak, fruit trees, rice, maize, sugarcane, tobacco, vegetables and cotton.

Damage/symptoms: Larvae live in the soil, feeding on living roots. Adults are leaf feeders. On young, tender leaves they mainly feed from the edge inwards, leaving ragged or scalloped edges. On older leaves they generally feed on softer tissue between the veins.

Larvae and adults damage seedlings and young plants in nurseries and plantations.

There is one generation per year.

Description: Larvae are 15–20 mm long with a dark head, greyish-white tapered body and no legs.

Adults are 14 mm long, spindle-shaped, with a short snout and elbowed antennae. Newly emerged adults are covered with shiny yellow or green scales, which are gradually worn away.



Adult feeding damage showing feeding from leaf edge inwards (Pham Quang Thu)



Hypomeces squamosus adult (Pham Quang Thu)



Hypomeces squamosus adult. Note yellow scales (Amy Carmichael)



Typical weevil larva (Judy King)



Name: *Phalera grotei* (Lepidoptera: Notodontidae)

Common name: Grote's buff-tip moth

Host: *Acacia auriculiformis*

Damage/symptoms: First instar larvae chew the upper and lower surfaces of young leaves, sometimes making holes. Second and third instar larvae chew the edges of young and mature leaves. Fourth and fifth instar larvae feed on entire leaves.

Outbreak populations can cause complete defoliation.

There are three generations each year—March to May, June to July and September to November.

Description: Young larvae are grey with tufts of hairs, changing to green and pale green in later instars. Fully grown larvae are 70–80 mm long; the body is pale dorsally with tufts of long hairs and a distinctive lateral line; the ventral surface and legs are brown. Pupae are blackish brown and 25–40 mm long.

Adults have brownish forewings with a lighter patch along the upper margin and brownish hindwings; wingspan is 60–90 mm.



Outbreak populations can defoliate *A. auriculiformis* (Dao Xuan Uoc)



Fully grown *Phalera grotei* larva (Le Van Binh)



Phalera grotei fifth instar larva (Le Van Binh)



Phalera grotei adult (Le Van Binh)



Name: *Pteroma plagiophleps* (Lepidoptera: Psychidae)

Common name: Bagworm

Host: *Acacia auriculiformis*, *A. mangium* and a range of trees, including *Eucalyptus* spp. *Terminalia catappa* (Singapore almond) and *Tamarindus indica* (Indian tamarind), recorded from 22 plant families.

Damage/symptoms: Larvae chew holes in leaves. Outbreak populations that cause heavy defoliation can occur once or twice a year, usually in small patches within plantations.

Generation time is about 10–11 weeks, with up to five generations each year.

Description: Larvae build a case from silk and host material, which is attached to the host. Larvae remain inside, exposing only the head and the first pair of legs while moving about and feeding. Frass is expelled through a hole in the bottom of the case. The caterpillar increases the size of the case as it grows. Pupation occurs inside the case, which is fastened to the host plant and closed with silk.

The adult male is grey brown with characteristic antennae and a 6–22 mm wingspan. The male moth emerges from the bottom of the case, leaving the pupal skin protruding. The adult female is wingless and remains in the case.



Pteroma plagiophleps larval shelter and leaf damage
(Pham Quang Thu)



Pteroma plagiophleps larva removed from shelter
(Pham Quang Thu)



Pteroma plagiophleps adult male
(Pham Quang Thu)



Name: *Speiredonia retorta* (Lepidoptera: Noctuidae)

Common name: Comma moth

Host: *Acacia mangium*, *Albizzia* spp. and other legumes.

Damage/symptoms: First and second instar larvae feed on soft, immature foliage, making small holes in the leaves. Most damage occurs on new foliage in the upper crown. Third to sixth instar larvae eat the entire leaf. Larvae feed during the night, and in the late morning move to shelter in litter at the base of the tree.

Larvae damage 2–10 year old plantations, with most severe damage to 4–10 year old plantations.

There are 5–6 generations per year, with larvae present at all times. Peak numbers occur from September to December.

Description: Fully grown larvae are 50–70 mm long, light brown with black spots on the underside of the abdomen. Pupae are brown and occur on the host under a silken net. Adults are greyish brown with distinctive wing patterns and a red-tipped abdomen; wingspan is 35–40 mm.



Speiredonia retorta early instar larvae make small holes in young leaves (Pham Quang Thu)



Fully grown *Speiredonia retorta* larva showing black spots on abdomen (Nguyen The Nha)



Speiredonia retorta pupa (Pham Quang Thu)



Speiredonia retorta adult (Pham Quang Thu)



Name: Unknown noctuid (Lepidoptera: Noctuidae)

Host: *Acacia mangium* and a wide range of other hosts.

Damage/symptoms: Early instar larvae make small holes in soft, immature foliage, predominantly in the upper crown. Older larvae eat entire leaves.

Larvae damage 2–10 year old plantations, with most severe damage to 4–10 year old plantations.

There are 5–6 generations per year. Larvae are present all year round, with biggest populations from September to December.

Description: Mature larvae are yellow-brown to blackish-brown and 45–50 mm long. Pupae are brown. Larvae feed at night and shelter in litter at the base of the tree during the day.

Adults are grey with four black lines on the forewings and three on the hindwings; wingspan is 22–25 mm.



Feeding damage in the crown of *Acacia mangium*
(Pham Quang Thu)



Larvae, showing feeding damage to leaves (Nguyen The Nha)



Pupae (Nguyen The Nha)



Adult (Nguyen The Nha)



Name: *Helopeltis* spp. (Hemiptera: Miridae), particularly *H. theivora* and *H. fasciaticollis*

Common name: Tea mosquito bugs

Host: *Acacia mangium*, *A. mangium* x *A. auriculiformis* (*Acacia* hybrid), and a range of other hosts (including tea, cocoa and cotton).

Damage/symptoms: Nymphs and adults feed on new shoots and young leaves of nursery cuttings and hedge trees. Damage appears initially as a lesion or area of necrosis around the feeding site and progresses to wilt, dieback and shoot death.

There are many generations each year.

Description: Nymphs are similar to adults but smaller and without fully developed wings. There are five nymphal stages taking two months to complete, with each stage showing more developed wings.

Adults have slender bodies with long legs and long antennae. Adults live for up to one month.



Feeding damage to young shoots leads to wilt, dieback and shoot death (Pham Quang Thu)



Early damage appears as a lesion or area of necrosis around the feeding site (Pham Quang Thu)



Helopeltis theivora
(Pham Quang Thu)



Helopeltis fasciaticollis
(Pham Quang Thu)



Name: *Xylosandrus crassiusculus* (Coleoptera: Scolytidae)

Common name: Asian ambrosia beetle

Host: Almost any broad-leaved tree or sapling can be attacked, including *Acacia* spp., *Eucalyptus* spp., coffee, cacao, mango, papaya, Australian pine, rubber, camphor, mahogany, tea, teak and crape myrtle.

Damage/symptoms: Female beetles bore into twigs, branches and small trunks from 2–30 cm in diameter. They do not feed on the plant tissue itself, but on pathogenic fungi, which they introduce into their tunnels and cultivate. Attacked plants may show signs of wilting, branch dieback, shoot breakage or a general decline in vigour. Beetles can cause tree death, particularly of young trees shortly after planting.

Infestations are most easily detected by the presence of boring holes, generally close to the ground, and frass produced during gallery construction. Frass is pushed out to form a compact cylinder, which may reach a length of 3–4 cm before it breaks off and falls to the ground.

Breeding is continuous throughout the year, so that the species is present at all times and in all stages of development.

These beetles are serious pests of hardwood plantations and young trees in nurseries. Due to the wide host range, there are also potential impacts on biodiversity of native species.

Description: Adult beetles are small (2.2–2.5 mm long). Larvae are about 3.5 mm long.



Xylosandrus crassiusculus exit holes and frass tubes (JR Baker & SB Bambara)



Timber staining caused by fungus (G Keith Douce)



Xylosandrus crassiusculus adult (Natasha Wright)



Name: *Zeuzera coffeae* (Lepidoptera: Cossidae)

Common name: Coffee borer

Host: Highly polyphagous and recorded on over 40 hosts, including *Acacia auriculiformis*, *A. mangium*, *Eucalyptus deglupta*, *E. urophylla*, *Cedrela odorata*, *Swietenia macrophylla*, *Casuarina equisetifolia*, *Melaleuca cajuputi*, coffee, tea, teak, sandalwood, citrus and cotton.

Damage/symptoms: Larvae tunnel within twigs and branches of the host, causing the leaves to wilt and dry out (becoming brittle and susceptible to breakage). Seedlings can be killed when the main stem is attacked. Holes are visible in the trees, from which frass is exuded.

Larvae pupate within the feeding tunnel. After pupae emerge the pupal skin remains protruding from the exit hole.

