GOVERNMENT OF WESTERN AUSTRALIA

Department of
Primary Industries and Regional Development

AgriFutures Australia

Australian Truffle Orchards

Pest and disease field guide

Summary

This guide was produced as part of the national project ‘Pests and diseases of truffles and their host trees”. This project received support from AgriFutures™ Emerging Industries Program, Department of Primary Industries and Regional Development (DPIRD) Western Australia, Australian Truffle Growers Association, Truffle Producers Western Australia, the Australian National University (ANU) and New South Wales Department of Primary Industries (NSW DPI).

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Where photos used in this guide were not provided by the above contributors, acknowledgement of the source are provided at the end of the guide.

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Cover images: (left) Striped slug feeding on truffle, (right) truffle with springtail feeding damage.

How to use this guide

This guide provides a practical reference for Australian truffle producers for the identification of pest and non pest invertebrates and diseases most often encountered in truffle orchards. The contents table indicates if the invertebrates and diseases in this guide are a pest of trees, truffles or a non-pest. Non-pests are either beneficial, benign or their pest status is not known and requires further observations and research to confirm. Some invertebrates fit into multiple categories. Also included in this guide are some significant pests and diseases of truffles and their host trees that are not currently found in Australia. It is important that growers be aware of these exotics so that they may be reported to the relevant state authority if if found in Australia.

This guide provides guidance on when and how to monitor as well as descriptions of pests and their damage and symptoms. Many pests and disease of truffles and their host trees occur only occasionally or may be present in small numbers that do not justify management. Regular orchard and harvest monitoring is encouraged as part of an integrated pest and disease management (IPDM) program to determine if pests and diseases present are of economic significance and to guide management decisions.

Some pests of truffles are small and may be difficult to identify with the naked eye. Use a 10x hands lens, or similar, to aid in correct identification.

The guide should be used in conjunction with the ‘Australian truffle orchard integrated pest and disease management (IPDM) manual’. The IPDM manual contains more detail on each of the pests, diseases and beneficials outlined in this guide as well as information on how to implement IPDM in a truffle orchard and how to conduct orchard and harvest monitoring. The manual is available on the DPIRD website, agric.wa.gov.au

Contents

● Pest may be present in both newly established and mature orchards but is likely to cause economic damage only in young orchards.

● Pest may interfere with operation of mini-sprinklers.

Ants

Description: A native species (*Cardiocondyla atalanta*) that occurs across Australia. They are about 1.5mm long. Important because they can block mini-sprinklers but other species may cause the same problem.

Damage: Ants cluster inside mini-sprinklers when not in use causing blockages.

Monitor: Check sprinklers for blockages at the start of each irrigation season. Send problem ants to a specialist for correct identification, control methods are species dependent. To send ants for identification, collect on sticky tape, attach the tape with ants to a light-coloured piece of card and post the card in a crush proof container.

Note: Because ants forage over a wide area and construct underground nests, they may play a beneficial role in the spreading of truffle fungus spores within orchards.

Left: Native ant associated with blocking mini-sprinklers
Right: Type of mini-sprinkler that can be blocked by ants, they crawl into the lower blue section when the sprinklers are not in use

Aphids
Family Aphididae

Description: Aphids are soft-bodied insects, about 2mm long. Adults can be wingless or winged with one pair of frail wings. They have a pair of tube-like structures (cornicles) on the end of the abdomen.

Damage: Feeding by these sap-sucking insects deforms foliage especially near the growing tips. This reduces tree vigour, especially in newly planted trees. Feeding is unlikely to impact mature trees and has not been observed so far.

Monitor: Aphids occur on growing tips and young leaves of oaks and hazelnuts. Check the underside of leaves during autumn and spring, when they are most abundant. Generally, aphids are attacked by a wide range of natural control agents – parasites, predators and disease; they can reduce aphid numbers without the need for intervention.

Left: Aphids on an oak leaf – black aphids have been parasitised by a wasp
Right: Winged and wingless aphids on a hazelnut leaf

African black beetle

Heteronychus arator

Description: African black beetle adults are shiny black about 10mm long. They are active on the soil surface at night and shelter in the soil during the day. The larvae are soil borne, 'C' shaped with a strongly sclerotized brown head, prominent black jaws, three pairs of well-developed legs on the thorax, white thorax/abdomen and a distended anal end.

Damage: Adults feed on the bark of trees near ground level up to about two years after transplanting. Damaged plants will have flayed bark tissue near the soil surface, often wilt and can die. They can cause extensive tree death in establishing orchards. Adults have occasionally been observed feeding on truffle but are generally not in high enough numbers in mature orchards to cause concern.

Monitor: Use pitfall traps or spade sampling to monitor orchard site prior to planting to determine presence and need for management.

Left: Tree guards installed at planting to prevent African black beetle adults feeding on trunks

Middle: African black beetle adult feeding on a truffle

Right: African black beetle larva

Other cockchafer beetles

Redheaded pasture cockchafer, *Adoryphorus coulonii,* Yellowheaded cockchafer, *Sericesthis spp.* Blackheaded pasture cockchafer, *Acrossidius tasmaniae*

Description: These native cockchafer beetles or scarabs, are closely related to African black beetle. They occur in south eastern Australia. The soil borne larvae are pasture pests. Adults can be distinguished by their size, shape, colour and markings on their wing covers. Larvae can be distinguished by the colour of the head capsule, legs and pattern of spines on their abdomen.

Damage: Unlike African black beetle, adults are relatively short-lived and are unlikely to damage trees. Larvae are present for a longer period. They have not been reported to damage trees, but may damage truffles.

Monitor: They may be residents, or fly into an orchard. Monitoring or control methods are not discussed because their pest status is unknown.

Top: (left) Blackheaded pasture cockchafer adult; (middle) Redheaded pasture cockchafer adult; (right) Redheaded pasture cockchafer larva

Bottom: (right) Yellowheaded pasture cockchafer adult

‘Australian truffle beetle’

Thalycrodes species near *australe*

Description: Adults of ‘Australian truffle beetle’ are about 3mm long, honey-brown, have clubbed antennae and bear rows of short spines behind their head and along their back. Larvae are white to cream coloured, grow up to 4mm long, have a brown head, black jaws and bear three pairs of very short legs on the thorax.

Damage: Adults and larvae feed on truffles producing 1 to 2mm diameter pinholes in the peridium and galleries within truffles where soil may be introduced.

Monitor: Adults can fly but spend most of their lives underground feeding and laying eggs on and in truffles. The insect and damage are usually detected after they are washed and during grading. Monitor with pitfall or pipe traps baited with an attractant solution – see Australian truffle IPDM manual for details.

Top: (left) ‘Australian truffle beetle’ adult; (right) pinholes in the peridium of truffles caused by ‘Australian truffle beetle’

Bottom: (left) honeycomb of tunnels in a truffle caused by ‘Australian truffle beetle’; (right) the larval and pupal stages of ‘Australia truffle beetle’

Predatory beetles

Carabidae and Staphylinidae

Description: These ground dwelling predatory beetles are the most common beneficial agents in truffle orchards.

