Observatree
monitoring tree health

Field Identification Guide

Emerald ash borer

Photograph: David Cappaert, Bugwood.org

Forest Research
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Emerald ash borer

The emerald ash borer (EAB, *Agrilus planipennis*), a beetle belonging to the family Buprestidae, is a highly destructive insect pest of ash trees (*Fraxinus* species). This pest can cause extensive mortality to ash populations, especially as it is able to attack trees of all ages and sizes. Larvae have been found in branches with a diameter of just 10–20 mm. Trees typically die within three to four years of initial attack with small trees often being killed in just one year.

Species affected	North American species of ash (often used for amenity planting in the UK), for example green ash (*F. pennsylvanica*), are particularly susceptible to EAB, but the beetle will also attack the more common species of ash in the UK including the native common ash (*F. excelsior*) and narrow-leaved ash (*F. angustifolia*). This pest does not attack mountain ash, (also known as rowan; *Sorbus aucuparia*).
Signs and symptoms	The adult beetles are slender, elongated (7.5–13.5 mm long) and are a metallic emerald green colour. They live for around three weeks and are strong fliers. EAB infestation is usually difficult to detect until the symptoms become severe. In most cases, the beetles have already become established and spread to new hosts by the time they are discovered. Early signs of EAB infestation include discolouration/yellowing of the foliage and thinning of the crown or individual branches. This occurs as the larval galleries become extensive on the trunk or in branches and start to disrupt water and nutrient transport within the tree. Crown dieback and dying branches typically occur from the top of the tree moving downwards as the infestation progresses. Epicormic growth (prolific sprouting) is common on the main stem, larger branches and in the crown of infested trees. Abnormally heavy seed production can also occur in trees affected by EAB. In the USA, Canada and Russia, EAB was first detected in many areas by the presence of groups of dead ash trees. Galleries are created by EAB larvae as they feed beneath the bark of the trees they are infesting. Typical EAB galleries have a serpentine or S-shaped or zig zag pattern, are filled with brown frass and can eventually reach 500 mm in length. The galleries become progressively larger as the larvae creating

	them increase in size (fully grown larvae are 26–32 mm long). Cracks (50–100 mm long) caused by callus (healing) growth can develop in the bark overlying larval galleries. Trees that have been infested in previous years will have old galleries present. The galleries remain hidden beneath the bark until pieces of bark fall from the trees to expose them. There may also be woodpecker holes in the bark of infested trees as they strip away small patches of bark to extract the larvae. This may result in a lighter coloured damaged area where the bark has been removed, which makes the holes more obvious. The bark of infested trees may also be damaged by other birds and mammals as they try to extract the larvae from the underlying galleries. D-shaped exit holes (about 3 mm in diameter) will be visible in the bark. These are produced by adult beetles as they emerge from the tree. Oval/circular/irregular exit holes in ash tree bark, or D-shaped exit holes in trees other than ash, are not indicative of EAB infestation. Damage caused by the adults feeding on the foliage may be visible on infested ash trees in severe infestations. The adult beetles create irregularly shaped notchs around the edges of the leaves as they feed. Canopy thinning, crown and branch dieback and discoloration of foliage can be caused by a number of factors other than EAB, such as drought, waterlogging and adverse cultural and environmental conditions, as well as diseases such as ash dieback (caused by the fungus *Hymenoscyphus fraxineus* formerly known as *Chalara fraxinea*). Symptoms of various root and butt rots such as late flushing, thinning foliage and decline leading to eventual death are also similar to those caused by EAB infestation. However, the presence of D-shaped exit holes and larval galleries under the bark of ash trees are the key indicators of EAB which can differentiate it from signs and symptoms of other factors.

Timing	Canopy thinning, crown and branch dieback and discolouration of foliage can be seen during the summer months when the trees are in leaf. The adult beetles emerge between mid-May and July so foliage feeding damage may be evident from these times in severe infestations. Bark symptoms will be visible all year round but may be easier to see during the winter months when the leaves are absent.
Biosecurity	Ash wood with a stem diameter of just 10 mm and over can contain EAB life stages, therefore it is extremely important that no wood from ash trees is removed from a potentially infected site. The movement of firewood has been key to its spread in North America. All clothing should be brushed down and checked for ash tree material including the inside of boots, hoods and outer pockets. If any ash material is intentionally removed from an infested site (e.g. samples) then it should first be triple-wrapped in strong and robust plastic bags and/or double wrapped in bags which then must be secured within a plastic container.
Reporting requirements	If you find this pest, please report it through Tree Alert (https://treealert.forestresearch.gov.uk). In Northern Ireland please report via the TreeCheck website (www.treecheck.net) or phone app, or by emailing planthealth@daera-ni.gov.uk For traded plants and any non-tree hosts please email planthealth.info@apha.gov.uk (England & Wales), or hort.marketing@gov.scot (Scotland).