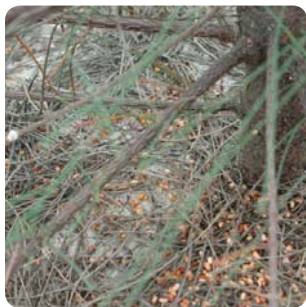
The adult moth lives for up to 18 days. Generation time is 3–9 months, resulting in 1–2 generations per year (depending on climate).

Description: Young larvae are a dark orange-red. Older larvae are up to 50 mm long and lighter in colour, with a brownish-black head, thoracic plate and anal plate.

The adult moth has white forewings with numerous steel-blue spots, chiefly between the veins; wingspan is 30–50 mm. The thorax is white with four blue-black spots near the margin. The abdomen is variegated blue.



Zeuzera coffeae damage on *Eucalyptus* (Pham Quang Thu)



Zeuzera coffeae damage on young *Casuarina* (Pham Quang Thu)



Zeuzera coffeae damage on *Melaleuca*. Note frass around tree base (Pham Quang Thu)



Zeuzera coffeae adult and pupal case (Pham Quang Thu)

See page 56 for additional images



Name: *Gryllotalpa africana* (Orthoptera: Gryllidae)

Common name: Mole cricket

Host: *Acacia mangium*, *A. auriculiformis*, *Pinus* spp., *Eucalyptus* spp. and a wide variety of other tree species and agricultural crops.

Damage/symptoms: The adult cricket feeds on young seedlings and low shoots, cutting them off at night and dragging the pieces into its tunnel for feeding.

The tunnel is usually deep, with its opening surrounded by ejected earth. Mole crickets are important pests in forest nurseries and young plantations.

Description: Adults are usually brown or black, and 30–55 mm long. *Gryllotalpa africana* have strong forelegs for excavating soil. Adults occur throughout the year.



Gryllotalpa africana (Lambert Smith)



Name: *Holotrichia trichophora* (Coleoptera: Scarabeidae)

Common name: White grub

Host: *Acacia mangium*, *A. auriculiformis* *A. mangium* x *A. auriculiformis* (*Acacia* hybrid) and *Eucalyptus* spp.

Damage/symptoms: Larvae feed on roots of young trees, girdling the stem below ground, resulting in foliar wilt and browning as the tree dies. Adults feed on the leaves of their hosts, sometimes causing severe defoliation and reduced growth. This pest is a particular problem in young plantations.

There is one generation per year, larval development being completed in about nine months. Adults emerge from the soil to form feeding swarms at dusk, usually following rainfall in spring and early summer. The earliest activity occurs after the first rain showers of the monsoon season.

Description: Larvae are typically cream-coloured, C-shaped, with well developed thoracic legs and a head capsule bearing strong mandibles. Adults have a light brown head, pronotum and legs and pale elytra with punctures.



Damage to seedlings. Note loss of roots (Pham Quang Thu)



Holotrichia trichophora larva (Pham Quang Thu)



Holotrichia trichophora adult (Pham Quang Thu)



Name: *Macrotermes* spp. and *Nasutitermes* spp.
(Isoptera: Termitidae)

Common name: Termite

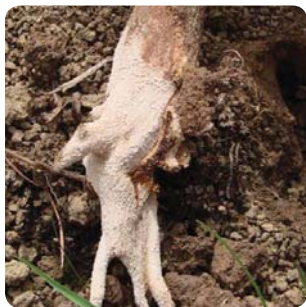
Host: *Acacia mangium*, *A. auriculiformis* and *A. mangium* x *A. auriculiformis* (*Acacia* hybrid), *Pinus* spp. and *Eucalyptus* spp.

Damage/symptoms: Termites attack the roots of young transplants, girdling or destroying the underground stem, resulting in withering and death of the tree. Losses of up to 60% of newly planted trees have been recorded in some areas, necessitating replanting.

Description: Worker termites are pale creamy white and 3–6 mm long. Soldiers have darkened heads with prominent mandibles or elongated snouts that produce defensive fluids. Mud-covered termite galleries are sometimes visible on the above-ground stem.



Termite damage to *Acacia*
(Pham Quang Thu)



Termite damage to *Eucalyptus*
(Pham Quang Thu)



Macrotermes sp.
(Pham Quang Thu)



Nasutitermes sp.
(Pham Quang Thu)



Name: *Atelocauda digitata* (syn. *Uromyces digitatus*, *U. phyllodiorum*)

Common name: Phyllode rust

Host: *Acacia aulacocarpa*, *A. auriculiformis*, *A. crassicarpa*, *A. koa*, *A. leptocarpa*, *A. mearnsii*, *A. mangium* and *A. polystachya*.

Damage/symptoms: Infected phyllodes, shoot tips, petioles and fruits may become malformed, or covered in galls or blister-like swellings.

Initial symptoms may be present as chlorotic areas more or less circular in shape and associated with a small blister. These blisters expand and become cinnamon brown in colour, covered with spores. Old blisters or swellings may become black.

When the growing points of young trees are infected, the rust causes extreme swelling of the apical meristem, which can result in death of the shoot and loss of apical dominance.

WARNING – BIOSECURITY THREAT

This species has not been recorded from Vietnam. Please alert FSIV forest health officers if you think you have collected this disease.



Initial symptoms of phyllode rust may be present as chlorotic areas more or less circular in shape and associated with a small blister (Geoff Pegg)



Blisters expand and become cinnamon brown in colour, covered with spores (Geoff Pegg)



Infected phyllodes, shoot tips, petioles and fruits may become malformed and covered in galls or blister-like swellings (Geoff Pegg)



Name: *Colletotrichum gloeosporioides*

Common name: Colletotrichum leaf spot; anthracnose

Host: *Acacia* spp.

Damage/symptoms: *Colletotrichum gloeosporioides* produces a range of symptoms including tip necrosis and foliar spots.

Infection first appears as circular to oval reddish-brown spots of variable size with raised margins. These coalesce to produce larger spots. Drying and cracking of the phyllode and premature defoliation can be the result of severe infection.

Symptoms can vary between different *Acacia* spp. On *A. aulacocarpa* spots are black, circular to oval and scattered on the leaf surface. Spots on *A. crassicarpa* are chocolate-brown with necrotic centres and darker margins.



Symptoms caused by infection of *Acacia* spp. by *Colletotrichum gloeosporioides* include tip necrosis and foliar spots (Pham Quang Thu)



Name: *Meliola* spp.

Common name: Black mildew

Host: *Acacia* spp.

Damage/symptoms: Black mildew is common on *Acacia* spp. The fungus forms black, velvety colonies on the phyllode surface and generally has a radial pattern. The entire phyllode can become covered when infestation levels are high. In some instances young stems and twigs may also become infected.

On mango trees there is often a close association with the presence of *Meliola* spp. and scale insects and mealybugs, suggesting the honeydew provides a source of food for fungal growth and establishment.



Meliola spp., black mildew, forms black, velvety colonies on the phyllode surface (Pham Quang Thu)



Name: *Oidium* spp.

Common name: Powdery mildew

Host: *Acacia* spp.

Damage/symptoms: Early symptoms of infection occur as cobweb-like or powdery white patches of hyphae and spores on primary, juvenile, pinnate leaves. Patches increase in size and coalesce as the infection progresses, often spreading onto secondary leaves or phyllodes.

High levels of infection can result in defoliation and, in rare cases, death of seedlings. Heavily infected foliage becomes coated in a mat of superficial hyphae and spores, giving a powdery appearance.



Symptoms of infection by *Oidium* spp., powdery mildew, occur as cobweb-like or powdery white patches of hyphae and spores (Pham Quang Thu)



Powdery mildew occasionally causes death of seedlings (Pham Quang Thu)



Name: *Pestalotiopsis* spp.

Common name: Pestalotiopsis foliar spot

Host: *Acacia* spp.

Damage/symptoms: Symptoms of infection vary and can include small, scattered, dark-brown or reddish-brown, discrete spots. On living phyllodes these spots can sometimes have a bleached central region. Fruiting bodies can also be found on large necrotic lesions that coalesce toward the phyllode tip.

This group of fungi are regarded as minor pathogens, appearing only when trees are under stress and leaves begin to senesce. These fungi can commonly be found in nurseries.



Symptoms of infection by *Pestalotiopsis* spp. can include small, scattered dark-brown or reddish-brown discrete spots (Pham Quang Thu)



Name: *Phomopsis* spp.

Common name: Phomopsis leaf spot

Host: *Acacia* spp.

Damage/symptoms: Symptoms caused by these fungi can differ among *Acacia* species.

On *A. auriculiformis*, *Phomopsis* sp. causes a foliar spot on young phyllodes. The disease initially forms small dark reddish-brown necrotic lesions that later coalesce to form large, pale necrotic lesions, sometimes extending the length of the phyllode.

