

Exit Holes

What are exit holes?

- Tunnels through bark caused by insects exiting the tree
- Infestations often start in upper crown and spread down the tree
- As infestation progresses, new exit holes become more easily visible lower down the tree
- Shape and size of holes can be indicative of the type of insect
- The app has classes for ones that represent serious pests

What different types are there?

- Pencil-width round exit holes
- Small, D-shaped exit holes
- Multiple pen-tip sized exit holes
- Tiny holes surrounded by cankers
- Other - for any exit holes that don't fit these classes

What can they be confused with?

- Woodpeckers and sapsuckers make similar-looking holes
- Human activity, like drilling, can also create holes into the tree



Daniel Herms, The Ohio State University, Bugwood.org

UGA1523072

Tiny D-shaped holes caused by Emerald Ash Borer adults exiting an ash tree



Kenneth R. Law, USDA APHIS PPO, Bugwood.org

Round exit holes caused by Asian longhorned beetles exiting a tree



Joseph LaForest, University of Georgia, Bugwood.org

UGA5

The holes on this trunk are caused by sapsuckers, a type of woodpecker



The mobile app is available for free at the Apple App Store and on Google Play.



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Exudation

What is exudation?

- Exudation is a substance that oozes from a damaged area of a tree
- When damaged or diseased, the vascular tissues of a tree can ooze or seep out of holes in the bark

What different types of exudation are there?

- Red or black staining ooze
- Black fungal mat in the sapwood
- Brown fungal mat present in sapwood, on branches, or base of tree
- Apple cider odor
- Wet or dry discoloration around exit holes
- White powdery substance around exit holes
- Black or reddish ooze around cankers
- Sooty mold visible on leaves

What can they be confused with?

- The white, woolly egg masses of the hemlock woolly adelgid can be confused for exudation



Edward L. Barnard, Florida Department of Agriculture and Consumer Services, Bugwood.org

Exudation around a wound on this tree is staining the bark a reddish color



Joseph OBrien, USDA Forest Service, Bugwood.org

Dark exudation oozing from cankers



Bruce Watt, University of Maine, Bugwood.org

5529058

The egg masses of hemlock woolly adelgid can be confused for exudation



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Egg Sites or Eggs

What are egg sites or eggs?

- Pest insects may leave visible egg masses or egg sites on trees or nearby surfaces
- Egg sites are chewed into bark by wood boring beetles
- Eggs or egg sites can sometimes be seen when adults or larvae are inactive, like winter

What different types are there?

- Waxy, woolly, white egg masses at the base of needles
- Brown, fluffy masses on tree trunks or other vertical surfaces
- Clusters of small, oval eggs
- Shallow, round, discolored divots in bark
- Gray, mud-like egg masses on vertical surfaces

What can they be confused with?

- Other small objects on trees can be confused for eggs
- Squirrel chew marks and other damage to bark can be confused for egg sites



Bruce Watt, University of Maine, Bugwood.org

5529058

Waxy, white, woolly egg masses of the hemlock woolly adelgid



Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org

Egg masses of gypsy moth



David Hall, USDA Agricultural Research Service, Bugwood.org

Small, oval eggs of the Asian citrus psyllid



Donald Owen, California Department of Forestry and Fire Protection, Bugwood.org

Egg site chewed into bark by Asian longhorned beetle



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Adult Insects, Larvae, Pupa

What are adult insects, larvae, and pupae?

- Insects have different stages of life
- Species may be most visible at different stages of life – as adults, larvae, or as a pupa

What different types are there?

- The HTHC Mobile App has several choices – but there are many different types of destructive insect.

What can they be confused with?

- All of our pest insects can be confused with other insects – local experts can help with identification.