Carabid adults occur in a range of sizes and are hard shelled. Most are dark coloured and shiny, some are brightly coloured or metallic. The hardened wing covers have grooved stripes running their length. Adults’ eyes are prominent, on the side of the head. Adults and the soil borne larvae have prominent jaws.

Staphylinid adults occur in a range of sizes and most are dark coloured. They are more elongate than carabids with a shortened wing cover, exposing at least half of the abdomen. Adults and the soil borne larvae have prominent jaws.

Both groups are nocturnal. They feed on a range of soft-bodied organisms – larvae within the soil and adults prey on invertebrates that occur on the soil surface.

From left: Metallic green carabid beetle; Shiny black carabid beetle; (top) Black staphylinid beetle – note short wing covers; (botom) Carabid beetle attacking a slug

Spring beetle

Colymbomorpha vittata

Description: Adult spring beetle are flat/rounded in shape, shiny metallic green/brown/yellow with striped wing covers, prominent branched antennae and long legs bearing prominent spines. They are about 12mm long. Not recorded in eastern Australia.

Damage: Spring beetle adults are chewing insects which skeletonise leaves. Feeding damage is obvious on young growth but occurs only for a short period so is not considered important. If the beetles are very abundant and trees less than two years old, they may slow tree growth.

Monitor: Trees in truffle orchards adjacent to native vegetation are most likely to be infested, but in years when beetle numbers are high, any orchard can be infested by spring beetle. Check trees in spring for signs of leaf feeding and presence of beetles.

Left: Feeding by spring beetle adults cause a windowing effect on leaves

Right: (top) Spring beetle damage to young foliage of an evergreen oak; (bottom) Adult spring beetle

Stinking longicorn

Stenoderus suturalis

Description: Adult stinking longicorn are about 8mm long, black with tan wing covers and long black antennae and legs. Larvae are legless, have a broad thorax, white well-defined body segments and are about 20mm long when mature.

Damage: Larvae are the damaging stage. They are borers and have been recorded feeding within branches of hazelnut trees. Infested branches become weakened and may snap or die.

Monitor: Adult stinking longicorn may not be seen in truffle orchards but are more likely to be present in adjacent vegetation, clustering on flowers. Damage to branches and stems by larvae is likely to be detected well after the infestation first occurs. Cracks in the bark may lead to signs of sap exudation and larvae will be found within the damaged plant.

Left: External symptoms of cracks and sap exudate in a hazelnut branch from stem boring by stinking longicorn larva

Right: (top) Larval stage of stinking longicorn borer; (bottom) Male and female stinking longicorn adults

Wireworms

Family Elateridae

Description: Wireworms are the larvae of click beetles. They are soil borne, long cylindrically shaped and usually cream to yellow/orange with black jaws and a flat plate with protruding spines on the tail. They can grow to 40mm long and about 5mm in diameter. They may be confused with false wireworms. Adult click beetles are hard-shelled, flattened, dull brown to grey with a district gap behind their head/prothorax and wing covers. They can 'click' to right themselves if upside down.

Damage: Feeding by wireworm larvae results in a shallow circular hole in the truffle.

Monitor: Monitoring to date has found the proportion of truffles damaged by wireworm larvae to be very low. Damage by this insect is best identified at harvest. Monitoring for wireworm larvae can be done using cut pieces of potato tubers as lures buried across an orchard; refer to the Australian truffle orchards IPDM manual for more details.

Left: Larval stage of true wireworm/click beetle
Right: True wireworm/click beetle adult

False Wireworm/vegetable beetle and bronzed field beetle

Family Tenebrionidae

Description: Larvae of vegetable beetle (VB) and bronzed field beetle (BFB) occur in the surface litter layer feeding on organic matter and occasionally plants. VB larvae are straw coloured, long and cylindrical without the black jaws and flattened plate on the tip of the abdomen present on click beetle larvae. BFB larvae are dark brown and grow to 12mm long and 2-3mm wide, with two distinct upturned spines on the end of the abdomen. Adults of VB & BFB feed on decaying organic matter, occasionally attacking plants. VB adults are about 1cm long, flattened dull brown to grey beetles and are nocturnal. BFB adults are a similar size but are shiny black, slightly bronzed. VB and BFB adults occur in pasture and have been observed in truffle orchards. They are not true soil insects so are less likely to feed on truffles.

Left: False wireworm/vegetable beetle adult
Right: (top) Bronzed field beetle life cycle – from left: larva, pupa, newly emerged adult, hardened adult; (bottom) Larval stage of false wireworm/vegetable beetle

Centipedes - garden
Class Symphyla

Description: Garden symphylans are white, centipede-like soil arthropods that grow to about 6mm long when mature and have a pair of prominent antennae. They are soft bodied and translucent with only two body parts, head and trunk. Unlike insects, they have legs on most trunk segments, with the number of legs increasing from 5 to 6 pairs to 12 pairs when mature.

Garden centipedes or garden symphylans have been observed in low numbers associated with truffles. They are primarily herbivores, some species are pests of vegetable crops and tree seedlings, feeding on root hairs, rootlets, germinating seeds and soil detritus. Other species are predatory. The identification and pest status of symphylans on truffles requires clarification. To date they have not been observed feeding on truffles.

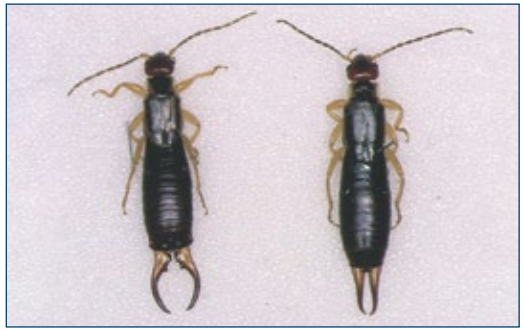
Above: Garden centipede on truffle

Earwigs
Order Dermaptera

Description: A range of species of earwigs has been recorded from Australian truffle orchards. European earwigs (*Forficula auricularia*) are omnivorous, are 12 to 24mm long and have uniform smooth and shiny brown bodies with distinguishing light brown/yellow legs, pincers and 'shoulders'. Native predatory earwigs (*Genus Labidura*, e.g. *L. truncata*) are usually honey brown and larger than European earwig. A yet to be identified species has been observed to feed on truffles. It is uniformly black, grows to about 12mm long and is usually present in low numbers.

Damage: European earwigs are both harmful and beneficial to crops, as they eat both the foliage and some soft-bodied pest insects. Tree feeding damage has not been recorded in truffle orchards to date. Earwigs have been observed feeding on truffles, producing deep cavities. The proportion of truffles damaged by earwigs has been very low to date.

Monitor: Earwigs can be observed when conducting tile monitoring and during harvest.



Left: Male (left) and female European earwigs

Right: (top) Black earwig implicated with damage to truffles; (bottom) Female (left) and male predatory earwig, *Labidura truncata*

Flatworms

Phylum Platyhelminthes

Description: Flatworms have a flat ribbon-like or leaf-like shaped body, with a glistening, moist appearance. The types observed in truffle orchards vary in length up to about 30mm and range in colour from pale yellow with stripes, to orange and black.