On *A. crassicarpa* and *A. aulacocarpa* symptoms are similar and characterised by light-coloured necrotic areas with irregular, raised and well demarcated dark brown margins. Lesions gradually spread across the surface and can cover up to half of the phyllode.



Infection by *Phomopsis* sp. initiates as small, dark, reddish-brown necrotic lesions which later coalesce to form large, pale necrotic lesions, sometimes extending the length of the phyllode (Pham Quang Thu)



Name: *Botryosphaeria* spp.

Common name: Botryosphaeria canker

Host: *A. auriculiformis*, *A. mangium* and *A. mangium* x *A. auriculiformis* (*Acacia* hybrid)

Damage/symptoms: Cankers are dead areas of bark sometimes with sapwood exposed or with sunken lesions extending from a few centimeters to more than a metre along branch and stem axes. These may be darkly discoloured and cracked, especially toward the centre of the lesion. Branches and stems may be partially or completely girdled, causing crown dieback and possibly tree death.

Cankers are often associated with wounds, borer damage or branch stubs. Fruiting bodies of the causal fungi can usually be found on the cankers themselves, especially at the margin between diseased and healthy bark or on newly dead branches. These are typically partially submerged in the outer bark but can be readily seen through a hand lens.

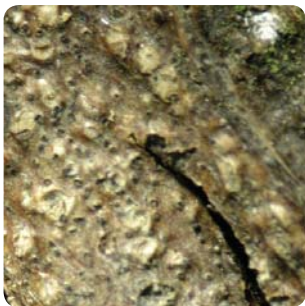
Trees planted in unsuitable environments—for example, infertile soils and climates to which they are poorly adapted (drought-prone areas)—are more susceptible to canker diseases.



Areas of dead bark and sunken lesions associated with *Botryosphaeria* spp. extending along branch and stem axes (Pham Quang Thu)



A dark discolouration may be evident under the bark of the infected area (Pham Quang Thu)



Fruiting bodies of *Botryosphaeria* spp. are typically partially submerged in the outer bark (Pham Quang Thu)



Name: *Corticium salmonicolor*

Common name: Pink disease

Host: *Acacia mangium* and *A. mangium* x *A. auriculiformis* (*Acacia* hybrid)

Damage/symptoms: Pink disease causes serious damage in areas of high rainfall. The first sign of infection is the cobweb stage where silky, white mycelia grow over the surface of the bark. The pustule stage is readily identifiable when pink pustules consisting of sterile mycelia are produced on the affected area.

The foliage on infected branches wilts and subsequently dies, turning brown but remaining attached to the branch for some time. Infected branches often die, resulting in progressive crown dieback, but green epicormic shoots may develop from lateral dormant buds.

Where infection is localised, death and shedding of limited areas of bark may lead to the development of open wounds or cankers. In cases of severe infection, or of susceptible hosts, the whole tree may die.



Presence of silky, white mycelia growing over the surface of the bark associated with infection by *Corticium salmonicolor* (Pham Quang Thu)



Pink pustules consisting of sterile mycelia are produced on the affected area (Pham Quang Thu)

Name: *Anomala* spp. (Coleoptera: Scarabeidae)

Common name: Scarab beetle; flower chafer

Host: *Eucalyptus* spp.

Damage/symptoms: Adult beetles mainly feed on young and expanding eucalypt leaves, causing a characteristic jagged, ripped pattern.

Feeding can cause distortion and dieback of young shoots, as well as defoliation. Beetles feed in swarms and can cause extensive damage to young plantations, particularly those surrounded by pasture.

Larvae or white grubs occur in the soil and feed on grass roots and soil organic matter but sometimes girdle roots and stems of nursery stock and young trees.

There is one generation per year, with larval development completed in about nine months. Adults emerge from the soil to form dusk feeding swarms, usually following rainfall in spring and early summer. The earliest activity occurs after the first rain showers of the monsoon season.

Description: One of the most important species, *Anomala cupripes*, is a smooth, shiny beetle about 25 mm long. It is green above and bright copper beneath.

Larvae are about 35 mm long when fully grown, C-shaped, with well developed thoracic legs and a head capsule bearing strong mandibles.



Adult damage to young and expanding leaves
(Pham Quang Thu)



Typical scarab feeding damage on *Eucalyptus* (Simon Lawson)



Adult beetle (Pham Quang Thu)



Typical C-shaped scarab larvae
(Judy King)



Name: *Trabala vishnou* (Lepidoptera: Lasiocampidae)

Common name: Lappet moth; pomegranate hairy caterpillar

Host: *Eucalyptus alba*, *E. torelliana*, (also *Macaranga* sp., *Mallotus philippensis*, *Shorea robusta*, *Ricinus communis*, *Terminalia myriocarpa* and *Psidium guajava*).

Damage/symptoms: Larvae are leaf feeders—preferring soft, immature foliage—with most damage occurring in the upper crown. Larvae feed mainly at night, and remain concealed during the day. Early instars feed gregariously, while later instars are solitary and voracious feeders.

There are four or more generations per year.

Description: Eggs are laid in straight double rows on the host leaves. Larvae are easily distinguished by their yellow and black banding, long white hairs, twin setal horns, and red prolegs and head. Older larvae grow to 60 mm and develop long dorsal tufts and blue spots along the dorsal surface.

Pupation occurs in a tough papery cocoon, interwoven with larval hairs, usually fixed along a twig.

Adult males are pale green. Females are yellow. Wingspan is 50 mm.

WARNING

Take care with larvae as hairs can cause stinging and itching.



Second instar larvae. Note the twin horns and characteristic red feet and head (David L Mohn)



Mature larva showing pre-pupal colour change (David L Mohn)



Cocoon attached to twig and containing stinging hairs (David L Mohn)



Left: *Trabala vishnou* female
Right: *Trabala vishnou* male
(David L Mohn)



Name: *Strepsicrates rothia* (Lepidoptera: Tortricidae)

Common name: Leaf tyer

Host: *Eucalyptus* spp. (also *Psidium guajava*)

Damage/symptoms: The larva rolls a single leaf, forming a shelter in which it feeds and rests. The leaf turns brown and withers as a result of feeding, and the larva crawls out to a fresh leaf to repeat the process. Pupation takes place in the rolled-up leaf. The life cycle is completed in 3–4 weeks. Adults live for only a few days.

Impact is most severe on younger trees, though older trees above 10 years age are still attacked.

Description: Larvae are pale green in the early instars, changing to green by the final instar. Adults are brown; wingspan is 18–25 mm.



Larvae roll a leaf to form a shelter (Pham Quang Thu)



Larvae rest within the rolled leaf (Pham Quang Thu)



Name: *Leptocybe invasa* (Hymenoptera: Eulophidae)

Common name: Blue gum chalcid

Host: Numerous eucalypt species, including *Eucalyptus tereticornis*, *E. camaldulensis*, *E. urophylla*, *E. exerta*, *E. botryoides*, *E. bridgesiana*, *E. globulus*, *E. gunii*, *E. grandis*, *E. robusta*, *E. saligna*, *E. viminalis* and *Eucalyptus* hybrids.

Damage/symptoms: Larvae feed within plant tissue, causing galls to form on leaves and young shoots. Galls cause deformation of terminal shoots and leaves. Severe infestations interfere with photosynthesis, causing leaves and shoots to shrivel and die; this leads to growth retardation, stunting and loss of vigour. Galls form predominantly on young shoots and along both sides of the midrib of juvenile leaves, but in heavy infestations also occur in leaf tissue and twigs.

Outbreaks may occur in nursery seedlings and plantations, particularly plantations up to two years of age.

Description: Adult female wasps are about 1.4 mm long, black with rounded abdomens and clear wings. Eggs are laid in young shoot tips and midribs of juvenile leaves (1–2 weeks old) leaving scars on both sides of the midrib. Maggot-like larvae feed and develop inside the gall, with gall size correlated to the number of larvae present. Mature galls are usually deep pink and often have visible emergence holes.

Development time, from egg to adult, is 4–5 months.



Gall showing characteristic red colour and wasp exit hole
(Zvi Mendel)



Stages of gall formation on leaves and leaf midribs
(Zvi Mendel)



Severe galling damage
(Zvi Mendel)



Adult wasp (Zvi Mendel)



Name: *Ophelimus maskelli* (Hymenoptera: Eulophidae)

Common name: Eucalypt gall wasp

Host: *Eucalyptus* spp., including *E. tereticornis*, *E. camaldulensis*, *E. saligna*, *E. botryoides*, *E. grandis*, *E. cinerea*, *E. globulus* and *E. robusta*.

Damage/symptoms: Larvae feed within young leaves, causing numerous small, pimple-like galls on both upper and lower surfaces.