USDA APHIS PPQ, USDA APHIS PPQ, Bugwood.org UGA2652079

A moth with white to light brown wings – the gypsy moth



Michael Bohne, USDA Forest Service, Bugwood.org

A black beetle with white spots and long antennae – the Asian longhorned beetle



Debbie Miller, USDA Forest Service, Bugwood.org 5449380

A small, emerald green beetle – the emerald ash borer



Mike Lewis, Center for Invasive Species Research, Bugwood.org

A small, brown beetle with orange spots on its outer wings – the goldspotted oak borer



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Adult Insects, Larvae, Pupa Continued



Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org

A bright green winged insect – the Asian citrus psyllid



E. Richard Hoebeke, Cornell University, Bugwood.org

A tiny brown beetle – the invasive shot hole borer



Karla Salp, Washington State Department of Agriculture, Bugwood.org

5558988

A caterpillar with three sets of blue spots and six sets of red spots – the gypsy moth caterpillar



Lacy L. Hyche, Auburn University, Bugwood.org

Other – insects are hard to identify – if choosing 'Other', be sure to include a note about what you saw



Lawrence Barringer, Pennsylvania Department of Agriculture, Bugwood.org

5537180

Nymphs, black with white spots or black and red with white spots – the spotted lanternfly (nymph)



Lawrence Barringer, Pennsylvania Department of Agriculture, Bugwood.org

5522641

Moth-like grey insect with black spots and red, black, and white coloring on open wings – the spotted lanternfly



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Damaged Fruits or Tree Buds

What are damaged fruits or tree buds?

- Diseases that affect fruit can cause them to grow poorly, making them have low or no value to orchard growers
- Discolored or misshapen fruits can indicate disease
- Citrus greening keeps fruit like lemons and oranges green, even when ripe
- If the buds that lead to flowers are damaged by pests and disease, fruit can't be produced

What different types are there?

- Misshapen fruit
- Discolored fruit
- Buds appear shriveled

What can they be confused with?

- Cultivars can have differing forms of fruit and buds
- Some cultivars are bred to have flowers, but will not produce fruit



Citrus greening on oranges



Citrus greening



Shriveled buds on a twig



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Holes in Leaves

What are holes in leaves?

- Holes in leaves can be caused by pests feeding on them
- This feeding can be a significant stress on a tree when large amounts of leaf area are missing
- This can occur during large pest outbreaks
- The type of feeding can suggest what specific pests are present



USFS & HTHC Staff Photo

These maple leaves have been eaten by an insect pest

What different types are there?

- Holes on leaves near the outer edge of the leaf
- Holes on leaves closer to the central vein or midrib of the leaf



Landesforstpräsidium Sachsen, Bugwood.org

UGA1259094

Holes on leaves near the outer edge of the leaf

What can they be confused with?

- Mechanical damage, caused by storms or humans, can also cause holes in leaves



Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org

Holes on leaves closer to the central vein or midrib of the leaf



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Frass

What is frass?

- Frass is the waste produced by insect larvae tunneling through wood
- Can be pushed out of the tree through exit holes and wounds
- Will collect along ground near base of tree, or in elbows at tree branches

What different types are there?

- No specific classes in the app
- Frass can look different based on how finely it has been chewed
- It can be as fine as sawdust or look more like miniature matchsticks
- In some cases, it can even appear as intact tubes being pushed out of the tree

What can it be confused with?

- Recent tree work can leave wood shavings, especially if chainsaws were used



Randy Cyr, Greentree, Bugwood.org

Sawdust-like frass accumulating at the base of a tree



Kenneth R Law, USDA APHIS PPQ, Bugwood.org

Frass from the Asian longhorned beetle can look like wood shavings or miniature matchsticks



Albert (Bud) Mayfield, USDA Forest Service, Bugwood.org

Frass tubes from an ambrosia beetle being pushed out of tree bark



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Epicormic Sprouts

What are epicormic sprouts?

- New, green growth coming from the base of a tree or along the trunk, also called 'suckers'
- Trees store energy in their roots. When the tissues connecting the roots to the crown of the tree are damaged, the tree will send signals to other parts of the tree to start growing leaves.
- Often, this is a sign of serious disease or damage to a tree, although not always
- Can be caused by disease, insect infestation, or poor pruning like tree-topping
- In ash trees, they can be a strong sign of emerald ash borer damage



Edward Czerwinski, Ontario Ministry of Natural Resources, Bugwood.org

The green growth along the trunk in this ash tree is characteristic of emerald ash borer damage

What different types are there?

