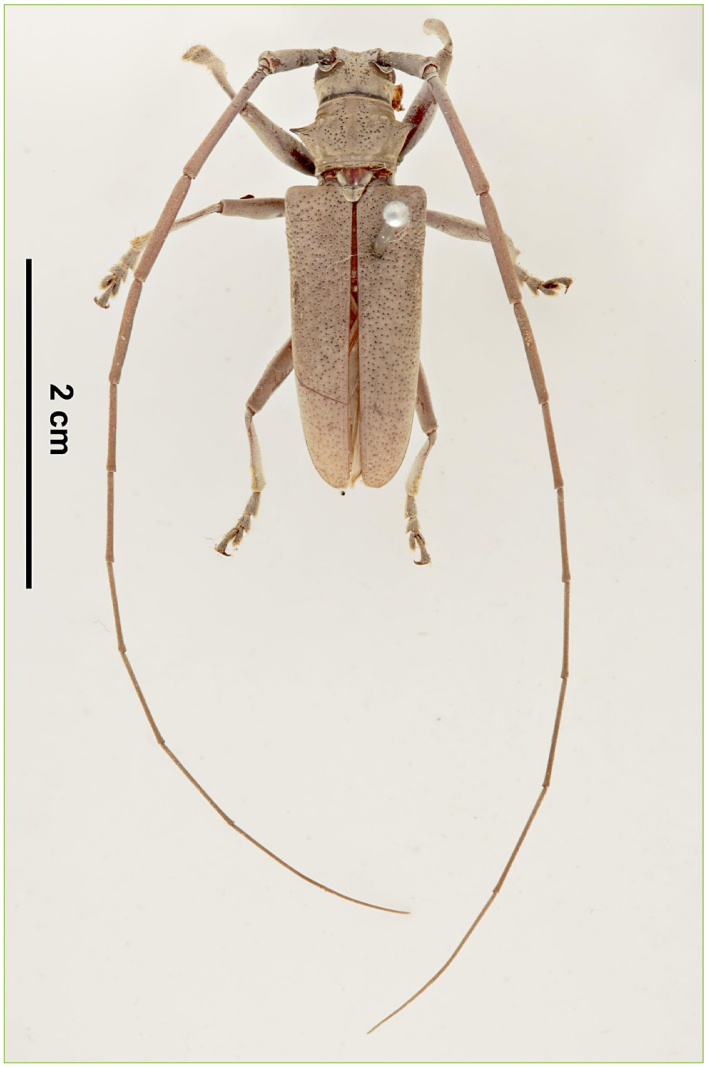
Managing Wood-Boring Insects in Production Nurseries

Wood-boring insects are among the most destructive pests of trees and shrubs. Most wood-borers are the larvae (immature stages) of certain moths and beetles. They can feed on all woody parts of the tree, including growing points, stems, main trunks and sometimes even roots. They use their well-developed, chewing mouthparts to tunnel or remove woody tissue, which can provide an entry point for plant pathogens. While dieback of the damaged area is the most common symptom, different insect groups often have slightly different symptoms including the way they tunnel, deposit their frass (insect waste and chewed wood articles), and whether they produce webbing or stain on the tree.

Once boring insects are present, they can be very hard to remove while still producing a saleable plant; prevention is critical. Some of the most important boring beetle groups include longicorn beetles, weevils, jewel beetles, bark beetles, ambrosia beetles and pinhole beetles. Some important boring moths include fruit tree borer moth, wood moths and clearwing moths.



Male fig longicorn beetle, *Acalolepta vastator*.
Source PaDIL, Bugwood.org

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APPEARANCE

Wood-boring insects are either beetles (Order Coleoptera) or moths (Order Lepidoptera). As adults, these groups are very easy to distinguish, but larval stages can appear very similar. Furthermore, adults may be difficult to find on nursery stock, often being nocturnal or well hidden.