Heavy galling results in premature leaf shedding not long after the wasps emerge. Populations can build up rapidly, causing defoliation of large parts of the crown. Continuous loss of leaves results in dieback and death of young and newly-planted trees and decline in growth of older trees. Damage is greatest on nursery seedlings and young plantations.

In Israel, clouds of wasps during peak emergence periods have caused problems for human health and industrial operations.

Adults live only a few days and there are at least two generations per year.

Description: Adult female wasps are 0.8–1.1 mm long and brown-black. They tend to oviposit in young leaves, close to the petiole and particularly in the lower canopy. Galls range from 0.9–1.2 mm in diameter and are green initially but become a reddish colour when exposed to the sun.

Distribution: Australia (native), Israel, Italy, Spain, France and Portugal.

WARNING – BIOSECURITY THREAT

This species has not been recorded from Vietnam. Please alert FSIV forest health officers if you think you have collected this pest.



Galls on leaves (Alex Protasov)



Ophelimus maskelli adult
(Alex Protasov)



Small, pimple-like, nearly round galls on leaf surface
(Alex Protasov)



Name: *Aristobia approximator* and *A. testudo* (Coleoptera: Cerambycidae)

Common name: Longicorn beetle

Host: *Eucalyptus camaldulensis* and *E. tereticornis*.

Damage/symptoms: Larvae live under the bark where they bore into the xylem and create tunnels up to 60 cm long. Damage to stems and branches restricts tree growth, while wood quality can be severely affected by staining and physical damage. Fine, sawdust-like frass in the bark or at the base of the tree and kino bleeding are early signs of longicorn activity.

Adult beetles chew bark for food. Female *A. approximator* chew oviposition depressions in the bark and *A. testudo* girdle branches by chewing off 10 mm strips of bark prior to laying eggs.

There is one generation per year. Adults emerge from June to August. Larvae hatch from late August and live under the bark until January when they bore into the wood.

A. approximator was recorded for the first time in Vietnam in 2002 in the Mekong Delta, when about 1000 ha of eucalypt plantations were seriously damaged and removed.

Description: The adult is a 25–35 mm long and patterned with orange and black. A characteristic of *Aristobia* is the presence of dense tufts of hairs on the distal portion of some antennal segments.



Adult *Aristobia approximator*
(Pham Quang Thu)



Adult *Aristobia testudo*
(Pham Quang Thu)



Name: *Sarathrocera lowi* (Coleoptera: Cerambycidae)

Common name: Longicorn beetle

Host: *Eucalyptus urophylla*, particularly clone U6.

Damage/symptoms: Female beetles deposit eggs singly into slots made in the bark. Larvae emerge and initially feed just under the bark, later boring into the stem. Pupation occurs towards the end of April and adults emerge from the end of May to early June.

Wood quality can be severely affected by staining and physical damage associated with larval feeding, reducing productivity for saw logs.

A fine frass (similar to sawdust) caught in the bark or at the base of the tree and kino bleeding are early signs of longicorn activity.

Heaviest damage to date has been to eight year old plantations where the incidence and severity have been very high.

Description: The adult is brown, slightly tinged with orange and 35–50 mm long. The antennae are 1.2–2 times the length of the body and are fringed with hairs.



Frass at the base of an attacked tree (Pham Quang Thu)



Larvae in stem tunnels (Pham Quang Thu)



Larval tunnels in stem (Pham Quang Thu)



Sarthrocera lowi adult (Pham Quang Thu)



Name: *Xylosandrus crassiusculus* (Coleoptera: Scolytidae)

Common name: Asian ambrosia beetle

Host: Almost any broad-leaved tree or sapling can be attacked, including *Eucalyptus* spp. and *Acacia* spp., coffee, cacao, mango, papaya, Australian pine, rubber, camphor, mahogany, tea, teak and crape myrtle.

Damage/symptoms: Female beetles bore into twigs, branches, and small trunks from 2–30 cm in diameter. They do not feed on the plant tissue itself, but on pathogenic fungi which they introduce into their tunnels and cultivate. Attacked plants may show signs of wilting, branch dieback, shoot breakage or a general decline in vigour. Beetles can cause primary deaths of trees, particularly young trees shortly after planting.

Infestations are most easily detected by the presence of boring holes, generally close to the ground, and frass produced during gallery construction. Frass is pushed out to form a compact cylinder, which may reach a length of 3–4 cm before it breaks off and falls to the ground.

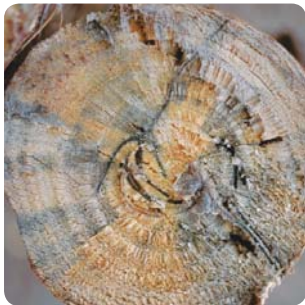
Breeding is continuous throughout the year, so that the species is present at all times and in all stages of development.

These beetles are serious pests of hardwood plantations and young trees in nurseries. Due to the wide host range there are also potential impacts on biodiversity of native species.

Description: Adult beetles are small (2.2–2.5 mm long). Larvae are about 3.5 mm long.



Xylosandrus crassiusculus exit holes and frass tubes (JR Baker & SB Bambara)



Timber staining caused by fungus (G Keith Douce)



Xylosandrus crassiusculus adult (Natasha Wright)



Name: *Zeuzera coffeae* (Lepidoptera: Cossidae)

Common name: Coffee borer

Host: Highly polyphagous and recorded on over 40 hosts, including *Eucalyptus deglupta*, *E. urophylla*, *Acacia auriculiformis*, *A. mangium*, *Cedrela odorata*, *Swietenia macrophylla*, *Casuarina equisetifolia*, *Melaleuca cajuputi*, coffee, tea, teak, sandalwood, citrus and cotton.

Damage/symptoms: Larvae tunnel within twigs and branches of the host, causing the leaves to wilt and dry out (becoming brittle and susceptible to breakage). Seedlings can be killed when the main stem is attacked.

Holes are visible in the trees, from which frass is exuded.

Larvae pupate within the feeding tunnel and after emergence the pupal skin remains protruding from the exit hole. The adult moth lives for up to 18 days. Generation time is 3–9 months, resulting in 1–2 generations per year (depending on climate).

Description: Young larvae are a dark orange-red. Older larvae are up to 50 mm long and lighter in colour, with a brownish-black head, thoracic plate and anal plate.

The adult moth has white forewings with numerous steel-blue spots, chiefly between the veins; wingspan is 30–50 mm. The thorax is white with four blue-black spots near the margin. The abdomen is variegated blue.



Zeuzera coffeae damage on *Eucalyptus* (Pham Quang Thu)



Zeuzera coffeae damage on *Melaleuca*. Note frass around tree base (Pham Quang Thu)



Zeuzera coffeae larva (Pham Quang Thu)



Zeuzera coffeae adult and pupal case (Pham Quang Thu)



Name: *Grylotalpa africana* (Orthoptera: Gryllidae)

Common name: Mole cricket

Host: *Eucalyptus* spp., *Acacia mangium*, *A. auriculiformis*, *Pinus* spp., and a wide variety of other tree species and agricultural crops.

Damage/symptoms: The adult cricket feeds on young seedlings and low shoots, cutting them off at night and dragging the pieces into its tunnel for feeding. The tunnel is usually deep, with its opening surrounded by ejected earth. Mole crickets are important pests in forest nurseries and young plantations.

Description: Adults are usually brown or black and 30–55 mm long. *Grylotalpa africana* have strong forelegs for excavating soil. Adults occur throughout the year.



Gryllotalpa africana (Lambert Smith)



Name: *Holotrichia trichophora* (Coleoptera: Scarabeidae)

Common name: White grub

Host: *Eucalyptus* spp., *Acacia mangium*, *A. auriculiformis* and *A. mangium* x *A. auriculiformis* (*Acacia* hybrid).

Damage/symptoms: Larvae feed on roots of young trees, girdling the stem below ground, which causes foliar wilt and browning as the tree dies. Adults feed on the leaves of their hosts, sometimes causing severe defoliation and loss of tree growth increment. This pest is a particular problem in young plantations.

There is one generation per year, larval development being completed in about nine months. Adults emerge from the soil to form feeding swarms at dusk, usually following rainfall in spring and early summer. The earliest activity occurs after the first rains of the monsoon season.

Description: Larvae are typically cream-coloured, C-shaped, with well developed thoracic legs and a head capsule bearing strong mandibles. Adults have a light brown head, pronotum and legs, and pale elytra with punctures.



Damage to seedlings. Note loss of roots (Pham Quang Thu)



Holotrichia trichophora larva (Pham Quang Thu)



Holotrichia trichophora adult (Pham Quang Thu)



Name: *Macrotermes* spp. and *Nasutitermes* spp.
(Isoptera: Termitidae)

Common name: Termite

Host: *Eucalyptus* spp., *Acacia mangium*, *A. auriculiformis* and *A. mangium* x *A. auriculiformis* (*Acacia* hybrid) and *Pinus* spp.

