



Emerald Ash Borer (EAB)

Where is it from? EAB is native to China and Korea.

How did it get here? It most likely arrived in the United States in Michigan on shipping crates or pallets. It was first discovered in southeast Michigan in 2002 and in northwest Ohio in 2003. However, EAB is often present in an area several years before it is detected.

What does it look like? Adult beetles are slender, elongate, and green (Figure 1). They are usually bronze, golden, or reddish green overall with darker metallic emerald green wing covers (Figure 3). An adult beetle is usually 7.5 to 13.5 millimeters long (Figure 2). Larvae are white to cream colored (Figure 4). Larvae are much longer than adult beetles.

What is its life cycle? EAB has a 1-year life cycle. Adult beetles emerge in May or early June. They feed on leaves of ash trees, creating small irregularly shaped patches on the edges. After feeding, adults mate and females lay eggs 1-2 weeks later. Longer-lived females can lay over 200 eggs in their lifetime. They lay eggs in cracks and crevices of bark on tree trunks or branches. Seven to ten days later, eggs hatch and larvae begin to chew through the bark. They feed for several weeks and create a serpentine (S-shaped) gallery that gets wider as the larva grows bigger (Figure 5). They usually finish feeding in fall and overwinter in shallow chambers under the bark. In April or May, they pupate into adults and one to two weeks later the new adults exit the tree creating a D-shaped exit hole.

How does it spread? EAB spreads primarily through flight of the adults and accidental movement by humans. EAB can infest nursery stock, firewood and other wood products made from ash trees. When that wood is moved to a new area, adults may emerge, begin feeding, and establish a new population in the local ash trees. EAB adults are also good flyers and can reach new ash trees far from the tree from which they emerged. Due to their rapid spread, EAB infestation has been documented in all counties of Ohio, as of 2016.

How does it damage trees? EAB larva damage trees by boring into trunks or branches of ash trees. Beneath the outer bark of the tree are the xylem and phloem which transport water and nutrients throughout the tree. Feeding by larvae disrupts the flow of the xylem and phloem. Without normal flow of water and nutrients, branches die and the crowns become thin. Ash species native to Ohio like white ash and green ash typically die after three to six years from EAB infestation.

What can be done to stop it? Both chemical insecticides and biological control methods are used to help manage EAB. An important part of preventing the spread is a quarantine of ash firewood. The most effective and quick response treatment to protect ash trees from EAB, is the use of chemical insecticides. There are also several tiny wasp species that are being used as a biological control for EAB.





Asian Longhorned Beetle (ALB)

Where is it from? ALB is native to China, Korea, and Taiwan.

How did it get here? ALB has been accidentally introduced to several locations in the United States likely in wood packaging material. ALB infestation was discovered in Ohio in 2011.

What does it look like? Adult beetles have a black body about $\frac{3}{4}$ to $1\frac{1}{4}$ inches long with white spots on the back (Figure 6). Their

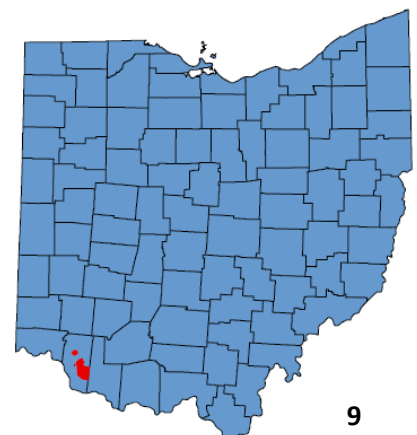
long antennae are 1.5 to 2.5 times the length of their body and have white and black bands. Their legs are black and blue.

What is its life cycle? ALB has one generation per year. Adult beetles are present July to October and do not usually move far. Females lay 35-90 eggs during their lifetime by chewing out a shallow pit in a tree's bark and laying one egg per pit. After 10-15 days, the eggs hatch. The larvae then feed under the bark on the living outer parts of the tree and then bore deeper into the center of the trunk or branch. They pupate in the deeper part of the wood and new adult beetles emerge from the tree creating a round exit hole (Figure 7). The exit holes are about the diameter of a pencil (Figure 8).

How does it spread? ALB are heavier beetles and do not fly far. Most adults will stay on the same trees from which they emerged rather than flying to a new tree. This is helpful because it keeps ALB from spreading quickly on its own. It is more likely for ALB to spread due to movement of infested wood by humans. In Ohio, it has only been found in Clermont County.