They live in shaded, moist, decaying organic matter situations such as in leaf litter in truffle orchards.

Flatworms that occur on the floor in truffle orchards are most likely to be free-living. Such flatworms are mostly predators. They have not been identified to species, so their diet is not known. If they are predatory, it is possible they could feed on small invertebrates such as springtails, or that their main diet is decaying organic matter.

They may be found in damaged or rotten truffle during harvest and grading but they have not been observed feeding on undamaged truffle and are thought to be non-pests.

Above: Striped flatworms

Fungus gnats

Fungus gnats (Family Sciaridae) and other flies

Description: Various species of flies are associated with truffles. Larvae of fungus gnats are the most common and grow to about 8mm, have slender white bodies and a black head capsule. Fungus gnat adults are frail mosquito-like flies about 2.5mm in length with a distinguishing Y-shaped vein on each of their single pair of wings.

Damage: Larvae are primarily fungus feeders. In the absence of fungus, they will feed on root hairs and organic matter. They have been found associated with damaged truffles and in some cases appear to have caused primary damage. The likelihood of damage may be influenced by the condition of the truffle, e.g. how firm it is and the presence of cracks.

Monitor: There is no monitoring technique for use in the field for fungus gnats. They may be observed in and around truffles at harvest.

Left: Pupae of an unidentified fly in a truffle
Right: (top) Pupae of an unidentified fly in a truffle; (bottom) Fungus gnat adult fly

Grasshoppers - wingless

Phaulacridium vittatum

Description: Wingless grasshopper adults are mainly wingless but some have wings. Adults are about 20mm long, light brown with a darker coloured back and either with or without white stripes along each side of the head and thorax. Newly emerged nymphs are about 2mm long and dark grey.

Damage: Primarily leaf feeding, but can chew green bark on young trees and around the growing tip. If this feeding occurs on young trees, it can kill them.

Monitor: Adults are the easiest identifiable stage but check in spring for newly emerged nymphs that often feed on prostrate plants and flower petals. Wingless grasshoppers may lay eggs in the same area each year; check for the location of egg beds in adjacent paddocks by observing where newly emerged nymphs occur to help with future control.

Above: Wingless grasshopper adults

Millipedes

Class Diplopoda

Description: A range of species of millipedes has been recorded from Australian truffle orchards. The most common species are *Cylindroiulus latestriatus*, a small brown millipede approximately 25mm long and Portuguese millipede *Ommatoiulus moreleti*, which is shiny black and about 45mm long.

Damage: The brown millipede, *C. latestriatus*, occurs in large numbers in some truffle orchards and has been observed to browse the peridium (skin) of immature truffles. Portuguese millipede occurs across southern Australia in many truffle orchards. It has been observed to feed on immature truffle in the laboratory, browsing the peridium of the truffle or creating neat holes the same width as the millipede. Because they are usually present in low numbers, it is not regarded as a major pest.

Monitor: The abundance of millipedes can be assessed with tile monitoring.

Left: Portuguese millipedes removing the peridium of immature truffle
Right: *Cylindroiulus latestriatus* on a truffle

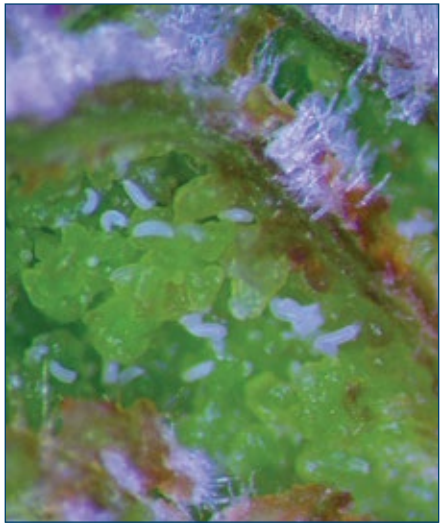
Big bud mite/Hazelnut gall mite

Phytoptus avellanae

Description: At 0.3mm long, a high-powered microscope is required to see these mites. Their presence is detected when growing tips become distorted.

Damage: The main host for this mite is hazelnuts. Mite-infested buds reduce tree vigour by adversely affecting normal tree growth. They have been observed in hazelnut orchards for nut production but have not lead to any records of significant damage so are considered a minor pest.

Monitor: An infestation of hazelnut bud mite would be suspected if new shoots appears stunted and growing tips are enlarged or have a gall-like appearance. Samples of buds need to be examined under a microscope to confirm the cause. It is a key pest of hazelnut trees overseas and is known to occur in eastern Australia, and for this reason, care should be taken with sourcing planting material.



Left: Deformed bud on hazelnut tree caused by big bud mite
Right: Infestation of big bud mites in a deformed hazelnut bud

Hazelnut mite

Tetranycopsis horridus

Description: Hazelnut mites are red/black and characterised by the presence of many spines on their back. It is similar in size to the more common two-spotted mite. The mite feeds on the lower leaf surface. The eggs are red.

Damage: It feeds on hazelnut trees, oaks and pines. Some hazelnut varieties appear to be more susceptible. Symptoms on leaves from feeding include white or yellowish feeding spots on the upper leaf surface. Mite feeding results in loss of leaf function and reduced tree health. They have been observed in truffle orchards but have not lead to any records of significant damage so are considered a minor pest.

Monitor: The presence of the mite would be detected by checking for the characteristic signs of feeding and then checking for the mites themselves on the underside of leaves, using a 10x hand lens.

Left: Hazelnut mite adult
Right: (top) Hazelnut mite egg; (bottom) Hazelnut mite nymph

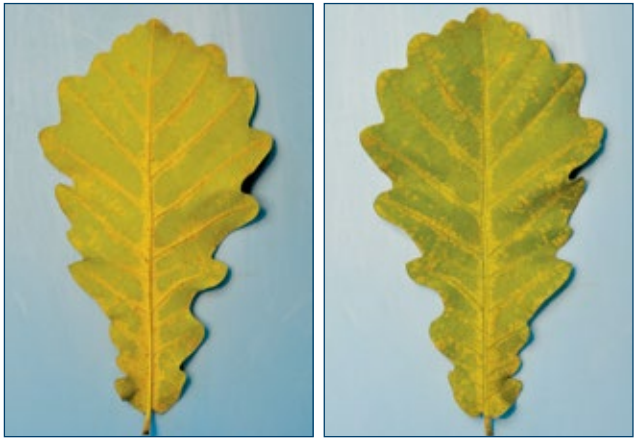
Other mites

Oak mite, Bryobia mite (*Bryobia rubrioculus)*, two-spotted mite (*Tetranychus uritcae)* and European red mite (*Panonychus ulmi*)

Description: These mites vary in appearance. Except for two-spotted mite, they feed on the upper surface of leaves. To confirm the species present, a 10x hand lens or microscope is required. Refer to the Australian truffle orchards IPDM manual for more information.