Damage/symptoms: Termites attack the roots of young transplants, girdling or destroying the underground stem, which causes withering and death of the tree. Losses of up to 60% of newly planted trees have been recorded in some areas, necessitating replanting.

Description: Worker termites are pale creamy white in colour and 3–6 mm long. Soldiers have darkened heads with prominent mandibles or with elongated snouts that produce defensive fluids. Mud covered termite galleries are sometimes visible on the above-ground stem.



Termite damage to *Acacia*
(Pham Quang Thu)



Termite damage to *Eucalyptus*
(Pham Quang Thu)



Macrotermes sp.
(Pham Quang Thu)



Nasutitermes sp.
(Pham Quang Thu)



Name: *Cryptosporiopsis eucalypti*

Common name: Leaf spot; shoot blight

Host: *Eucalyptus camaldulensis*

Damage/symptoms: Leaf spots are discrete but irregularly shaped and often dark chocolate-brown in colour.

On mature leaves extensive areas of reddish-brown tissue burst through the leaf, producing a very rough surface. Infected shoot tips become distorted and die. The tree may produce epicormic shoots forming double leaders. These may also become re-infected the following season. The crown assumes a flattened appearance.



Discrete but irregularly shaped leaf spots (Pham Quang Thu)



Name: *Cylindrocladium reteaudii* (*C. quinqueseptatum*)

Common name: Cylindrocladium leaf spot and blight

Host: *Eucalyptus* spp.

Damage/symptoms: The initial symptoms are greyish, water-soaked spots on young leaves. These spots then coalesce, developing into extensive necrotic areas.

Spores can be seen at the margin of lesions, appearing shiny white in colour. These spore masses can also be seen on older necrotic portions of leaves, especially along midribs on the lower leaf surface and on fine shoots.

Under conditions of high humidity and frequent rainfall, necrotic lesions cover the entire area of the leaf. Fungal fruiting bodies cover and kill young shoot tips, resulting in leaf and shoot blight symptoms.



Leaf blight symptoms caused by *Cylindrocladium reteaudii*
(Pham Quang Thu)



Name: *Mycosphaerella* spp.

Common name: Mycosphaerella leaf disease

Host: *Eucalyptus* spp.

Damage/symptoms: Leaf spots can be single or coalesce, often causing leaves to crinkle. Small black fruiting bodies are often seen within leaf spots, aggregating on leaf veins and often prominent on the underside of leaves. Some species of *Mycosphaerella* can cause defoliation, mostly in the lower crown.

Many variations in symptom development are associated with *Mycosphaerella* infections, resulting in different combinations of lesion size, colour and morphology. Fruiting bodies can form on either one or both leaf surfaces. Infected leaves develop spots and blotches, their severity depending on the pathogen species and the susceptibility of the host. In highly susceptible hosts, large lesions develop, often with crinkling of the leaves, which causes premature defoliation.



Mycosphaerella marksii
(Pham Quang Thu)



Mycosphaerella cryptica
(Geoff Pegg)



Name: *Pilidiella* spp. (e.g. *Pilidiella eucalyptorum* = *Coniella fragariae*)

Common name: Coniella leaf blight

Host: *Eucalyptus* spp.

Damage/symptoms: *Pilidiella eucalyptorum* causes large, circular yellow-brown spots that begin on leaf margins and spread to form large blights. These are often numerous and can cover most of the leaf. Small black fruiting bodies are seen in concentric rings within spots and blights, mostly on the upper leaf surface. It is more often observed on older, lower foliage. Heavily infected leaves are prematurely shed.



Coniella leaf blight symptoms on *Eucalyptus pellita* (Geoff Pegg)



Coniella leaf blight symptoms on *Eucalyptus pellita* (Geoff Pegg)



Name: *Puccinia psidii*

Common name: Eucalyptus rust

Host: *Eucalyptus* spp. and other Myrtaceae.

Damage/symptoms: The fungus attacks young tissues of new leaves, fruits, flowers, shoots and succulent twigs.

The first symptoms are chlorotic specks that, after a few days, become pustules containing uredia producing yellow masses of spores. Pustules can coalesce and parts of the plant can become completely covered with pustules. After about 2–3 weeks, pustules dry and become necrotic.

The disease can cause deformation of leaves, heavy defoliation of branches, dieback, stunted growth and even death.

WARNING – BIOSECURITY THREAT

This species has not been recorded from Vietnam. Please alert FSIV forest health officers if you think you have collected this disease.



Rust pustules on *Eucalyptus* leaf
(Acelino C Alfenas)



Rust infection of new shoots and
young stems (Acelino C Alfenas)



Name: *Quambalaria simpsonii*

Common name: Quambalaria shoot blight

Host: *Eucalyptus globulus*

Damage/symptoms: Distortion and twisting of young shoots, leaf spots and stem lesions are associated with infection by *Q. simpsonii*. The diseased shoots are shiny white as a result of a massive development of the fungus pushing through and rupturing the waxy cuticle.

Leaf spots range in size from 1–2 mm in diameter to large irregular lesions—sometimes coalescing—and often develop along one edge, resulting in distortion and twisting of the leaf.

Sporulation occurs abundantly on all diseased tissues, although on leaf spots it is more prominent on the lower surface. The pustules consist of a dense layer of conidiophores from which conidia are produced.



Shoot death associated with infection by *Quambalaria simpsonii* (Pham Quang Thu)



Infected shoots covered in conidiophores and conidia of *Quambalaria simpsonii* (Pham Quang Thu)



Name: *Teratosphaeria destructans* (syn. *Kirramyces destructans*, *Phaeophleospora destructans*)

Common name: Kirramyces leaf blight

Host: *Eucalyptus grandis*, *E. camaldulensis*, *E. urophylla* and hybrids.

Damage/symptoms: *T. destructans* causes a blight of shoots and leaves, producing light brown leaf spots, which are irregular to rounded, with indistinct borders. Masses of conidia ooze onto the surface of leaves, often giving them a 'sooty' appearance.

This pathogen can cause extensive blights, distortion of young leaves and premature leaf abscission as a result of necrosis of the leaf and petiole.

This pathogen caused severe defoliation in clonal plantations of *Eucalyptus camaldulensis* in eastern Thailand in 1999 and was found on native *E. urophylla* in East Timor during 2002. In 2002, the pathogen was recorded in several locations in northern, central and southern Vietnam.



Blight of shoots and leaves caused by *Teratosphaeria destructans* (Pham Quang Thu)



Masses of conidia ooze onto the surface of leaves, often giving them a 'sooty' appearance (Pham Quang Thu)



Name: *Teratosphaeria epicoccoides* (syn. *Kirramyces epicoccoides*, *Phaeophleospora epicoccoides*)

Common name: Charcoal leaf disease

Host: *Eucalyptus grandis*, *E. camaldulensis*, *E. urophylla* and hybrids.

Damage/symptoms: Disease symptoms caused by *T. epicoccoides* include small, angular, purplish-red spots, but variation occurs between hosts and the disease can sometimes be seen as a sooty blotch on otherwise healthy leaves.

Chlorotic spots are followed by the development of necrosis of the leaf. Spores are then exuded from the pycnidia through the stomatal pore, often oozing onto the underside of leaves, giving the appearance of sooty mould. Purple colouring on the upper leaf surface is often associated with infection by *T. epicoccoides*. In some cases it can be associated with significant levels of defoliation, usually in the lower canopy.



Teratosphaeria epicoccoides can sometimes be seen as a sooty blotch on otherwise healthy leaves (Geoff Pegg)



Purple colouring on the upper leaf surface is often associated with infection by *T. epicoccoides* (Geoff Pegg)



Infection can be associated with significant levels of defoliation, usually initiated in the lower canopy (Geoff Pegg)



Name: *Botryosphaeria* spp.

Common name: Botryosphaeria canker

Host: *Eucalyptus* spp.

Damage/symptoms: Stem cankers are dead areas of bark that sometimes extend into the underlying sapwood. They vary in size from localised lesions confined by callus tissue to sunken lesions that may extend more than a metre along the branch or stem axis. *Eucalyptus* stems usually secrete kino from these lesions, discolouring the bark with reddish to dark brown pigments. Branches and stems may be partially or completely girdled, causing crown dieback and possibly tree death.

Fruiting bodies of the causal fungi can usually be found on the cankers themselves, especially at the margins between diseased and healthy bark or on newly dead branches. The fruiting bodies are typically partially submerged in the outer bark, but can be readily seen through a hand lens.



Stem canker associated with *Botryosphaeria* sp. infection
(Pham Quang Thu)



Name: *Chrysoporthe cubensis* (syn. *Cryphonectria cubensis*)

Common name: Chrysoporthe canker

Host: *Eucalyptus* spp.