How does it damage trees? ALB prefers maple species in the United States: boxelder, Norway, red, silver, and sugar maples. Other preferred hosts are birches, buckeyes, elms, and willows. ALB is a wood-boring insect. When its larvae feed on the inner wood of tree branches and trunks, it weakens them. This can result in branches breaking off the tree. Over time, an infested tree may also struggle to distribute water and nutrients if the xylem and phloem are interrupted.

What can be done to stop it? The only effective way to stop ALB is to remove and destroy infested trees. Areas in which ALB has been found are quarantined to avoid transporting infested trees and branches from the area. In the ALB quarantine area in southwest Ohio, there are strict rules about the movement of wood to reduce the likelihood of ALB spreading to new areas (Figure 9). ALB infestations are monitored on a federal level by the United States Department of Agriculture's Animal and Plant Health Inspection Service (APHIS). In Ohio, USDA APHIS partners with state agencies such as the Ohio Department of Agriculture to inspect and remove infested trees and eventually eradicate ALB.





Hemlock Woolly Adelgid (HWA)

Where is it from? HWA is native to Japan.

How did it get here? HWA was first reported near Richmond, Virginia in 1951. It was likely brought to the U.S. unintentionally with ornamental Japanese hemlock trees.

What does it look like? HWA is a very tiny insect, less than 1/16 of an inch and barely visible to the naked eye. The most obvious visible sign of HWA is its woolly covering present

October through June (Figure 10). HWA attach to the base of a hemlock needle on the underside of the branches. HWA produce a woolly covering to protect itself and its eggs.

What is its life cycle? HWA has two generations per year (Figure 11). All individual adelgids are female and reproduce asexually. The longer-lived generation hatches around June and then goes into a dormant state through the hot summer months. Then in the fall to winter months, the nymphs develop into adults and produce their woolly covering (Figure 12). These adults then lay 50-300 eggs each in March to April. These eggs hatch into crawlers (Figure 13) that quickly develop into adults and lay 25-125 eggs in June.

How does it spread? HWA is not mobile except for the crawler stage of their life cycle. When the insect is in this stage, they can spread by wind, or when birds or other forest animals brush up against infested hemlock branches. As of 2018, HWA infestations had been found in 12 Ohio counties.

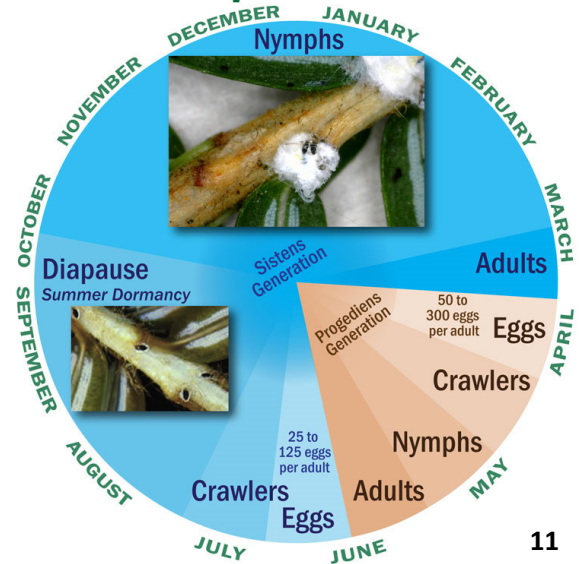
How does it damage trees? Young adelgids feed on the twig tissue of hemlock branches. They consume the starch reserves in the tree's sap. Starch reserves are critical to the tree's growth and long-term survival. Hemlock decline and mortality typically occur within 4 to 10 years of infestation.



What can be done to stop it? Chemical insecticides can be applied to hemlock trees to protect them from HWA for 5-7 years depending on the application method. Another treatment option is the release of biological controls. There are several insect predators from Asia and North America that can be used to help control HWA populations. This method is chosen to limit HWA but not eradicate it as the



Annual Lifecycle of HWA in Ohio



12

13



Gypsy Moth

Where is it from? Gypsy moth is native to Europe.

How did it get here? It was introduced to Massachusetts in the 1860s. It was introduced from Europe by an artist who was hoping to breed a better silkworm. Some of the gypsy moths escaped and established in the neighborhood. Gypsy moth was first reported in Ohio in 1971.