Damage: These are all leaf feeding mites causing discolouration adjacent to leaf veins or yellowing/silvering of leaves that can lead to premature leaf drop. They have been observed in truffle orchards but have not led to significant damage so are considered minor pests.

Monitor: The presence of these mites would be detected by checking for the characteristic signs of feeding and then checking for the mites themselves using a 10x hand lens. When monitoring also check for the presence of predatory mites that can provide good control of some pest species.



Above: Symptoms of yellowing adjacent to the veins caused by mites on the (left) lower and (right) upper leaf surface of oak

Fruit tree borer

Maroga melanostigma

Description: Moths of fruit tree borer have a wingspan of about 40mm, white forewings with a black dot near the centre and grey and white hindwings. The tip of their abdomen is yellow and they have orange hairs near the top of their legs. Larvae have a dark brown head and pale brown body sparsely covered with hairs.

Damage: Larvae bore into trees covering the holes with dark brown silk and frass. Feeding by larvae results in weakened stems that are susceptible to snapping in windy condition. Branches can be killed and tree vigour adversely affected.

Monitor: Infestation of trees is first noticed by the presence of sawdust-like material webbed together, hanging on the side of a tree with some bark removed and a cavity in the trunk.

Left: Webbed sawdust from wood moth larva feeding on hazelnut
Right: (top) Fruit tree borer moth; (bottom) Larval stage of fruit tree borer

Heliothis: native budworm and corn earworm

Helicoverpa punctigera and *H. armigera*

Description: Heliothis moths are arrow-head shaped at rest, about 2cm long, with pale brown forewings and two-tone coloured hindwings. Eggs are white when first laid and develop a black dot when near hatching. Larvae are cream coloured when they hatch but can range in colour from brown to green pink and near black as they mature. They have lateral white stripes and grow to about 3cm long.

Damage: Heliothis larvae mainly feed on young leaves and sometimes immature nuts. When infestations are heavy, growing tips may be attacked. This can adversely affect tree shape and survival.

Monitor: The first sign of an infestation of heliothis larvae is windowing of young leaves. Gross leaf loss may occur in heavy infestations. Separate pheromone traps for each species may be installed to monitor for presence of moths. Moths may be observed at lights at night. Eggs may be observed near growing tips.

Left: Heliothis larva

Right: (top) Heliothis larva and damage to leaf and immature hazelnut; (bottom) Heliothis moth

Lightbrown apple moth and Western fruit moth

Epiphyas postvittana and *E. pulla*

Description: Adults of both species are about 1cm long, bell-shaped at rest and have two-tone coloured forewings. Females lay a flat raft of 20 to 30 pale green eggs that darken as they mature. Larvae are lime green with a brown head, grow to about 2cm long and produce silk to web leaves together to feed. Western fruit moth only occurs in parts of WA.

Damage: Larvae are minor pests in nurseries where the growing tip may be killed affecting tree shape. Occasionally they may be pests in newly planted orchards.

Monitor: The first sign of an infestation is clumped leaves from webbing by larvae. Separate pheromone traps for each species may be installed to monitor for the presence of moths. Egg masses are very cryptic and are unlikely to be noticed.

Left: Lightbrown apple moth adult

Right: Lightbrown apple moth larva and associated leaf damage and webbing

Oak leaf miner

Phyllonorychter messaniella

Description: Oak leaf-miner moths are about 3-4mm long, light brown with dark brown and white markings on the forewing. They lay eggs on the underside of leaves. Larvae feed on the underside of leaves below the epidermis creating blister-like symptoms. These appear as necrotic areas on the upper leaf surface. When mature, larvae pupate within the leaf mine. Adults emerge from the pupal case, which protrudes from the mine.

Damage: Feeding by larvae reduces the photosynthetic area of leaves but unless infestations are heavy and trees are young, they are unlikely to adversely affect tree health.

Monitor: The first signs that oak leaf-miner is present are the necrotic brown patches on leaves. When the underside is checked, the characteristic blisters will be evident.




From left: Symptoms of oak leaf miner feeding by larvae on upper leaf surface; characteristic blisters on lower leaf surface; oak leaf miner larva; oak leaf miner pupa

Painted apple moth and Western tussock moth

Teia anartoides and *T. anthlophora*

Description: Male painted apple moths have brown forewings with darker waves and bright yellow and brown hind wings. Adult male western tussock moth have similar colour forewings, but grey/brown hind wings. Both species are 10mm long with a wingspan of about 20mm. Female moths are light brown, about 10mm long, wingless and lay a mass of white circular eggs covered in hairs. Larvae of both species are hairy, reasonably brightly coloured and grow to about 25mm.

Damage: Larvae feed on leaves and may adversely affect tree health, especially in newly planted orchards. To date, they have occurred infrequently in truffle orchards so are regarded as a minor pest.

Monitor: An infestation would be associated with leaf loss. Should painted apple moth be a consistent pest, pheromone traps can be used for monitoring.



Left: Larvae of western tussock moth and associated feeding on hazelnut leaves

Right: (top) Painted apple moth male ; (bottom) Wingless female western tussock moth and egg mass

Potworms
Family Enchytraeidae

Description: Potworms are in the same group of invertebrates as earthworms. They have the same appearance as earthworms except lack distinguishing external features. They are white, except for their gut contents which is a similar colour to their food. The potworms most commonly observed with truffles grow to about 5mm long and 0.2mm diameter.

Potworms require moist conditions and usually feed on decaying organic matter but do feed on fungi and nematodes. Potworms lack the mouthparts to be primary pests of truffles but are often associated with truffles already damaged by other agents and when conditions of high moisture are present.

Potworms are most noticeable in the grading room.

Above: Potworms in rotten truffles

Soft scales
Family Coccidae

Description: Two species of soft scale have been observed on hazelnut trees – a brown scale and Chinese wax scale. Adult scale are circular, about 8mm wide. Chinese wax scale is grey with darker markings on the top and around the edges. Scales excrete honeydew onto leaves and stems that turns black from sooty mould fungus growing on the excretion. Ants may farm scales for their honeydew and protect them from natural enemies. Up to 500 eggs are laid under each scale. Eggs hatch to mobile crawlers, which are oval, flattened, pale brown and 0.25mm long.

Damage: Feeding by scale affects shoot growth. Sooty mould affects photosynthesis. Scale infestation is rare and observed only on hazelnut trees in truffle orchards.

Monitor: The first signs of infestation are scales or sooty mould. Assess the stage of adults in relation to egg laying/ hatching by checking for eggs and crawlers with a 10x hand lens.

From left: Brown frosted scale on a hazelnut tree; Chinese wax scale on a hazelnut tree; (top) Eggs under a Chinese wax scale after the adult has completed egg laying; (botom) Black sooty mould on an olive tree infested with black scale

Slaters

Including Common pill bug - *Armadillidium vulgare*, Common rough woodlouse - *Porcellio scaberers*

Description: Slaters are hard shelled crustaceans, oval shaped, with seven body segments each with a pair of legs. They are usually grey but can be brown or near orange. Adults vary in length to about 20mm. Pill bugs can roll into a tight ball. Other species may occur in truffle orchards.