Based on information available in November 2016.

Signs and symptoms

Photograph: Jodie Ellis, Purdue University

Three dying ash trees that have been infested with emerald ash borer showing thin crowns and epicormic growth on the stems and among the branches.

Signs and symptoms

Photograph: Daniel Herms, The Ohio State University, Bugwood.org

Small dying ash tree that has been infested with emerald ash borer. The crown is dying from the top down and the foliage is discoloured and yellow.

Signs and symptoms

Photograph: Steven Katovich, USDA Forest Service, Bugwood.org

Mature ash tree dying from emerald ash borer infestation.

Signs and symptoms

Photograph: Leah Bauer, USDA Forest Service Northern Research Station, Bugwood.org

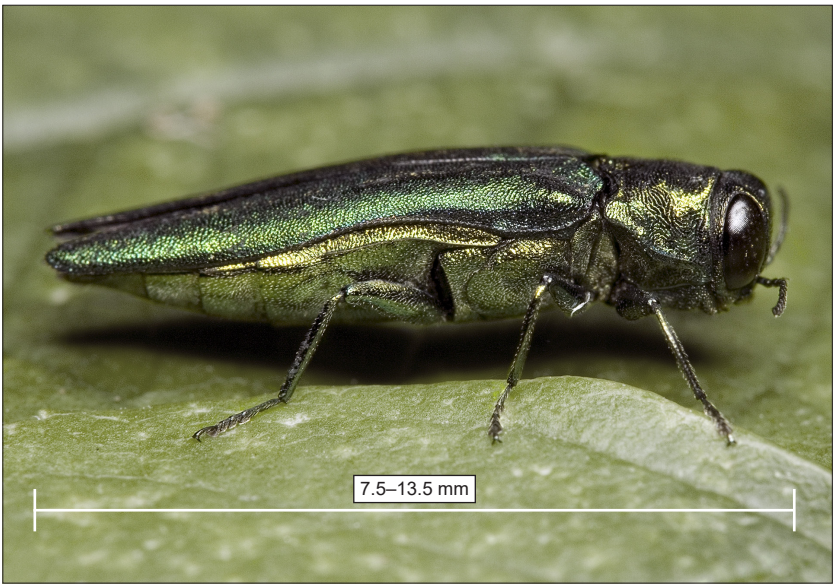
A row of declining ash trees affected by emerald ash borer. All have very thin crowns and epicormic growth at the base of their stems.

Photograph: Forest Research / David T Williams

Epicormic growth at the base of the main stems of a row of ash trees infested with emerald ash borer. All upper parts of the trees are dead.

Photograph: Steven Katovich, USDA Forest Service, Bugwood.org

Epicormic growth and woodpecker damage on the main stem of an ash tree infested with emerald ash borer.



Photograph: David Cappaert; Bugwood.org

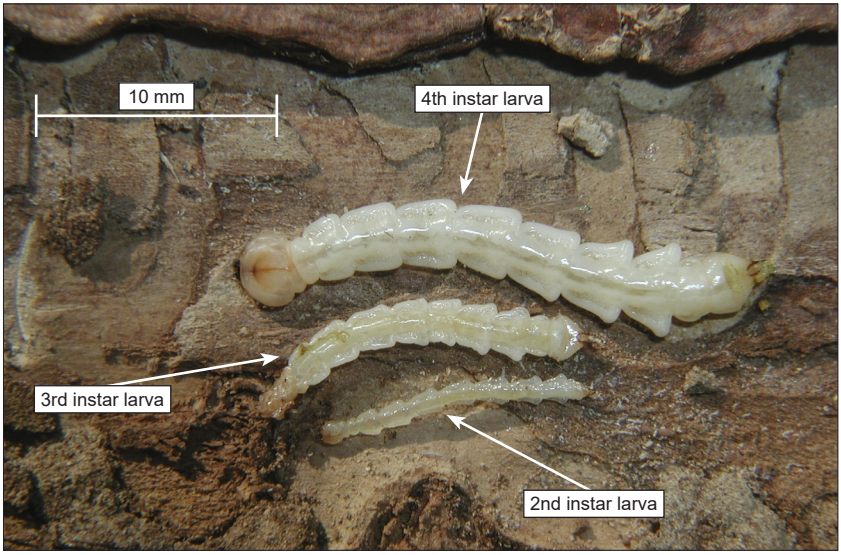
Adult emerald ash borer.