What does it look like? The caterpillars are hairy with five pairs of blue spots and six pairs of red spots along their backs (Figures 14 & 15). The male moth is brown while the female is white with brown markings (Figure 16).

What is its life cycle? Gypsy moth has one generation per year. Eggs hatch in spring that were laid the previous summer. Once they hatch, larvae will crawl down a silken thread they spin, and wind will blow them to another tree. They then feed for about 8 weeks on leaves and develop through 5 or 6 larval

stages in which they shed their skin. Then they find a protected location like a crevice in bark to pupate (Figure 18). Female adults cannot fly so male moths find females by smelling their pheromones. Females then lay eggs in a mass on tree trunks (Figure 17). Gypsy moth remains in the egg stage to survive the winter and then hatches the following spring.

How does it spread? Without control measures in place, gypsy moth will spread about 13 miles per year. The moth may also spread with nursery stock, vehicles, forest products and things like outdoor furniture that are moved by people. In 2019, gypsy moth had been found in 51 of Ohio's 88 counties.

How does it damage trees? Gypsy moth larvae ravenously consume the leaves of many tree species in the Midwest, Northeast, and southern Appalachians and Ozark Mountains. Of the many tree species they eat, the caterpillars prefer oaks and aspens. After two to three years of being defoliated by gypsy moth, a tree becomes weakened and is more likely to be impacted by other insects and diseases eventually leading to death.

What can be done to stop it? There is a federal program called Slow the Spread (STS) being implemented in multiple states to suppress further expansion of gypsy moth. This program includes survey and inspection to determine the area of the infestation. The infested areas are treated in various ways. Typically a larvacide, which kills the caterpillars of the gypsy moths, or the female pheremone which disrupts gypsy moth mating, is applied.



Invasions Around the Globe

The native ecosystems of the United States and North America are not the only places battling invasive species. With increased international trade and travel and interest in exotic species as pets, many other countries around the world are also concerned for their native flora and fauna. There are several species that the United States has exported to other areas of the world that have become invasive. One example is the Eastern gray squirrel. It was brought to Europe as a pet and quickly established populations in the wild. In Britain and Italy, the Eastern gray squirrel is so prevalent that the smaller native red squirrel is now locally extinct. While not all exotic, non-native plants and animals become invasive, those that do have a significant negative impact. International movement of people, animals, plants, and other things must be done with extreme care to reduce the likelihood of introducing a new invasive species.

What You Can Do

There are many ways that anyone can help prevent and reduce the spread of invasive species. Invasive species often establish after being transported by humans either on purpose or accidentally. Help protect native ecosystems by taking the following actions:

- Make sure that any plants you are purchasing are not invasive. Choose native alternatives instead!
- Do NOT move firewood. Always buy local and leave any leftover behind.
- If you own woods, work with a professional forester (Call 4-H U Cut) and learn how to control invasive species that may be present on your property
- For yard trees, work with an ISA certified arborist (www.treesaregood.org)
- Report invasive species infestations to your local, county, state, or federal government agency
- Clean your hiking boots, boats, animals, and any gear off before you hike in a new area to prevent movement of invasive species
- Do NOT release aquarium fish and house plants, live bait or other exotic animals into lakes, streams, or other natural areas
- Volunteer at your local park to help remove invasive species
- Educate others about the threats invasive species pose to our native ecosystems

Where to find more information about invasive pests:

Ohio Department of Agriculture

agri.ohio.gov/wps/portal/gov/oda/divisions/plant-health/invasive-pests

USDA Animal and Plant Health Inspection Service

aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases

USDA National Invasive Species Information Center

invasivespeciesinfo.gov/terrestrial-invasives/terrestrial-invertebrates

USDA Forest Service

fs.usda.gov/managing-land/invasive-species

Ohio Invasive Plants Council

oipc.info/invasive-plants-of-ohio.html

Ohio Department of Natural Resources

ohiodnr.gov

Early Detection & Distribution Mapping System

eddmaps.org/

Information and photos retrieved from the United States Department of Agriculture (USDA) Forest Service, USDA Animal and Plant Health Inspection Service (APHIS), and the Ohio Department of Natural Resources (ODNR) Division of Forestry.

May 2020.