Damage: Slater feeding on truffles results in shallow or deep holes, gouges and/or large cavities, indistinguishable from damage by slugs. Shallow forming truffles are more likely to be damaged.

Monitor: Slater numbers can be assessed with tile monitoring. An action threshold in an individual orchard can be determined through regular monitoring and recording the level of truffle damage. A preliminary action threshold of an average of 6 to 10 slaters per tile is suggested. Refer to the 'Australian Truffle Orchards Integrated pest and disease management manual' for more detail.

Left: Slater damage to a truffle
Right: Slaters seek shelter under leaf litter in a truffle orchard

Slugs

Including Black keeled slug *Milax gagates*, striped field slug *Lehmannia nyctelia*, reticulated slug (grey field slug) *Deroceras reticulatum*, brown field slug *D. invadens* and hedgehog slug *Arion intermedius*

Description: Many species of slugs are found in truffle orchards. They range in colour from white, through pale and dark brown to near black and may or may not have stripes and other patterns.

Damage: To date all species found will feed on truffles. Slug feeding results in shallow or deep holes, gouges and/or large cavities, indistinguishable from feeding by slaters. Shallow forming truffles are more likely to be damaged.

Monitor: The abundance of slugs can be assessed with tile monitoring. An action threshold in an individual orchard can be determined through regular monitoring and recording the level of truffle damage. A preliminary action threshold of an average of one slug per tile is suggested. Refer to the 'Australian Truffle Orchards Integrated pest and disease management manual' for more detail.

Left: Slug damage to a truffle
Right: (top) Striped slug feeding on a shallow forming truffle; (bottom) Slug eggs in a damaged truffle

Garden snail

Cornu aspersum

Description: The shell of garden snail is light brown with dark brown broken bands and yellow transverse stripes, up to 40mm across with four or five spirals (whorls). The shell opening is bordered in white. The body of the snail is grey brown and slimy. They lay clusters of spherical white eggs near 1mm diameter, in the soil.

Damage: Garden snail attacks a wide range of plants, feeding on leaves and will attack buds affecting shoot growth. Newly planted trees are most susceptible. Garden snail is not considered to be a pest of truffles.

Monitor: The snails are large so their abundance is easily monitored. Snails are nocturnal, remaining sedentary in a sheltered location during the day. Whether any control action is required depends on the level of snail damage.

Above: A range of growth stages of garden snail on the trunk of an oak tree

Small pointed snail

Prietocella barbara

Description: Small pointed snail have shells about 1 cm long and 8mm at the widest point with 7 to 8 spirals (whorls). They are pale brown with dark brown patches and lay clusters of 0.4mm diameter spherical white eggs in leaf litter and crevices in the soil.

Damage: The presence of small pointed snail is not always associated with damage to plants. Feeding damage by the snail in truffle orchards may be important on newly planted trees, but they have a greater impact on interfering with mini-sprinklers.

Monitor: Small pointed snails are large enough to be detected by observation and checking mini-sprinkler during watering for interference with the irrigation pattern. Their presence does not always necessitate action, which should be based on the level of feeding damage and/or the proportion of mini-sprinklers affected.

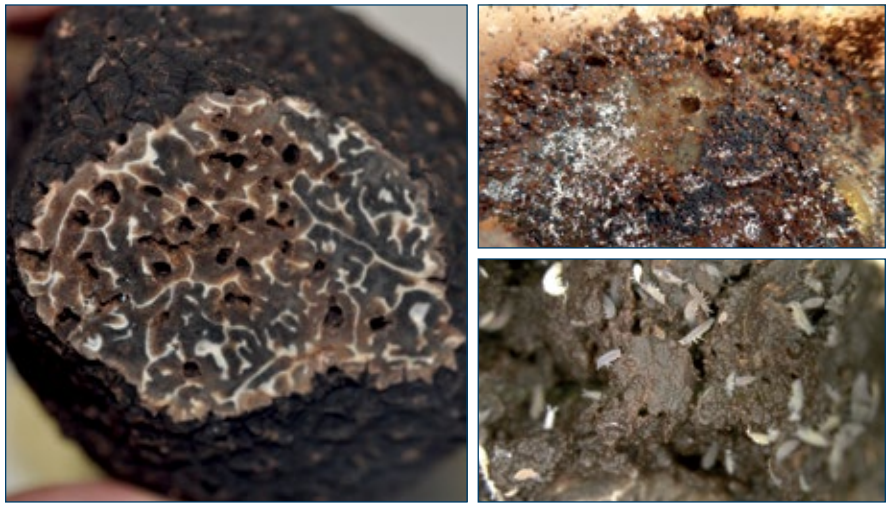
Left: Small pointed snails clustered on the trunk of an oak tree
Right: Small pointed snails can interfere with the operation of mini-sprinklers

Springtails
Subclass Collembola

Description: Springtails are small soft-bodied hexapods, 1-2mm long. They are wingless but possess an appendage under their bodies that allows them to jump - a characteristic useful in detecting and identifying them. The grey/purple springtails may cluster under organic matter debris or rocks.

Damage: Where springtails are found in truffles, it is often because they are cracked or were damaged previously. Occasionally springtails appear to cause primary feeding damage, creating tiny pinholes and small galleries or pits just under the peridium of truffles. Any damage is generally localised and shallow. Time taken to remove springtails from infected truffles during grading is also a cost.

Monitor: Springtails are best monitored with pitfall traps. Their presence does not necessarily mean they will damage truffles because many species are benign detritus feeders. The pest status and biology of springtails in truffle production requires clarification.



Left: Narrow galleries in a truffle caused by springtails

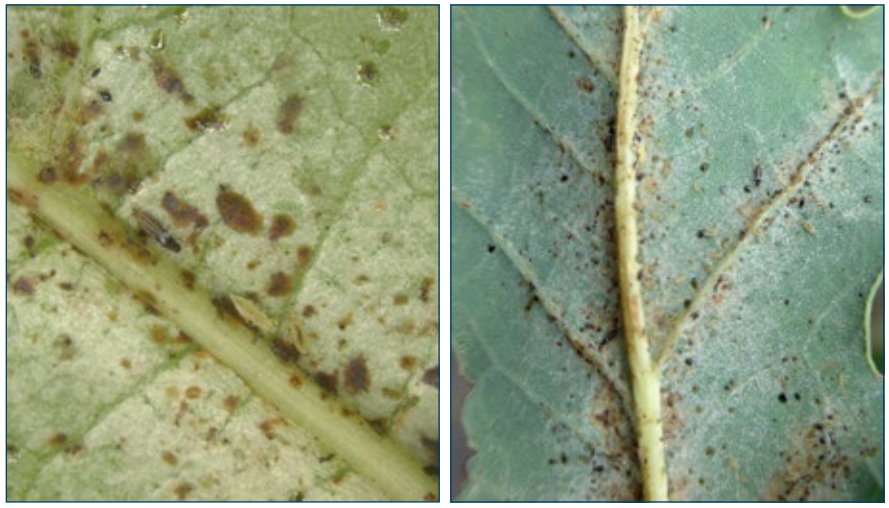
Right: (top) Springtails (purple) and their cast skins (white) in a pitfall trap; (bottom) Springtails and galleries in a truffle

Thrips – greenhouse thrips
Heliothrips haemorrhoidalis

Description: Greenhouse thrips adults are elongate cigar-shaped insects about 1.5mm long with narrow fringed wings held along their body. They are black with white antennae, legs and wings. A white band across the body is formed at the point of attachment of the wings. Nymphs are white to yellow and wingless.