Photograph: Marianne Prue, Ohio Department of Natural Resources - Division of Forestry, Bugwood.org

Adult emerald ash borer.

Photograph: David Cappaert, Bugwood.org

Fourth instar larva (26–32 mm long) of the emerald ash borer. The sawdust-like material is larval frass.

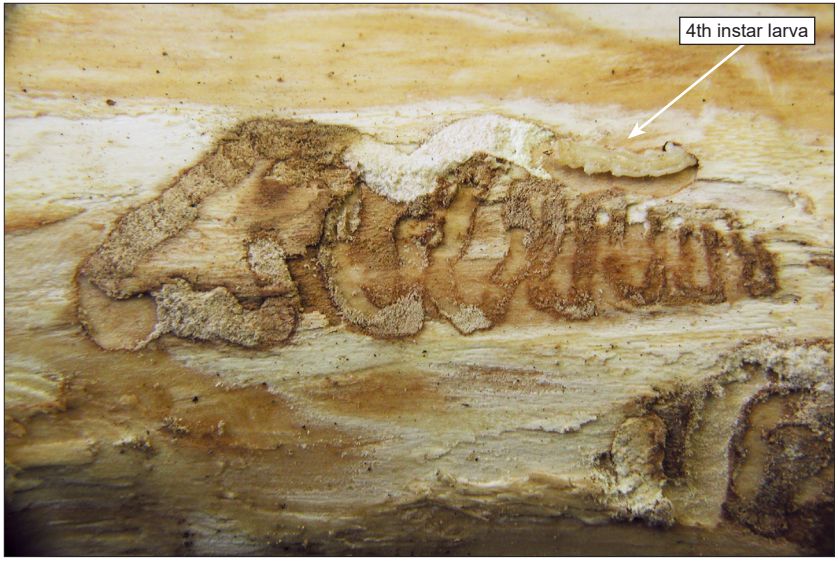


Photograph: David Cappaert, Michigan State University

Different larval development stages of the emerald ash borer feeding in the inner ash bark.

Photograph: David Cappaert, Michigan State University

Typical S-shaped gallery (200–300 mm long) and 4th instar larva of emerald ash borer with the tunnel increasing in size as the larva grows.



Photograph: David Cappaert, Michigan State University

Emerald ash borer gallery (200–300 mm long) and 4th instar larva entering the sapwood of its host tree to overwinter.

Photograph: David Cappaert, Michigan State University

Numerous emerald ash borer larval galleries in a heavily infested tree.

Photograph: Michigan Department of Agriculture; Bugwood.org

Cracks (50–100 mm long) can develop in areas of bark overlying the larval galleries. This is caused by the growth of callus tissue.

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Photograph: Kenneth R. Law, USDA APHIS PPQ, Bugwood.org

Woodpeckers may damage infested ash trees as they feed on the larvae beneath the outer bark. They produce irregularly circular holes surrounded by lighter areas and they also rake off outer bark plates as shown.

Close-up of holes caused by woodpecker damage.

Photograph: William M. Ciesla, Forest Health Management International, Bugwood.org

D-shaped exit hole made by emerging emerald ash borer adults.

Signs and symptoms

Photograph: Kenneth R. Law, USDA APHIS PPQ

D-shaped exit holes made by emerging emerald ash borer adults. Top section of image shows outer bark removed.

Emerald ash borer feeding damage on leaves. The adults create irregularly shaped notches around the periphery of the leaves as they feed.

Photograph: David Cappaert, Michigan State University

Emerald ash borer feeding damage on leaves. The adults create irregularly shaped notches around the periphery of the leaves as they feed.