- No specific classes

What can they be confused with?

- Some species, like lindens or some flowering fruit trees, grow suckers at their base regularly, even when healthy



David Cappaert, Bugwood.org

Epicormic sprouting of small, diseased trees



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Blonding

What is blonding?

- Blonding is a type of damage caused by woodpeckers looking for insect larvae in wood
- As woodpeckers search for larvae, they strip away outer layers of bark
- This reveals the lighter-colored inner bark below, hence the term 'blonding'
- Widespread blonding can indicate an emerald ash borer infestation on ash trees

What different types are there?

- No specific classes

What can it be confused with?

- Woodpecker damage on trees is common
- Other types of woodpecker damage, like pecking large holes or horizontal lines caused by sapsuckers, are generally not a serious health issue for trees



Jim Tresouthick, Village of Homewood, Bugwood.org

Light-colored (blond) wood exposed on an ash branch



David Cappaert, Bugwood.org

Blonding seen on the trunk of an ash tree



Joseph LaForest, University of Georgia, Bugwood.org

Sapsucker damage on a tree



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S-Shaped Galleries

What are s-shaped galleries?

- S-shaped galleries are the winding tunnels chewed by insect larvae feeding in or underneath the bark of a tree
- Can be seen when the bark cracks open or has peeled away
- These tunnels kill the vascular tissues that move nutrients and water through the tree



Art Wagner, USDA - APHIS, Bugwood.org

S-shaped galleries visible where bark has been removed

What different types are there?

- Different species create galleries that look somewhat different, but the app classes them all together



Joseph OBrien, USDA Forest Service, Bugwood.org

S-shaped galleries visible in crack in bark

What can they be confused with?

- No significant confusion potential, although they may be difficult or impossible to see on trees where no bark has cracked open or peeled away



Edward Czerwinski, Ontario Ministry of Natural Resources, Bugwood.org

UGA1439007

S-shaped gallery



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Bark Fissures

What are bark fissures?

- Cracks in the outer bark
- As the living tissues of the tree die due to disease or pest infestation, they become brittle and lose connection to the outer bark
- As this happens, the bark can crack open into long fissures
- Fissures can also be a site for oozing of fluids from the tree – another possible sign of disease
- Cracks can also be caused by freezing temperatures or mechanical damage, like storms, string trimmers, or car crashes
- These cracks can be a point of entry for disease to a tree

What different types are there?

- No specific classes

What can they be confused with?

- Many species have bark that naturally flakes off or has patterning that looks like cracks
- Don't consider healthy bark when looking for fissures



Joseph OBrien, USDA Forest Service, Bugwood.org

S-shaped galleries visible through a bark fissure



Joseph O'Brien, USDA Forest Service, Bugwood.org

Cracks in the bark of a tanoak caused by sudden oak death



T. Davis Sydnor, The Ohio State University, Bugwood.org

Species like this London plane can have normal, peeling or cracking bark that can look like fissures



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Cankers

What are cankers?

- Cankers are areas of dead plant tissue
- They are often sunken, or depressed into the bark
- They are open wounds or injuries to a tree
- They can be very small or large
- Some may ooze or stain the bark around them
- Many diseases spread by invasive pests cause cankers
- The tissue around cankers is dead, and having many cankers can starve parts of a tree of nutrients

What different types are there?

- No specific classes in the app, but cankers will look different depending on the tree species and disease

What can they be confused with?

- Discoloration of the bark without an open wound



The dark spots on this branch are cankers



Dark canker with oozing caused by sudden oak death



Canker in walnut branch caused by thousand cankers disease



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Galls on Twigs or Leaves

What are galls?

- Galls are caused by numerous species of insects or mites
- These parasites force the plant to make these structures for food or as a safe habitat
- Some types of galls do not cause harm to the tree
- Others are symptoms of significant disease
- Galls can be found on twigs, buds, or leaves
- Can take many shapes, from round growths to small 'finger-like' growths

What different types are there?

- No specific classes in the app, but galls can take many forms

What can they be confused with?