Damage: Adults and nymphs feed primarily on the lower surface of leaves causing them to turn grey. Only minor populations of thrips have been observed on mature oaks. They are not considered to be a major pest.

Monitor: The characteristic damage to leaves and the presence of the thrips are the first signs of an infestation.



Above: (left) Adult and yellow nymphs of greenhouse thrips on an oak leaf (right) characteristic greying of leaf from feeding damage along the veins

Apple weevil

Otiorhynchus cribricollis

Description: Adults of apple weevil are chocolate brown, 6 to 8mm long with rows of pits on their back bearing spines. Larvae are 'C' shaped, with a brown head capsule, obvious black jaws, legless and white to cream coloured. They are indistinguishable from garden weevil larvae.

Damage: Adults are the main pest stage in newly planted truffle orchards. Adults feed on leaves resulting in characteristic leaf scalloping. Their feeding can ringbark and kill growing tips. This can lead to adverse tree shape. Damage to truffles by larvae can occur but is rare.

Monitor: Transplanted trees should be checked for feeding damage – scalloped/dead leaves, leaves and growing tips. Confirm the presence of apple weevil by digging around the base of the tree, checking the canopy at night or using single faced corrugated cardboard trunk monitoring bands.

Top: (left) Scalloping and holes on hazelnut leaves by apple weevil adult feeding; (right) Stem girdling by apple weevil adults

Bottom: (left) Apple weevil larva and damage to truffle; (right) Apple weevil adult

Fuller's rose weevil

Naupactus cervinus

Description: Adults are around 10mm long, grey with yellow markings on the side, and are not covered in spines. Larvae are 'C' shaped, have a white head capsule, obvious black jaws, legless and yellow to cream coloured.

Damage: Their main impact is blocking mini-sprinklers when laying egg masses. Adults are leaf feeding. Trees up to two years after transplanting may be affected. Larvae are root feeding and while not associated with tree damage, may very occasionally feed on truffles.

Monitor: If Fuller's rose weevil is present, leaf damage will occur before sprinkler blockage. Adults feed during the day. Timing of emergence and abundance across the orchard can be monitored using stakes with a sticky material at the top; see the Australian Truffle Orchards IPDM manual for details. Particular types of mini-sprinklers are less affected by them.

Left: Fuller's rose weevil adult and associated leaf damage

Right: The yellow plug affecting the operation of this mini-sprinkler is a Fuller's rose weevil egg mass

Garden weevil

Phlyctinus callosus

Description: Adults of garden weevil are grey-brown, about 7 mm long with a bulbous abdomen and white V stripe. Larvae are 'C' shaped with a brown head capsule, obvious black jaws, legless and white to cream coloured. They are indistinguishable from apple weevil larvae.

Damage: Adults are the main pest stage. Their feeding on leaves results in scalloped edges and holes. They may kill branches and the growing tip by feeding on green bark. Trees up to two years after transplanting are most susceptible. Larvae are root feeding but while not associated with tree damage, may very occasionally feed on truffles.

Monitor: Check recently transplanted trees for feeding. Dead growing tips may be present. Confirm the presence of garden weevil by checking the canopy at night or using single faced corrugated cardboard trunk monitoring bands.

Above: Garden weevil adults and leaf scalloping

Hypsomus weevil

Hypsomus sp.

Description: Adults are about 2mm long and are grey with white lateral stripes and some stripes along their back. They are abundant during summer when truffle orchards may require irrigation. Little is known about the larval stage but they are thought to feed within stems of grasses.

Damage: They are a pest in truffle orchards because adults are small enough to seek shelter in mini-sprinklers and interfere with the irrigation pattern or block them. Whether particular types of mini-sprinklers are less likely to being affected requires further study.

Monitor: Regularly check sprinklers for malfunction.

Left: Hypsomus weevils on a mini-sprinkler
Right: Hypsomus weevil adults

Redlegged weevil

Catasarcus spp.

Description: Adults are about 15 mm long. The most common species has cream coloured stripes on the head, a black thorax, yellow/cream coloured pits on an otherwise black abdomen and red/grey legs.

Damage: Adult weevils chew the edges of leaves, giving a scalloped appearance, and chew green bark which has resulted in tip damage on oak trees. Damage to newly planted trees may affect tree growth.

Monitor: They occur in the higher rainfall southern areas of Western Australia, South Australia and Victoria. Trees in young orchards should be checked for feeding on leaves, damaged growing tips and the relatively large weevils which feed during the day. The abundance of redlegged weevils observed in truffle orchards to date has not warranted management.

Left: *Catasarcus* weevil on oak
Right: *Catasarcus* weevil damage to the stem of an oak tree

Whitefringed weevil

Naupactus leucoloma

Description: Adults of whitefringed weevil are 10 to 14mm long, covered in fine hairs and grey with a pale stripe down each side. The soil borne larvae are 'C' shaped, legless and white to cream coloured with a white head capsule and obvious black jaws.

Damage: Adults are the main pest stage. Leaf feeding results in scalloped edges and holes, which can lead to defoliation in young trees. Trees older than about two years after transplanting, are less susceptible to attack. Larvae are root feeding and while not associated with tree damage, may very occasionally feed on truffles.

Monitor: Newly planted trees with leaf damage should be monitored to determine the cause. Adults are present from late spring to autumn. Whitefringed weevil adults feed during the day and are reasonably large so relatively easy to detect.

Left: Whitefringed weevil adult
Right: Whitefringed weevil larva

Exotic invertebrates – European truffle beetle

Leiodes cinnamomeus

Description: Both larvae and adults are obligate truffle feeders. European truffle beetle is larger than 'Australian truffle beetle', at 4–7mm long. It does not have clubbed antennae or rows of spines on its back. They are blackish brown with a cylindrical body. Larva are white to yellow, with a large head and powerful jaws.

Damage: Both adults and larvae cause the same type of damage to truffles as 'Australian truffle beetle', tunnelling into truffles and creating extensive galleries. European truffle beetle are larger so create wider tunnels.

Monitor: Most of the life cycle is spent underground. The insect and damage are detected during harvest and grading. Their presence in the orchard can be monitored with baited traps. The attractant used to monitor 'Australian truffle beetle' may be useful. A special attractant is available commercially in Europe.

Left: European truffle beetle larvae
Right: European truffle beetle adult

Exotic invertebrates – Truffle fly

Suillia species

Description: There are several truffle fly species in Europe that damage truffle. All are 5-9mm long, near orange with dark patches on their wings. Their flight is described as 'jumping'. Flies from the same family, Heleomyzidae, are found in Australia but no obligate truffle feeding flies have been identified here to date.