Damage/symptoms: Whole-tree symptoms associated with infection by *C. cubensis* include basal cankers, which can extend several metres up the stem. Where stems have been girdled, trees may wilt and die suddenly during hot, dry weather. Older trees, which have survived initial infection, often develop basal swellings and severe bark cracking over brown necrotic sapwood.

Infected stems become discoloured, deep red or brown, through copious secretion of kino from cankers, which dries on the bark surface. Large numbers of fruiting structures are produced either on the bark surface or in fissures and can be seen with the naked eye or using a hand lens. Conidia are produced within pycnidia, which are often borne superficially on the bark and bear long necks that ooze masses of yellow, elliptical conidia under humid conditions.



Basal swelling on *Eucalyptus* hybrid caused by *Chrysosporthe cubensis* (Geoff Pegg)



Fruiting structures are produced either on the bark surface or in fissures and can be present on other host species such as *Tibouchina* spp. (Geoff Pegg)



Name: *Ralstonia solanacearum*

Common name: Bacterial wilt

Host: *Eucalyptus urophylla*, *E. pellita*, *E. grandis*,
E. camaldulensis and *Corymbia citriodora*.

Damage/symptoms: Bacterial wilt typically affects young trees growing on ex-agricultural sites in hot, wet areas. It is characterised by the sudden wilting and death of a branch, or the entire crown, associated with a dark staining in the stem. A pale, yellowish sap typically exudes from cut stems. Evidence suggests that infection starts through wounds of transplanted trees. Avoiding wounds to roots during nursery and planting operations is recommended.

Wilting of plants may begin within months of planting, particularly in areas where daytime temperatures regularly exceed 30 °C. Xylem vessels become filled with bacterial slime and can be observed at the distal end of an infected piece of stem when its end is placed in water for a couple of minutes. Leaves of infected trees wilt and eventually dry. This can occur on a single branch, or on a portion within a branch. Some leaf drop can occur but the dead leaves are generally retained until the whole plant wilts and dies.



Sudden wilting and death of branches caused by bacterial wilt (Geoff Pegg)



Dark staining in the stem associated with bacterial wilt (Pham Quang Thu)



Name: *Teratosphaeria zuluense* (syn. *Coniothyrium zuluense*)

Common name: Coniothyrium canker

Host: *Eucalyptus* spp.

Damage/symptoms: Initial infections of *Teratosphaeria* canker include small, circular necrotic lesions on the green stem tissue in the upper part of trees. These lesions expand, becoming elliptical, and the dead bark covering them typically cracks, giving a 'cat-eye' appearance. Kino pockets can be seen under the bark of these lesions. Lesions coalesce to form large cankers that girdle the stems, giving rise to epicormic shoots and, ultimately, trees with malformed or dead tops. Small, black pycnidia can be seen on the surface of dead bark tissue, from where black conidial tendrils exude under moist conditions.



Small, circular necrotic lesions on the green stem tissue in the upper parts of trees or stems of young saplings (Geoff Pegg)



Elliptical lesions covered by dead bark covering giving a 'cat-eye' appearance (Geoff Pegg)



Name: *Dasychira axutha* (Lepidoptera: Lymantriidae)

Common name: Pine tussock moth

Host: *Pinus massoniana*.

Damage/symptoms: First instar larvae feed on the needle surface, with needles remaining on the tree but drying out. From the second instar, larvae consume the entire needle. In outbreak situations larvae cause complete defoliation. This first occurred in Vietnam in 2005, with thousands of hectares affected.

There are 3–4 generations per year (depending on climate), with most damage occurring from August to November in 3–10 year old plantations.

Description: Eggs are round and white and laid in clusters along the length of a pine needle. Larvae are hairy with four clusters of hairs on the dorsal surface. The adult moth is blackish-brown.



Dasychira axutha egg mass attached to pine needles (Pham Quang Thu)



Dasychira axutha larva (Pham Quang Thu)



Dasychira axutha adult female with eggs (Pham Quang Thu)



Damage on *P. massoniana* (Ha Van Hung)



Name: *Dendrolimus punctatus* (Lepidoptera: Lasiocampidae)

Common name: Masson pine moth

Host: *Pinus merkusii*, *P. massoniana* and a range of other *Pinus* spp.

Damage/symptoms: Newly hatched larvae feed on the needle edge, causing curling and yellowing. Older larvae consume whole needles or feed in the middle of the needle, leading to breakage. When populations are high, complete defoliation may occur. This leads to significant reductions in growth and can lead to tree death.

Eggs, larvae and cocoons can be seen on the foliage. The presence of frass on the forest floor indicates larval feeding.

Outbreaks occur every 2–3 years, affecting tens of thousands of hectares. There are 3–5 generations per year (depending on climate). In northern–central Vietnam, damage is heaviest from November to March. In northern Vietnam outbreaks occur from June to September.

Description: Eggs are reddish-brown and laid in clumps among pine needles. The larvae have two colour forms—brownish-red and black—and have stinging hairs. The adult moth is brown and is attracted to light and pheromone traps.

WARNING

Take care with larvae as hairs can cause stinging and itching.



Dendrolimus punctatus eggs
(Pham Quang Thu)



Early instar larvae
(Pham Quang Thu)



Later instar larvae. Note stinging
hairs (Pham Quang Thu)



Dendrolimus punctatus adult
female (Pham Quang Thu)



Name: *Nesodiprion biremis* (Hymenoptera: Diprionidae)

Common name: Pine sawfly

Host: *Pinus merkusii*, *P. massoniana* (also *P. caribaea*, *P. elliottii*, *P. kesiya*, *P. oocarpa*, *P. patula* and *P. taeda*).

Damage/symptoms: Sawfly larvae are voracious leaf eaters and can defoliate entire trees. They are a particular problem in nurseries (where they can cause mortality of seedlings) and in young plantations (where they may cause loss of growth and tree death). They are mostly restricted to a few trees in a plantation, and rarely cause widespread defoliation.

During the day, larvae are commonly observed on stems in clumps of 10 or more. They disperse and feed at night. When disturbed, they raise their tails and regurgitate a yellowish fluid as a defence mechanism.

Description: Eggs are transparent white when laid singly in pockets cut either in fairly young or mature needles. Eggs change to milky white and grey just before hatching.

There are normally six larval instars and larvae feed almost entirely on mature foliage unless food is short. Early instar larvae are green; in later instars they become yellower, with a pattern of black dots.

Cocoons are 8–12 mm long and are spun among the bases of living needles close to the stem.



Nesodiprion biremis larvae
feeding in clumps
(Ha Van Hung)



Name: *Dioryctria abietella* (Lepidoptera: Pyralidae)

Common name: Spruce coneworm

Host: *Pinus merkusii*, *P. massoniana*, *P. caribaea* (attacks the cones of *Abies spp.*, *Cedrus spp.*, *Picea spp.*, *Pinus spp.* and *Pseudotsuga spp.*).

Damage/symptoms: Larvae feed on growing shoots and cones, causing tip death and seed loss. Larvae produce tunnels of up to 30 cm long in tips, affecting growth rates and the quality of timber produced.

Evidence of shoot boring includes distortion and wilting of new growth, swelling and the presence of frass. Infested cones have visible holes through which frass is ejected.

In some areas the pine moth is considered one of the most damaging pests of *Pinus merkusii* plantations, affecting thousands of hectares of young planted forests.

Description: The adult moth is 15 mm long. Adults are predominantly grey with a brownish tint and distinct, jagged, transverse lines on the forewings. In early larval instars the body is pale brown. Last instar larvae are 22–25 mm long and dark brown with a reddish-brown head capsule.

Total development time, from egg to adult, varies from 46–59 days. The insect completes two generations per year.



Damaged shoots
(Pham Quang Thu)



Damaged cones
(Pham Quang Thu)



Dioryctria abietella pupa
(Pham Quang Thu)



Dioryctria abietella adult
(Natural History Museum,
London)



Name: *Dendroctonus valens* (Coleoptera: Scolytidae)

Common name: Red turpentine beetle; bark beetle

Host: *Pinus* spp. In China it mainly attacks *P. tabuliformis* but is also recorded infesting *Larix*, *Abies*, *Picea* and *Pseudotsuga* spp.

Damage/symptoms: Beetles transmit fungal spores that germinate in the host, causing timber staining and tree decline/death.

Feeding produces pitch tubes (resin and frass pushed out of the entrance hole) visible on the outer bark surface of the lower trunk and roots (to 2–3 m above ground level), or lying as pellets at the tree base. The damage is easily seen when the bark is lifted.

Needles of attacked trees show a colour change from green through to yellow and red as the tree dies. Unhealthy trees with a diameter at breast height (DBH) of 20 cm or more are most susceptible. Occasionally, large populations may develop and move into healthy trees.

The potential economic and environmental impact of this insect in Vietnam is extremely high.