Adult beetles have a hard exoskeleton and two pairs of wings. The first pair is hardened and covers the majority of the body; they do not look like true 'wings' and are not used to fly. The second pair are folded under the first and are used to fly. The size of wood boring beetles varies between species. For instance, adult longicorn beetles can measure between 30–80mm long, whilst bark beetles measure are often 2–6mm long. There is great diversity in the appearance of groups of boring beetles. The jewel beetle is often brightly coloured, making it easy to identify, whilst many other species such as different types of ambrosia beetles are small and similar looking. For instance, some species can only be distinguished by counting small hairs on particular regions.

Adults moths are soft-bodied and have two obvious pairs of wings, which are almost always covered in fine scales. These scales often appear as silvery powder that remains on your fingers if touched. Like beetles, moth size is species dependent. Some are very large, like wood moths that have a wingspan of 250mm. Smaller species, like the fruit tree borer adults, have a 35–60mm wingspan and are satiny white. Most moths are plain in colouration, e.g. brown or grey, however, some can be more striking in colour, e.g. white, orange or other colours. Adult moths are often hard to find as they are nocturnal.

Eggs of wood boring beetles and moths are laid on the surface of the bark, on twigs, in crevices and cracks on the tree or at branch junctions. The exact shape and size depend on the species, but are typically only 1–2mm in diameter. The fruit tree pinhole borer (a type of ambrosia beetle) has oval shaped eggs that are shiny and a pearly to yellow/white colour. The beetle lays them in loose lumps of up to 8–12 eggs inside a range of fruit trees (the females bore into the tree and lay their eggs in these tunnels, known as galleries). Moth eggs are typically spherical and often have ornate ribs running down their surface longitudinally. Moth eggs may be laid singly or in a batch that may have 50–100 eggs and be covered in scales, depending on the species.

Larvae generally remain hidden as they feed and move inside the plant or under the bark. Both beetle larvae and caterpillars (larvae of moths) appear similar with strong mouthparts that are well developed for grasping and chewing. Their heads are hard and are often light to dark brown or slightly red or orange. They are soft bodied and generally white, cream, off-white or slightly yellow or orange in colouration. Small moths and beetles have small larvae, usually being a little larger than their adult stage just before they pupate.

Citrus longicorn beetle (not present in Australia) has club shaped larvae that are typical of this family.

Pupae are immobile and do not feed. Beetle pupae look like a cross between an adult and a larva, and often occur inside the tree. Pupae of boring moths often resemble a silken cocoon. Many boring moths pupate inside or near the feeding galleries and exit holes.

BIOLOGY

The lifecycle of boring insects (beetles and moths) each consist of four life stages: adult, egg, larva and pupa. Adults lay eggs that hatch into larvae and begin feeding in or under the bark. Larvae pupate and then turn into adults, perpetuating the cycle.

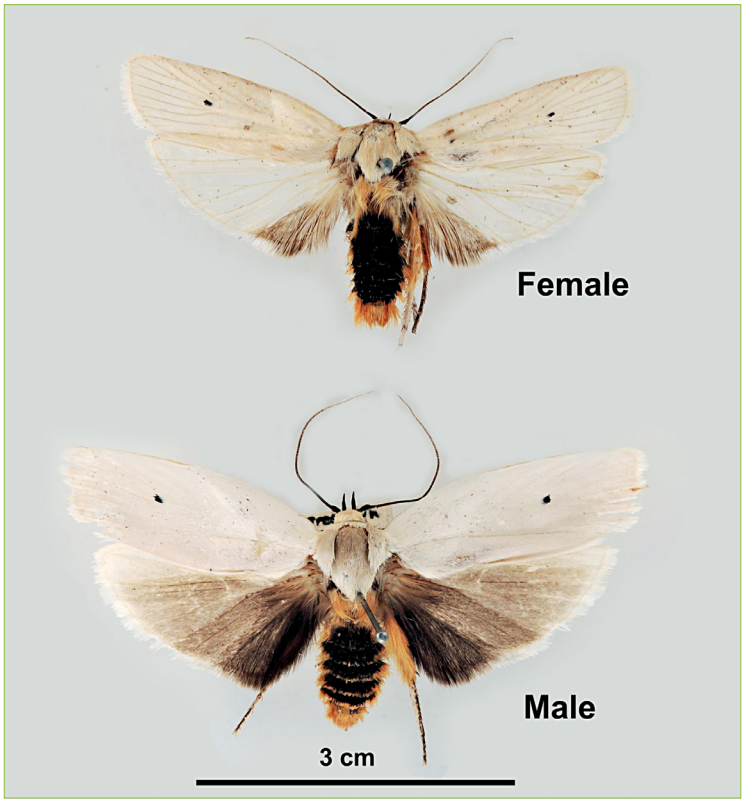
Typical damage produced by adult longicorn beetles.
Source: Dean Morewood, Health Canada, Bugwood.org