Damage: The larvae are obligate truffle feeders. Adults lay eggs in the ground near truffle and after hatching the larvae dig to feed on the truffle, creating galleries.

Monitor: Delta traps with a sticky insert have been found to be the most efficient trap to monitor these flies in truffle orchards in Europe.

Above: *Suillia* sp. fly

Australian honey fungus

Armillaria luteobubalina

Symptoms: The fruiting bodies of Armillaria root rot are honey coloured toadstools with white to cream gills and a cream to brown stem with a collar around the upper part of the stem. Other symptoms are white to cream fungal matting just below the bark, and on roots and stems. It can infect the roots of many plant species, eventually killing those already weakened/stressed by another factor.

Transmission: The source of infection is from fungus that has survived on the stumps and roots of infected trees.

Monitor: Observe for fruiting bodies, often occurring in large clusters at the tree base or on roots of infected or dead plants in early autumn.

Cultural control: Remove tree roots as much as practicable when preparing land for a truffle orchard. Deep rip on the edge of an orchard adjacent to native vegetation to reduce root contact.

Above: Fruiting bodies of Armillaria root rot

Bacterial Blight

Xanthomonas sp.

Symptoms: Considered the most serious disease affecting hazelnut production. Plants are more susceptible when young and succulent. Most characteristic symptom is dieback of emerging growth in late spring, which recurs every year on new shoots and may ultimately result in tree death. Leaf and fruit symptoms are observed only occasionally.

Transmission: Usually originates from infected planting material. Infection of buds occurs in spring during vegetative growth and high humidity. Conditions, such as poor soil drainage, moisture stress, cold injury, mechanical equipment damage, pruning cuts, sunscald and general cultural neglect can predispose trees to blight.

Monitor: Check all trees before planting to ensure they do not display disease symptoms. Observe for symptoms in orchards in spring and summer.

Cultural control: Use healthy planting material. Remove and destroy affected shoots and disinfect pruning tools. Use resistant cultivars where possible.

From left: Symptoms of bacterial blight of hazelnut trees include necrotic areas on leaves and tip dieback.

Discula

Discula quercina

Symptoms: In truffle orchards, only English oak (*Q. robur*) is susceptible. The first symptoms are small brown spots on the leaves in spring. Spots gradually increase in size and become reddish-brown. Spots may coalesce causing dying-off of large portions of the leaf blade and leaf twisting. Symptoms in older leaves remain limited to brown spots. Later symptoms include twig cankers, branch dieback and in severe cases, after several seasons of favourable disease conditions, tree death.

Transmission: Disease onset is due to drought stress. Disease incidence and spread is favoured by wet periods and high humidity in spring or summer.

Monitor: Check for large lesions on leaves in spring and summer.

Cultural control: Ensure adequate air flow in the tree canopy to reduce humidity required for infection and transmission - through pruning and careful site selection and orchard layout including consideration of any windbreaks. Reduce tree stress which may be caused by inefficient irrigation and poor nutrition.

Above: *Quercus robur* leaves infected with *Discula quercina'*

Oak powdery mildew

Erysiphe alphitoides

Symptoms: White to grey powdery spots on growing tips and leaves, with complete coverage of leaves in conditions of mild temperature and high humidity. Results in partial to severe defoliation. This disease is less significant when it appears only at the end of the growing season as leaves may already show senescence; it should not impact tree vigour. However, when trees are heavily infected in spring and summer it will affect tree vigour, especially of young trees, and may provide stress required for endophytic, non-disease causing fungi to become pathogenic.

Transmission: Promoted by mild temperatures and wet conditions.

Monitor: Monitor visually in spring to decide whether disease management is required.

Cultural control: Ensure adequate air flow in the tree canopy to reduce humidity - through pruning and careful site selection and orchard layout including consideration of any windbreaks.

Above: White powdery coating on leaves of oak trees infected with powdery mildew

Root and collar rot diseases

Includes members of the genera *Pythium* and *Phytophthora.*

Symptoms: Stunted trees with sparse appearance and yellowing leaves; root discoloration and death; a collar rot may be present. Infection may lead to tree death. The disease is not often detected until infections are advanced. *Phytophthora cinnamomi* infected trees are usually found at the bottom of a slope where water accumulates.

Transmission: Water borne spores (zoospores) swim in free water through soil to infect new roots. Zoospores are usually released in spring and autumn, when it is wet and night temperatures are cool. Spores are also dispersed with soil, such as on boots or machinery.

Monitor: Observe for leaf yellowing and stunted trees in spring and autumn. Send samples for analysis if Phytophthora is suspected. Failure to act will likely result in further tree deaths.

Cultural control: Ensure adequate soil drainage. Ensure irrigation water is free of Phytophthora. Install foot baths for visitors to disinfect footwear. Clean machinery coming onto property.

From left: Tree with stunted sparse appearance; collar rot caused by *P. cinnamomi*; (top/bottom) Symptoms of *P. cinnamomi* root disease through cut sections of tree trunks

Stem diseases and dieback

Diaporthe - multiple species

Symptoms: May be caused by a range of fungal species. Lesions and cankers on stems vary in shape and size, but always have a depression and cracks in the bark. In severe cases the stem may be girdled, resulting in tree death above the canker. Dieback symptoms include progressive dieback of twigs and branches. Symptoms are more pronounced, especially on evergreen/holly oak (*Q. ilex*), in prolonged wet conditions.

Transmission: Endophytes are often present, living within trees but without causing apparent disease. Tree stress can trigger disease onset. Spores produced on dead branches are transmitted by water splash, wind and insects.

Monitor: Check for stem cankers and dieback in spring and summer.

Cultural control: Modify irrigation to avoid wetting tree trunks. Remove and burn dead trees and diseased branches to reduce the spread of inoculum. Sterilise pruning shears between cuts. Reduce tree stress through appropriate irrigation and nutrition management.

From left: Symptoms of trunk lesions caused by Diaporthe species and other pathogenic fungi after bark removal; Symptoms of a stem disease after bark removal showing the demarcation between healthy and diseased tissue; External symptoms of cracked bark on trunk caused by *Diaporthe* species and other pathogenic fungi

Wood rot

Pycnoporus sp., *Ganoderma* sp., *Stereum* sp., *Fomitopora* (white rot) and *Trametes* (turkey tail)

Symptoms: Wood rot fungi are commonly found on dead stems and branches but can become pathogenic on living, stressed trees. *Pycnoporus* sp. cause a distinctive white rot. The fruiting bodies are corky, bright orange to red, do not have a stalk and vary in size up to 9cm across and 2cm thick. A tree may be infected by multiple wood rot fungi species.

Transmission: Infection occurs through wounds in the bark that may be caused by sunburn, pruning and mechanical or wind damage to trees. From there the infection can spread to healthy tissue. These fungi are commonly found in wet and warm environments.

Monitor: Observe for spore carrying fruiting bodies, the most obvious sign of an infection.