Photograph: Forestry Commission

Chronic ash dieback – a declining tree showing severe dieback and epicormic growth caused by a combination of environmental and biotic factors. Without galleries and exit holes this would not be indicative of emerald ash borer.

Photograph: Forest Research / Suzanne Sancisi-Frey

Mature ash tree showing canopy thinning and branch and crown dieback caused by *Hymenoscyphus fraxineus* (the ash dieback fungus).

Photograph: Forestry Commission

Stem lesions centred on a dead side shoot (as shown) are not indicative of emerald ash borer, but have been caused by the ash dieback fungus.

Photograph: Forestry Commission / © Thomas Kirisits

Leaves wilting above a stem lesion caused by ash dieback.

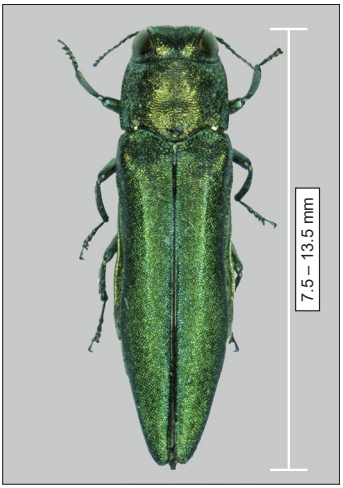
Photograph: Forest Research / Suzanne Sancisi-Frey

Dead, blackened retained leaves caused by ash dieback.

Photograph: Forest Research / Ana Perez-Sierra

Leaves infected with ash dieback showing leaf lesions.

Look-alike signs and symptoms

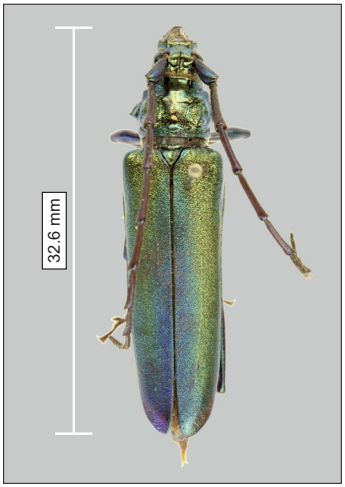


Photograph: Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org

Emerald ash borer (shown here for comparison).

Photograph: Valentyna Meshkova, Ukrainian Research Institute of Forestry and Forest Melioration, Bugwood.org

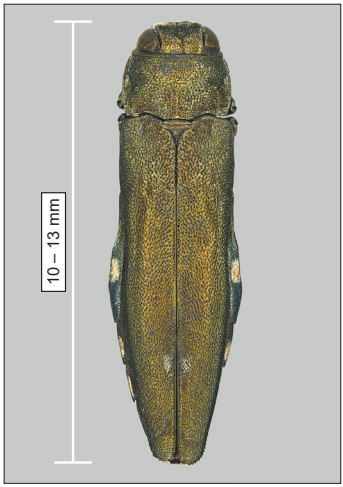
Rose chafer (*Cetonia aurata*).



Photograph: Pest and Diseases Image Library, Bugwood.org

Musk beetles e.g. *Aromia moschata*.

There are a number of other native green beetles that may be mistaken for emerald ash borer.



Photograph: Steven Valley, Oregon Department of Agriculture, Bugwood.org

Two spotted oak beetle (also known as oak jewel beetle) associated with acute oak decline (*Agrilus biguttatus*).

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Observatree aims to create a tree-health early-warning system using citizen science.

Observatree is a partnership project led by Forest Research, the research agency of the Forestry Commission. Project partners are the Animal & Plant Health Agency (APHA), Department for Environment, Food & Rural Affairs (Defra), Fera Science Ltd, the Forestry Commission, the National Trust, Scottish Forestry, the Welsh Government and the Woodland Trust. Supporting the project is Natural Resources Wales. The first four years of this project was 50% funded by the EU's LIFE programme.

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This booklet forms part of a set that supports Observatree volunteers when out looking for priority pests and diseases. It supplements face-to-face training and is not intended as a full or detailed description. It will also be useful for others who have some knowledge of the particular pest or disease and understand how to look for these. Further information is available online from the websites listed below:

www.observatree.org.uk

www.forestresearch.gov.uk/tools_and_resources/fthr/pest-and-disease-resources/

www.gov.uk/guidance/prevent-the-introduction-and-spread-of-tree-pests-and-diseases

https://planthealthportal.defra.gov.uk

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