Boring beetles and weevil larvae are the main damaging stage, but in some species, adults can also damage the plant, such as pine bark beetles and female ambrosia beetles, which bore into the plant to deposit their eggs. Adults of some beetles will also feed on plant bark, stripping it away and sometimes ring-barking the branch. Females lay their eggs onto or inside the tree, on bark, in cracks or crevices of twigs and small branches or in wounds of a tree. After hatching most larvae quickly tunnel beneath the bark where they feed and grow. Some species will overwinter in trunks, limbs or roots of host plants as larvae or pupae (pupa do not feed). In tropical and sub-tropical conditions, one generation per year is common for beetles. However, they can take 1–2 (or sometimes more) years to complete development from egg to adult.

The exact lifecycle will vary with the species and host plant. As an example, the fig longicorn beetle deposits its eggs inside cracks in the tree between October and March. The larvae hatch and then bore into the wood to feed and can tunnel throughout the trunk and roots (particularly in Ficus and grapevines). When fully grown, larvae pupate and emerge from the tree as adults.

Boring moths lay their eggs on the surface of the tree, on bark, twigs, small branches, stems and the trunk. Hatched larvae will burrow downward into the tree creating short tunnels where they will feed and continue to grow. For example, on hatching, clearwing moth larvae bore into the junction of branches, through the bark and top layer of wood. When the larvae are fully grown, they will pupate and emerge as an adult moth. As such, the general biology of boring moths is very similar to that of beetles. One main difference is that the larvae of boring moths (caterpillars) produce silk that is often used to line its tunnels. Some species will also produce a silken hatch to close its tunnel, e.g. the fruit tree borer that feeds until is about 6–10cm long, then closes its tunnel entrance with a wad of silken web and chewed wood and pupate.

The clearwing moth also covers the entrance of their tunnels with a mixture of frass and webbing to protect itself as it pupates. Unlike beetles, some boring moths can produce multiple generations per year, like the clearwing borer, which in Queensland can complete several generations per year. Like beetles, some moth species overwinter as larvae or pupae in tunnels in trunks, branches or stems of the tree.



Fruit tree borer moths. Source: PaDIL, Bugwood.org

DAMAGE AND HOST RANGE

Boring insects will often attack sick or dying plants. Healthy mature plants are normally able to tolerate attacks, with new growth outgrowing the weakened branches and exudation of sap restricting borer activity. However, in the nursery, specific boring insects will attack young healthy seedlings. Most damage by borers is caused internally by the larvae that chew tunnels in the phloem-cambium region (area under the bark) or in the shoots. While others tunnel more deeply into the inner sapwood and heartwood which may affect the sap flow to roots and branches, these are less likely to be found in production nurseries, except perhaps for in advanced tree stock. Severe infestations may result in girdling, branch dieback, tip dieback, structural weakness and sometimes eventual death of susceptible plants.

In the nursery, jewel beetles cause girdling to young trees by feeding on trunks, stems and branches. Clearwing moths can be an important nursery pest; larvae of some species will tunnel into the roots or lower limbs of the tree, feeding on the growing tissue and inner bark. Adult female ambrosia beetles bore into the trunk and stems of young trees, creating galleries into the heartwood of the tree, which they inoculate with fungus. In a production nursery setting, borers also cause damage to growing tips causing localised dieback. While this damage may not be extensive, if it effects

the structure of the plant or causes damage to a significant proportion of the growing tips plants may become unsalable, e.g. callistemon tip borer and mahogany shoot tip borer.