Cultural control: Minimise large open wounds. Remove dead branches. Prune when sunny and dry, preferably when there will be at least 48 hours of dry weather to help the wound seal.

Left: Fruiting bodies of *Pycnoporus* on a hazelnut trunk
Right: Fruiting bodies of *Stereum*

Truffle rot

Symptoms: Include discoloration, softness and wetness, and often accompanied by a foul smell. A number of fungal and bacterial species have been isolated from rotten truffles with *Erysiphe alphitoides* being the only primary pathogen resolved. Further work is required to identify other primary pathogens.

Transmission: Often associated with shallow and exposed truffles, which are more susceptible to environmental stresses such as high temperatures and desiccation, and are more accessible to microbial pathogens and invertebrate attack. Truffles have a high demand for oxygen, so rot can develop in heavy, poorly drained soils, or after heavy rainfall when oxygen is scarcer.

Monitor: The extent of truffle rot can be assessed both when covering immature truffles and more accurately at harvest.

Cultural control: Encouraging truffles to form deeper can reduce the incidence of rot. Covering exposed truffles with soil can prevent the spread of spores from rotten truffles and protect healthy truffles from infection. Apply appropriate levels of irrigation to support truffle development.

Above: Examples of the symptoms of truffle rot

Exotic disease – Sudden Oak Death

Phytophthora ramorum

Current distribution: Throughout North America and Europe

Symptoms: Stem or trunk cankers with red sap oozing from the bark surface, leaf blight and twig dieback. Infection typically results in blackened shoots and dark blotching of leaves, resulting in host death in the most susceptible tree species, and premature leaf death and leaf drop in less susceptible species.

Transmission: Unlike most other species of *Phytophthora, P. ramorum* is airborne and can be disseminated by wind and rain splash. Long distance dispersal can occur via rivers and streams and human activities such as the movement of infected plant material. Animals might also act as vectors.

Control: Once *P. ramorum* infects trees, there is no known cure. Management practices are directed at preventing the spread of the disease to new plants or areas and protecting susceptible trees before they are infected.

Left: Distinctive red sap oozing from trunk canker'
Right: Widespread tree death as a result of *P.ramorum*

Exotic disease – Pierce's disease

Xyllella fastidiosa

Current distribution: The disease is widely distributed in North and South America and has been introduced to Taiwan, Iran, Italy, France and Spain.

Symptoms: Vary depending on the degree of susceptibility of host species. They range from marginal leaf scorch, wilting of foliage and withering of branches to dieback, stunting and eventual death.

Transmission: This disease is transmitted by human movement of plant material, and insect vectors. There are several potential insect vector species in Australia. Such insects usually only fly short distances, but can be carried much further by wind. Long-distance spread can occur by the movement of infected planting stock. There can also be some transfer of the bacterium between neighbouring plants via root grafts.

Control: There are currently no truly *Xylella-resistant* varieties available. Management relies on a combination of tree removal and vector control, to reduce pathogen supply and vector abundance and activity.

Above: *Xylella fastidiosa* infected olive orchard in Italy

Exotic disease – Eastern filbert blight

Anisogramma anomala

Current distribution: Eastern filbert blight is native to eastern North America and currently only present in North America.

Symptoms: Cankers on the trunk and branches of hazel (*Corylus* spp.) leading to canopy and yield loss. Death of mature trees occurs in 5-15 years and within 4-7 years for younger trees. New shoots and suckers that may emerge from the tree base in turn become infected and die. Infected trees may not show symptoms for up to two years.

Transmission: New infections are usually a result of infected nursery stock. The fungus cannot spread over large distances as cool wet weather and rain splash is needed for dispersal and infection.

Control: Resistant cultivars have been bred in the US, but these are unavailable at present in Australia. In Oregon, scouting for cankers, therapeutic pruning, and copious fungicide applications are reported to be necessary, but costly measures, to continue hazelnut production in the presence of the disease.

Left: Eastern filbert blight dieback in hazelnut trees
Right: Eastern filbert blight fruiting bodies on an infected hazelnut branch

Truffle IPDM field guide image credits

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- Native ant, image courtesy: Gibson, L. (2008) Cardiocondyla paranuda (Cardiocondyla paranuda) Updated on 5/14/2018 5:29:15 AM Available online: PaDIL - padil.gov.au

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- Redheaded pasture cockchafer adult, image courtesy: Jon Augier Museums Victoria - collections.museumvictoria.com.au/species/8528
- Redheaded pasture cockchafer larva, image courtesy: SARDI
- Yellowheaded pasture cockchafer adult, image courtesy: SARDI
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- Fungus gnat adult fly, image courtesy: Manuel Lopez - diptera.info/photogallery.php?photo_id=8802

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- Deformed bud on hazelnut tree, image courtesy: naturespot.org.uk
- Big bud mite eggs and motiles, image courtesy: Magnus Gammelgaard plantesygdomme.dk/Hasselgalmide/index.html

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- Hazelnut mite adult, egg and nymphs, images courtesy: Alain Migeon - www1.montpellier.inra.fr/CBGP/spmweb/gallery.php?gallery=gallery

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- Fruit tree borer moth, image courtesy: Donald Hobern, Maroga melanostigma.jpg, available online - commons.wikimedia.org/wiki/File:Maroga_melanostigma.jpg
- Larval stage of fruit tree borer, image courtesy: Mark Hartley - treedoc.com.au lepidoptera.butterflyhouse.com.au/xylo/melanostigma.html

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- Heliothis larva and leaf damage, image courtesy: G. Anderson

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- Lightbrown apple moth adult, image courtesy: T. M. Gilligan & M. E. Epstein, TortAI - idtools.org/id/leps/tortai/

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- Painted apple moth adult male, image courtesy: Walker, K. (2007) painted apple moth (Teia anartoides) Updated on 8/12/2013 4:02:34 PM Available online: PaDIL - padil.gov.au

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- European truffle beetle adult and larvae, images courtesy: Víctor Pérez Fortea

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- Suillia sp. adult, image courtesy: Katja Schulz, Heleomyzid Fly (34916388016).jpg, available online - commons.wikimedia.org/wiki/Category:Suillia#/media/File:Heleomyzid_Fly_(34916388016).jpg Katja Schulz from Washington, D. C., USA [CC BY 2.0 - creativecommons.org/licenses/by/2.0]

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- Armillaria fruiting bodies, image courtesy: H. Eslick

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- Phytophthora ramorum symptoms, image courtesy: Bruce Moltzan, USDA Forest Service, Bugwood.org
- Phytophthora ramorum affected forest, image courtesy: Joseph OBrien, USDA Forest Service, Bugwood.org

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- Xyllella infected olive orchard, image courtesy: USDA-ARS - ucanr.org/blogs/blogcore/postdetail.cfm?postnum=17460

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- Eastern filbert blight black stroma and canker, and branch dieback, images courtesy: Jay W. Pscheidt pnwhandbooks.org/plantdisease/host-disease/hazelnut-corylus-avellana-eastern-filbert-blight

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