Description: Adult beetles are 6.5–9 mm long and tan when newly emerged but rapidly darken to a reddish-brown with yellow-brown hairs.

Larvae are up to 12 mm long, white, legless and C-shaped with a distinct, dark head capsule and a small brown area at the hind end.

Distribution: Continental United States except the eastern seaboard; southern Canada; Central America (native); China.



Dendroctonus valens damage to *Pinus tabuliformis*, China
(Donald Owen)



Dendroctonus valens pitch tubes
(Bob Oakes)



Larval galleries beneath bark
(Ladd Livingston)



Dendroctonus valens adult
(Pest and Diseases Image Library,
Bugwood.org)

WARNING – BIOSECURITY THREAT

This species has not been recorded from Vietnam.
Please alert FSIV forest health officers if you think
you have collected this pest.

Name: *Monochamus alternatus* (Coleoptera: Cerambycidae), a vector of the pine wilt nematode *Bursaphelenchus xylophilus*

Common name: Japanese pine sawyer beetle

Host: *Pinus kesiya* (also recorded to feed on many other species of *Pinus*, including *P. densiflora*, *P. thunbergii*, *P. luchensis* and *P. massoniana*, and species of *Picea*, *Abies*, *Cedrus* and *Larix*).

Damage/symptoms: *M. alternatus* is a vector of the pine wilt nematode, transmitted when adult beetles feed on the bark of twigs. Nematode infestation causes rapid wilt and chlorosis, followed by reddening of needles and tree death. Death can occur so rapidly that needles remain attached to the tree. Severe and widespread mortality of susceptible *Pinus* spp. can occur when this disease is present.

Signs of beetle activity in trees include the presence of a fine frass (similar to sawdust) caught in the bark or at the base of the tree, and kino bleeding. Adults leave emergence holes in stems and branches measuring 9 mm in diameter.

The insect has 2–3 generations per year.

Description: Adults have orange to brown elytra covered with numerous longitudinal bands composed of alternate brown (or black) and white rectangular spots. Adults are 15–28 mm long.

WARNING

Bursaphelenchus xylophilus has not been collected from Vietnam. If you see reddening and wilt of needles associated with *Monochamus* damage please alert FSIV forest health officers.



Adult *Monochamus* emergence hole (Jijing Song & Juan Shi)



Adult feeding damage to twigs (Pham Quang Thu)



Monochamus alternatus larva (Jijing Song & Juan Shi)



Monochamus alternatus adult female (Simon Lawson)



Name: *Gryllotalpa africana* (Orthoptera: Gryllidae)

Common name: Mole cricket

Host: *Pinus* spp., *Acacia mangium*, *A. auriculiformis*, *Eucalyptus* spp. and a wide variety of other tree species and agricultural crops.

Damage/symptoms: The adult cricket feeds on young seedlings and low shoots, cutting them off at night and dragging the pieces into its tunnel for feeding. The tunnel is usually deep, with its opening surrounded by ejected earth. Mole crickets are important pests in forest nurseries and young plantations.

Description: Adults are usually brown or black and grow 30–55 mm long. *Gryllotalpa africana* have strong forelegs for excavating soil. Adults occur throughout the year.



Gryllotalpa africana (Lambert Smith)



Name: *Macrotermes* spp. and *Nasutitermes* spp.
(Isoptera: Termitidae)

Common name: Termite

Host: *Pinus* spp., *Eucalyptus* spp., *Acacia mangium*,
A. auriculiformis and *A. mangium* x *A. auriculiformis*
(*Acacia* hybrid).

Damage/symptoms: Termites attack the roots of young transplants, girdling or destroying the underground stem, resulting in withering and death of the tree. Losses of up to 60% of newly planted trees have been recorded in some areas, necessitating replanting.

Description: Worker termites are pale creamy white and grow 3–6 mm long. Soldiers have darkened heads with prominent mandibles or with elongated snouts that produce defensive fluids. Mud-covered termite galleries are sometimes visible on the above-ground stem.



Termite damage to *Acacia*
(Pham Quang Thu)



Termite damage to *Eucalyptus*
(Pham Quang Thu)



Macrotermes sp.
(Pham Quang Thu)



Nasutitermes sp.
(Pham Quang Thu)



Name: *Cercospora pini densiflorae*

Common name: Cercospora needle blight

Host: *Pinus massoniana* and *P. merkusii*

Damage/symptoms: Cercospora needle blight causes yellowish-brown to grey lesions, appearing generally towards the distal part of the needles. Over time, these coalesce to give complete needle necrosis.

This is a disease of older nursery seedlings and the first few years of plantation establishment.



Yellowing and death of pine needles associated with *Cercospora* needle blight (Pham Quang Thu)



Name: *Coleosporium* sp.

Common name: Pine needle rust

Host: *Pinus kesiya*

Damage/symptoms: Pine needle rust first appears as yellow spots on individual needles followed by whitish pustules or blisters that break open to discharge orange spores of the fungus. The disease does not usually seriously damage trees but heavy infection can cause defoliation.

Pine needle rust is most prevalent on young trees up to sapling size.



Coleosporium sp. (Pham Quang Thu)



Name: *Diplodia pinea*

Common name: Diplodia needle blight

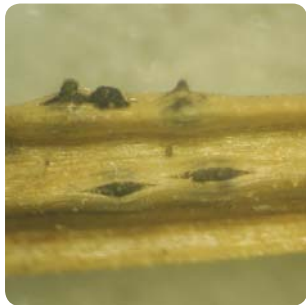
Host: *Pinus* spp.

Damage/symptoms: The disease first appears on the needles on the main stem and at the bases of the lower branches.

Early symptoms include deep green bands and yellow and tan spots on needles. The green bands do not last long and are only detected at the onset of symptom development. Later, the spots turn brown to reddish-brown and finally become necrotic. The ends of infected needles above the lesion often turn brown, and then die. Small, black stromata (fruiting bodies) produced on the diseased tissue result in a rupturing of the epidermal tissue, and under humid conditions spores of the fungus are produced from these structures.



Infection of young pine tree where the ends of infected needles above the lesions have turned brown (Pham Quang Thu)



Small, black fruiting bodies are produced on the diseased tissue, resulting in a rupturing of the epidermal tissue (Pham Quang Thu)



Name: *Cronartium* rusts (*C. flaccidum* and *C. orientale*)

Common name: Pine blister rust; pine gall rust

Host: *Pinus kesiya*

Damage/symptoms: Symptoms on pines include yellow-brown, diamond- to elliptical-shaped cankers or swellings on trunks or branches. These infections usually produce conspicuous amounts of resin. Galls, tip and branch dieback, trunk bushiness, and breakage at the lesion and canker are also typical of several *Cronartium* diseases. The presence of white to orange-yellowish, blister-like aecia (fruiting bodies) on the swollen or cankered organs is a typical symptom. Yellow-orange masses of aeciospores also form on these cankers.



Branch dieback associated with infection by pine blister rust, *Cronartium flaccidum* (Pham Quang Thu)



Orange-yellowish fruiting bodies of *Cronartium flaccidum* on the stem of *Pinus kesiya* (Pham Quang Thu)



Branch gall on *Pinus kesiya* associated with infection by pine gall rust, *Cronartium orientale* (Pham Quang Thu)



Gall covered in fruiting bodies of *Cronartium orientale* (Pham Quang Thu)



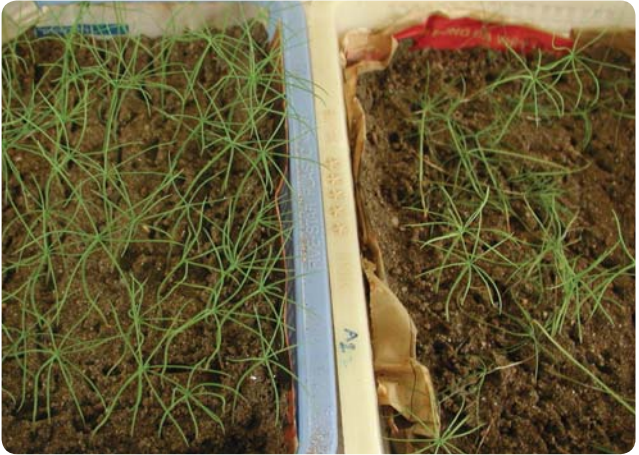
Name: *Fusarium oxysporum*

Common name: Seedling damping-off disease

Host: *Pinus* spp.

Damage/symptoms: *Pre-emergence damping-off*—Seeds may be infected as soon as moisture penetrates the seed coat or as the radicle begins to extend, all of which rot immediately under the soil surface. This condition results in a poor, uneven stand of seedlings, often confused with low seed viability.

Post-emergence damping-off—Infection results in cotyledon death or healthy-looking seedlings suddenly wilting or collapsing. Infected seedlings may show symptoms of stunting, low vigour, or wilting on a warm day. Needles may yellow and prematurely senesce, beginning on the oldest needles.