Vanda orchids with root boring beetles from the genus *Araecerus*. Pupa and frass, top right, adult bottom left, damage bottom right.

The external symptoms are a good way to identify what pest species you may have. This is very important as proper identification will determine the control measures you need to use. Damage signs and symptoms to look for include exit holes, wet or dark stained spots, sap bleeding, ring-barking and frass or webbing. It is important to know when adults are active, and frass can be used as a sign that boring insects are present and active in the nursery. Frass is pushed out of the tunnels by the emerging adult wood boring insects and is composed of faeces and wood fibre. Frass is different dependant on the species. The shape of the larva can also help to identify the group the insect belongs too; identifying the species can be more difficult. Larvae can also be dissected out of plants or stems that are dying back.

Not all wood boring pests can be controlled using the same management techniques. Therefore, you need to know which borer group your trees are susceptible to and develop your management plans accordingly. Some of the more common boring insects in nurseries include:

Longicorn beetle damage is characterised by oval holes and dead patches of bark. If not controlled they can cause excessive scarring, death by ringbarking and excessive tunnelling in young trees can girdle the stem causing it to break. Sometimes larvae will leave hard lumps of frass along infested plants on the outside of branches (longicorn frass is similar to sawdust or very fine powder). The adults of some species will feed on the trunks, limbs and roots, e.g. fig longicorn feed on young and old citrus trees. Damage from both adults and larvae can predispose the tree to secondary fungal or bacterial infections. The host range of certain species of longicorns is quite wide, e.g. fig longicorns can feed on native and cultivated figs (*Ficus* spp.), red cedar and citrus. Whereas other species may predominantly feed on one genus of plants, e.g. yellow longicorn beetle mainly feeds on Eucalyptus. Longicorn beetle larvae can grow up to about 40mm. They are creamy white and club-shaped with a dark brown head and a black jaw.

Male cypress pine jewel beetle. Source: Mary C Legg, Bugwood.org

Jewel beetles emerge through oval holes in a similar way to longicorn beetles, except that the frass is more tightly packed and the emergence holes (and galleries) are much smaller. Like longicorn beetles, jewel beetle larvae are also cobra shaped. They feed under the bark, before moving into the sapwood of various trees, including cypress, to pupate. They also create a characteristic swelling beneath the bark when they tunnel, which looks like raised, vein-like welts on the stem. The small cypress pine jewel beetle is 12–18mm long, whilst the cypress pine jewel beetle is 18–25mm long.

Weevil larvae are very small and humpbacked shaped. They feed under the bark where they construct a small chamber lined with small strips of wood to pupate. For example, the sugarcane weevil bores into the stem of bananas and palms, including coconut, sago and oil palm. They feed on the soft pith while packing the tunnels with fibre and waste. When they emerge, they leave a small exit

hole in the stem and have been observed killing seedlings in 140mm pots. Another important nursery weevil is the palm weevil borer, which feeds on the roots, leaves and fruit stalks of palms. Other species also attack ornamental cypress and pencil pines. The adults are easy to distinguish from other beetles due to their snout like mouthpart. Seedlings that are ring-barked can also indicate the presence of weevils.

Lesser coconut weevil, *Diocalandra frumenti*, (left, source: Pest and disease image library, Bugwood.org), white pine weevil exit holes, *Pissodes strobi* (right, source: Steven Katovich, Bugwood.org).