- Burls are deformed woody structures that are found on branches and the main trunk of a tree
- Some insect eggs are laid on twigs and leaves and can look similar to small galls



Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org

The round structure is a gall attached to a leaf bud



Daniela Lupastean, University of Suceava, Bugwood.org

Red galls on a beech leaf



Laszlo Ersek, NTSZ, Bugwood.org

The galls on this leaf are deforming it, sapping nutrients from the tree



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Fine Twig Dieback

What is fine twig dieback?

- Fine twigs are the support structures for the leaves, buds, flowers, and fruit of a tree
- Some pests and diseases damage and destroy the tissues supplying the fine twigs in the outer parts of the crown with nutrients and water
- A symptom for these infestations is the dieback of fine twigs, often starting at the top of the tree and working down

What different types are there?

- For Pest Detection, simply note the presence/absence of fine twig dieback

What can they be confused with?

- Trees naturally “self-prune” – selectively kill lower branches that have been shaded out
- This is a natural, healthy process and should not be considered fine twig dieback



USFS / HTHC Staff Photo

This tree has widespread fine twig dieback



Charles Hoysa, Virginia Cooperative Extension, Bugwood.org

Many fine, small twigs are still visible on this tree that has widely died back



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Leaf Discoloration (deciduous)

What is leaf discoloration?

- Damaged, dying, or stressed leaves will change color outside of the normal autumn fall.
- This can be caused by disease, nutrient imbalance, or drought
- Discolored leaves cannot photosynthesize, depriving the tree of energy



USFS / HTHC Staff Photo

Discoloration in leaves of a London plane

What different types are there?

- For Pest Detection, simply note the presence/absence of leaf discoloration
- In a Health Check, record the percentage of leaf area affected by leaf discoloration



USFS / HTHC Staff Photo

"Scorching" discoloration – red to yellow color near leaf edges – in a red maple

What can it be confused with?

- Some tree cultivars have naturally occurring off-green leaves
- 'King Crimson' Norway maples' and purple-leaved cherries' are deep purple when healthy
- Other cultivars can have variegation – striping or patterning in leaves



John Hartman, University of Kentucky, Bugwood.org 5424411

Bacterial leaf scorch on a maple leaf



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Needle Discoloration

What is leaf discoloration?

- Damaged, dying, or stressed needles will change color
- This can be caused by disease, nutrient imbalance, or drought
- Discolored needles cannot photosynthesize, depriving the tree of energy



Discolored hemlock needles

What different types are there?

- For Pest Detection, simply note the presence/absence of needle discoloration
- In a Health Check, record the percentage of leaf area affected by needle discoloration



Needle blight on a larch tree

What can it be confused with?

- Many evergreen trees will naturally have older needles turn color and fall off – when and how many depends on the species
- Focus on looking for discoloration in younger needles



Normal fall needle drop on a pine tree – all the brown needles are 4 years old



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Wilted or Brown Leaves

What are wilted or brown leaves?

- Damaged or dying leaves will wilt, turn yellow to brown, or both
- Some diseases cause rapid death of the tree
- Others, like tar spot on maple trees, can cause leaf browning but don't negatively impact the health of the tree

What different types are there?

- No specific classes in the app, but wilted or brown leaves can look different from species to species

What can they be confused with?

- Be careful not to confuse this with normal fall leaf drop occurring in autumn



Wilted leaves due to Dutch elm disease



Drooping, wilted leaves due to oak wilt



Tar spot causing dark brown patches on maple leaves



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Premature Leaf Loss

What is premature leaf loss?

- Disease, stress, or pest damage can cause trees to lose their leaves during the growing season instead of during autumn
- Diseases or pests that damage vascular tissue can cause this
- Herbicide drift can also cause leaf loss
- Can be noticed by gaps in tree crown or excessive trees on the ground

What different types are there?

- No specific classes in the app

What can it be confused with?

- Be careful not to confuse this with normal fall leaf drop occurring in autumn



Curtis Utley, CSUE, Bugwood.org

Missing leaves are evident on several branches of this tree



Joseph LaForest, University of Georgia, Bugwood.org

These trees have lost their leaves – note the fully green trees in the background



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