Damping off symptom on seedling of *Pinus massoniana* caused by *Fusarium oxysporum* (Pham Quang Thu)



Glossary

Abscission	The natural detachment of parts of a plant, typically dead leaves and ripe fruit
Aeciospores	A spore produced by certain fungi of the order Uredinales. Chains of aeciospores are produced in an aecium, which develops in the tissues of the host plant
Aecium/aecia (pl.)	A structure holding aeciospores that is produced in host plant tissue by fungi of the order Uredinales
Apical meristem	A region at the tip of each shoot and root of a plant where cell divisions continually occur to produce new stem and root tissue
Chlorotic	Loss of the normal green colour of leaves of plants, caused by disease, nutrient deficiency or lack of light
Coalesce	Come together to form one mass or whole
Conidia	A spore produced asexually by various fungi at the tip of a specialised hypha
Conidiophores	A specialised hypha upon which one or more conidia are borne
Cotyledon	An embryonic leaf in seed-bearing plants, one or more of which are the first leaves to appear from a germinating seed
Cuticle	A thin, waxy, protective layer covering the surface of the leaves and stems of plants

Distal	Referring to the region of an organ that is furthest from the point by which it is attached to the main body
Elytra	The thickened, horny forewings of Coleoptera (beetles), which cover and protect the membranous hindwings
Epicormic	Referring to a shoot or branch growing from a previously dormant bud on the trunk or a limb of a tree
Epidermal	Referring to the outermost layer of cells of an animal or plant
Frass	The fine, powdery material to which phytophagous insects reduce plant parts; sometimes mixed with faecal pellets
Girdling	Cutting transversely across the phloem in a plant stem so that downward transport of substances cannot occur
Hypha/ hyphae (pl.)	Branched or unbranched filaments that together form the mycelium or vegetative part of a fungus
Instar	A stage in the larval development of an insect between two moults
Kino bleeding	Gum leaking from the damaged area of a tree stem
Mycelium/ mycelia (pl.)	The vegetative part of a fungus, consisting of a network of fine, white filaments (hyphae)

Noctuid	A moth of the family Noctuidae, including many serious pests. Moths typically have dull forewings and pale or colourful hindwings
Nymphs	Young insect of primitive orders that do not undergo complete metamorphosis, encompassing all immature stages after the egg. The nymph resembles the adult
Oviposit	To lay an egg or eggs
Petiole	The stalk that joins a leaf to a stem
Phyllode	A flattened and widened petiole (leaf stalk) that looks like and functions as a leaf. In plants with phyllodes the true leaves are often tiny or do not develop
Polyphagous	Feeding on or using many kinds of plants, usually from several families
Prolegs	Unjointed, fleshy protuberances found on the abdomen of certain insect larvae, in contrast with true legs, which are jointed and found on the thorax
Pronotum	The dorsal, sclerotised cuticle of the first thoracic segment of an insect
Pupa/pupae (pl.)	An insect in its inactive, immature form between larva and adult
Pustule	A small, raised spot or rounded swelling on a plant caused by fungal infection

Pycnidium/ pycnidia (pl.)	A flask-shaped or spherical structure within which conidia are formed in certain types of fungi
Radicle	The part of a plant embryo that develops into the root system
Senesce	To grow old
Setal	Pertaining to a stiff, hair-like or bristle-like structure
Sporulation	To produce or form a spore or spores
Stomatal	Referring to the stomata pores found mostly on the undersides of leaves that allow atmospheric gases to pass in and out for respiration and photosynthesis
Thoracic	Referring to the three segments of an arthropod's body that lie between the head and the abdomen (thorax). Each thoracic segment carries a pair of legs
Uredium/ uredia (pl.)	A region of fungal tissue where spores (called uredospores) develop in a plant infected with certain rust fungi
Xylem	The vascular tissue that conducts water and mineral salts from the roots to the aerial parts of a plant and provides the plant with mechanical support



Appendix A: Protocols for collecting samples

Make sure a 'Health surveillance field form' or written description of the damage/symptoms accompanies all samples sent for identification. Health surveillance field forms can be obtained from FSIV regional offices or contact Forest Protection Research Division (as per page 119). This should include aspects such as:

- severity (on individual trees and within the plantation)
- area of plantation affected (e.g. confined to poorly drained area)
- incidence (how many trees are affected)
- part of the tree affected (e.g. lower senescing foliage only, rapid wilt vs slow decline)
- tree species
- GPS coordinates (where possible) of all samples.

Insect larvae (foliage)

- Larvae must be kept alive to be reared in the insectary for identification once they have emerged as adults. Do not put larvae in alcohol or freezers.
- Collect samples of the larvae and plenty of fresh foliage as the food source for rearing.
- Place larvae and foliage into a jar or container with a fabric or insect mesh lid.
- If larvae samples are brought into the lab, place them in a sealed plastic bag with plenty of air and **keep cool**.

Insect larvae (stems)

- Cut the tree or branch down (if possible) and send the affected area and larvae to the laboratory for rearing in the insectary.

Hard-bodied insects (beetles, cicadas etc.)

- Put insects into a vial of alcohol (70%) and send to the laboratory.

Moths and butterflies

- Do not put into alcohol. Keep all samples **dry**.
- Place in the freezer to kill, then into an empty vial or envelope. Try to minimise movement of the insect.

Foliage damage samples (scale insects, mites, galls, psyllids etc.)

- Place into a sealed plastic bag and send to the laboratory. Keep samples cool and out of direct sun.

Foliage diseases

- Make sure all samples are sent **as soon as possible**.
- Samples should represent the symptoms observed.
- Samples with fruiting bodies enable more rapid identification and increase the chance of getting a pure culture.
- Place leaf samples in a paper bag and keep dry to prevent rapid breakdown and colonisation by secondary fungi. If using a plastic bag, keep the sample cool and send to pathology ASAP (via overnight courier if possible).
- Keep leaves flat and avoid crumpling where possible.

Stem diseases/cankers

- Collect a sample that includes the live/dead zone.
- Store in a paper bag and keep cool.
- Samples with external fruiting bodies assist in a rapid identification of the pathogen.

Root collar and root diseases

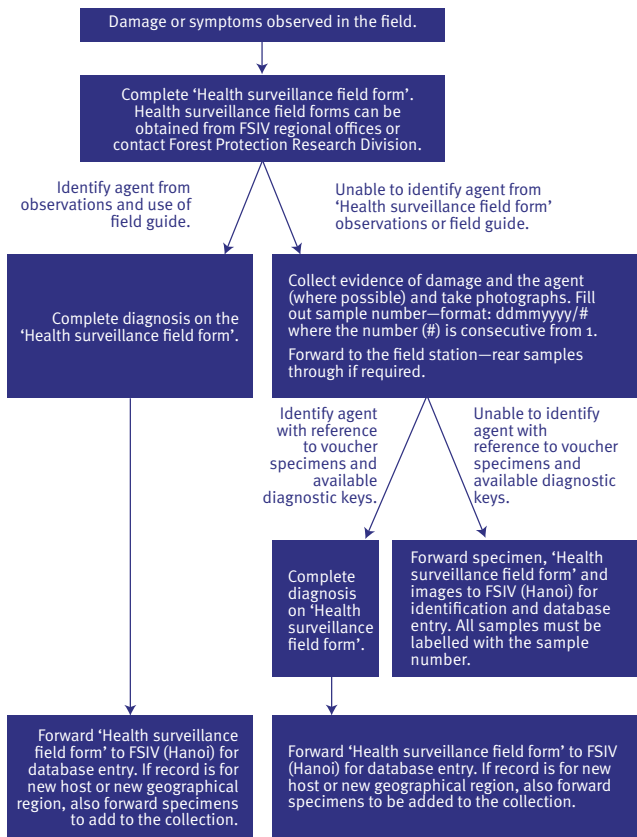
- Collect samples that include the live/dead zone for samples of root and root collar decay.
- Fruiting bodies will assist in a rapid identification.

Send all samples to:

**Forest Protection Research Division
Forest Science Institute of Vietnam
Dong Ngac - Tu Liem - Hanoi**

Ph: 84 4 3836 2376

Appendix B: What to do with field samples



Appendix C: Equipment for field surveys

- ***Healthy plantations: a field guide to pests and pathogens of Acacia, Eucalyptus and Pinus in Vietnam***
- waterproof/alcohol-proof pens/permanent markers (but not ball points) and moderately soft lead pencils (HB, B or 2B)
- ‘Health surveillance field form’ and/or 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
- hand lens/magnifying glass 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
- camera (digital)
- small pair of binoculars
- secateurs
- small combination pick/mattock for examining tree roots
- 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
- portable icebox
- insect net



Appendix D: Source material

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