Most **moth borers** attack fruit and eucalyptus trees. Many species will cover the tunnel entries with frass (chewed up wood), faeces and web material to prevent water flowing into the whole. **Clearwing moths** attack lychee, longan, persimmon and *Ficus*. They leave large open tunnels filled with sawdust-like frass and webbing, and in serious cases branches will die, crack and fall off. Clearwing moth larvae are a dirty-white colour with a brown head and grow to about 12mm in length. The **fruit-tree borer moth** will attack a range of ornamentals such as banksia, wattle, eucalypt, grevillea, stone fruits, especially cherry, peach, nectarine, plum, prune, apple, pear and raspberries. The tunnel openings, covered with frass and webbing, also allow entry of wood rot fungi. The larvae of the fruit borer moth are 50mm long, fleshy looking, brownish-red and can be recognised by their distinctive sparse hairs that cover their body.
The **Australian goat moth** attacks ornamental trees such as sugar gums and angophoras. Larvae of the **mahogany shoot tip borer** will tunnel into the shoots and branches of red cedar, creating large webbing and red-brown coloured frass around tunnel holes. In nurseries, the mahogany shoot tip borer is a serious pest as it can reduce height and cause stem distortion of young trees. The **Callistemon tip borer** also causes stunting and distortion, mainly attacking callistemon and melaleucas. The whole lifecycle of this small moth (adults are 3mm long) is completed within 5–8cm of the tip. The larvae tunnel into the shoot, where they pupate and cut a small exit whole on emergence.

Damage caused by callistemon tip borer.

MANAGEMENT

Owing to the long lifecycle of many boring species, nurseries producing advanced trees are at highest risk. Once a plant is infested, control can be difficult as the pest is protected inside the plant, and damage is usually not noticed until larvae are relatively large and tolerant to pesticides. Furthermore, once damage is clearly visible, nursery stock may already be unsalable. If boring insects regularly infest a crop line/s, significant effort should be made to prevent the infestation from occurring. This is particularly important when boring insects damage healthy, vigorous plants.

Preventing an infestation relies on knowledge of the lifecycle of the pest and modifying the growing environment to exclude the pest or protect the tree from attack. Pest species that are regularly encountered causing significant damage should be identified. Collect as many individuals from as many different stages as possible. Dissect branches to determine where the insect can most often be found and send in as much material as is practical. Take photos of whatever you find. Submit the sample in a sealed bag or container, in case individuals emerge during transport to your diagnostic laboratory. If in doubt, talk to experts to submit the best possible sample.

Identification of borers can sometimes be difficult and may use standard morphological taxonomy of larvae and or adults or molecular techniques. Once the species is identified, research what hosts it is known to attack, where adults may rest during the day, what season eggs are laid and when larvae are actively feeding. This information can then be useful when completing a management plan for the pest.

CULTURAL CONTROL

Provide optimal growing conditions to keep trees as healthy as possible; healthy trees are better able to resist borer attack and may even drown small larvae in sap. Regular pruning at the correct time (based on the lifecycle of the pest) can encourage vigour and may prevent loss of large sections of trees and minimise pests building up within the planting. Remove crop organic matter and unsalable plants from the nursery as they may have eggs or small larvae present. Ensure any pruning cuts are made cleanly so that stubs are not left to dieback and encourage further borer attack. Surfaces may also be painted as soon as possible with an insecticide, particularly for advanced trees.

If frass and webbing is present, scrape it away to expose the pest, which possibly can be killed or pruned out. If a tree is damaged and becomes unsaleable, remove it from the growing area and focus on protecting the remainder of the crop. Be aware of alternative hosts around the nursery that may cause populations of the pest to be higher, e.g. fruit tree boring moth can build up in black wattle. If the adults are flying and laying eggs in the crop during a discrete window, it may be possible to grow the crop in a protected structure (with doors kept shut) to reduce pest pressure. Alternatively, avoid growing susceptible crop lines during periods that are likely to receive damage, this can be very effective for relatively short-term lines. If possible, grow resistant or tolerant lines and avoid highly susceptible plants.

CHEMICAL CONTROL

Managing pests present inside plant tissue can be difficult because they are protected by the plant. Systemic products are required that are best applied during the egg laying period and when larvae have just hatched from eggs; most boring species will tolerate pesticides once they are relatively large. Furthermore, larger individuals are more likely to produce more extensive damage, which may have already resulted in the plant being unsaleable.

Very few systemic, active ingredients have registrations against boring insects. Most products would have to be used with a general registration against weevil, beetle or moth larvae (caterpillars generally). Products currently available that fit this profile include:

- Dinotefuran has a minor use permit (PER84742) allowing it to be used against beetle borers. It is systemic but is a neonicotinoid (group 4A), which currently precludes its use if plants are being sold to certain retail outlets.
- Imidacloprid (4A) + beta-cyfluthrin (3A) has a registration against caterpillars and garden weevil. Imidacloprid is systemic, but has the same problem as the previous product.
- Dimethoate is registered against beetle and moth larvae on most ornamental crops. However, many products in this group (1B – organophosphates) are under review by the APVMA.
- Indoxocarb has a general weevil minor use permit (PER81707), but is described as a translaminar product only. This may not be sufficient to penetrate into stems, particularly if they are thick. If using this product for this purpose monitor efficacy carefully.

Overall, relying on pesticides to manage boring insects is not recommended. Using pesticides as a component in a well thought out management plan may be successful.

BIOLOGICAL CONTROL

Natural enemies of boring insects include predatory beetles and bugs and parasitic wasps. Unfortunately, in a production nursery setting, these are unlikely to be a significant benefit; damage may already be significant before populations are large enough to control the pest.

BIOSECURITY

Many boring insects that are exotic to Australia are serious plant pests. Several that pose a risk to Australia include citrus longicorn beetle, Asian longhorn beetle, brown mulberry longhorn beetle and many others. These species can be confused with other endemic species; information and images on these and many other species can be found at the Pest Identification Tool. If you observe a pest that you suspect is an exotic species, call the **Exotic Plant Pest Hotline on 1800 084 881**.

FURTHER READING

Exotic pests and diseases of forests and timber factsheet

Ambrosia beetle factsheet

Some images of stem boring moths

Nursery paper on building a pest management plan

PRIMARY PEST OR SECONDARY PEST?

Furniture beetle exit holes (left), powder post beetle (middle) and house longhorn borer damage (right). Source: Gyorgy Csoka, Hungary Forest Research Institute (left), Pest and disease image library (middle), John C. French Sr., Retired, Universities: Auburn, GA, Clemson and U of MO (right). All Bugwood.org.

In nursery production, beetles affecting plants are considered primary pests. However, other beetles can move into your nursery, causing damage to timber tables, doors or other timber structures in the nursery. These are considered secondary pests. Secondary boring beetle pests generally only attack old, weak and dying trees, and timber (rotting and non-rotting timber).

If timber is untreated and an infestation is undetected for some time, the beetles can seriously weaken the structure. Because the beetles bore into the wood, you may not know you have a problem until the adults emerge. Like the primary boring beetles, there are signs you can look for to detect if you have secondary boring beetles in or around your nursery.

- Fresh exit holes
- Dust and frass
- Live and dead beetles
- Crumbling wood

Some key secondary borers to look for are the **common furniture beetle**, which can be found all year round. They have round or oval exit holes that are 1–2mm in diameter. A great deal of timber damage in Australia is caused by this small beetle (3–4mm in length), which infests soft and hardwood. Larvae live for 3–5 years, boring through timber before emerging. **Powderpost beetles** have similar exit holes that look like shot holes. This beetle can reduce timber to a mass of fine powder that crumbles when touched. The adults are 4–7mm long, and a red brown colour. **House longhorn beetles** exit holes are round and oval and between 3–7mm. These black/brown beetles are 8–25mm long and the larvae can tunnel for 3–11 years before emerging. They produce large amounts of frass that look like cylindrical pellets. Many other species exist that are common in Australia. Other species are present overseas that are not known to occur in Australia. If you have purchased furniture or wood products and observe frass or evidence that insects are present, contact the exotic plant pest hotline.

This document was prepared by Madaline Healey (University of Sunshine Coast) and Andrew Manners (Agri-science Queensland, Department of Agriculture and Fisheries, Ecosciences Precinct, GPO Box 267, Brisbane QLD 4001). It has been produced as part of the nursery levy and Hort. Innovation funded project 'Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry (NY15002)' in 2019. All photos by DAF, unless otherwise stated.