


First Detector Guide to

Invasive Insects

Biology, Identification & Monitoring

Extension

UtahStateUniversity

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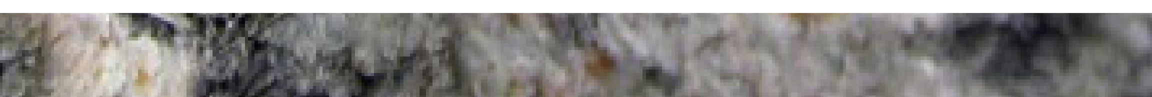

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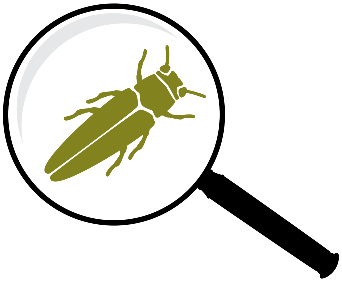

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UTAH FIRST DETECTOR PROGRAM

Invasive species are a leading and growing threat to our nation's agricultural and natural resources. Thousands of non-native (exotic) species have been introduced into the U.S., and the estimated damage and management costs of invasive species exceed $138 billion per year. In response to this threat, the Utah Plant Pest Diagnostic Lab (UPPDL) and Utah State University (USU) Extension created the Utah First Detector Program to prepare citizen responders with the knowledge and skills necessary to identify potential invasive insects, collect and submit high quality samples to the UPPDL, and notify the appropriate authorities when required.

The UPPDL and USU Extension work closely with other state and federal agencies, such as the United States Department of Agriculture and Utah Department of Agriculture and Food, to address invasive pest threats. The Utah First Detector Program is, in part, an extension of the Utah Cooperative Agricultural Pest Survey (CAPS) Program, which is part of the larger national CAPS program. For more information about the Utah CAPS program, visit http://utahpests.usu.edu/caps.

The target audience for the Utah First Detector Program includes Master Gardeners, Extension personnel, state agricultural inspectors, certified arborists, tree and lawncare professionals, forestry and natural resource professionals, conservationists, and others with an interest in pest detection and response.

PROGRAM GOALS

The primary goals of the Utah First Detector Program are to create a network of well-trained and committed citizen volunteers ("First Detectors") to:

1. Assist with ongoing invasive pest detection and outreach efforts.
2. Reduce the frequency of inaccurate and excessive reporting of common species.

The UPPDL, USU Extension, and their partners will train First Detectors to detect and identify invasive insects of concern, and will guide them to existing resources for their outreach activities. As part of this program, First Detectors will receive a printed copy of this guide and a toolkit of sample collection supplies and reference materials needed to support invasive pest awareness initiatives.

ROLES & RESPONSIBILITIES

In order to become a First Detector, individuals must have a working email address and phone number, attend a First Detector training workshop, and fill out and sign a First Detector Confidentiality Form (to be handed out during the workshop). In addition, First Detectors must agree to the following terms:

- *First Detectors never announce the arrival of a new pest.* All information regarding potentially new, invasive pests must be treated as confidential. First Detectors should immediately notify the UPPDL regarding suspected symptoms or collection of life stages. The UPPDL will then communicate that information to the appropriate agencies. This protocol is required to avoid premature and incorrect reports, as significant unintended consequences may result from hasty, inaccurate communications.
- *First Detectors do not have the authority to enter private property without permission.* If you do receive permission to enter private property, it is recommended that the property owner accompany you.
- *Being a First Detector is voluntary.* First Detectors will not be financially compensated or reimbursed for time and/or travel. However, Continuing Education Units (CEUs) may be available for pesticide applicators and certified arborists. Master Gardeners may also be able to use volunteer time as a First Detector toward Master Gardener service hours.

SUBMITTING SAMPLES

The UPPDL is a service of USU Extension and the Department of Biology at USU. The UPPDL is staffed with highly skilled and experienced professionals that provide rapid and accurate identification of pest-related problems. First Detectors can submit suspect samples (digital images and/or physical samples) directly to the UPPDL. If possible, send digital images to the USU CAPS Coordinator (caps@usu.edu) for screening prior to submitting physical samples to the UPPDL.

Submitting Digital Images

Send high-resolution images as an email attachment to one of the labs listed on the next page. Images should be **in focus** and well-lighted, contain a ruler or other object for scale, and contain different parts/views of the insect and/or plant symptoms.

Submitting Physical Samples

Live insects can escape from containers; therefore, it is very important that you kill (do not squish) the insect before submitting it to the UPPDL. Place the insect into a spill-proof jar or vial containing rubbing alcohol (hand sanitizer or white vinegar are suitable alternatives). You can also freeze the insect before placing it into a sealable crush-proof container. If submitting plant material, handle it as if it contains a live pest (i.e., secure plant material so that an emerging pest could not escape). Wrap plant material in paper bags or newspaper. Secure samples using packing material to avoid breakage/damage. Samples containing plant material should be overnighted.

Include with your submission, the date, collection location, email address, phone number, and physical address in case we have follow-up questions. Mail sample(s) to one of the labs listed below, and as soon as possible to prevent drying or deterioration of the insect or plant material.

Utah Plant Pest Diagnostic Laboratory
Utah State University
5305 Old Main Hill
Logan, UT 84322
Phone: 435-797-2435
Email: caps@usu.edu
Website: http://utahpests.usu.edu/uppdl/

Utah Department of Agriculture and Food
Plant Industry and Conservation Division
350 N. Redwood Road
Salt Lake City, UT 84114
Phone: 801-538-7184
Email: agriculture@utah.gov
Website: http://ag.utah.gov/plants-pests.html

Asian Longhorned Beetle

Anoplophora glabripennis Motschulsky

BACKGROUND

Asian longhorned beetle (ALB) (Coleoptera: Cerambycidae) is an invasive wood-boring pest that is a major threat to many hardwood tree species and to maple syrup production. It was first detected in the U.S. in New York during the 1980s, and probably arrived via wood packing material from China. The first major infestation of ALB in the U.S. was in Brooklyn in 1996. Soon after, infestations were found in other eastern locations, including Chicago and New England. ALB is currently only found in Massachusetts, New York, and Ohio, and is considered to have been successfully eradicated from New Jersey and Illinois. The western U.S. is thought to be less susceptible to ALB establishment, given the lack of suitable host plants outside urban areas.

Fig 1. Adult Asian longhorned beetle.

IDENTIFICATION

Adults are large, conspicuous beetles that are bullet-shaped, 3/4 – 1 1/2 inches in length (not including the very long black and white antennae), and have a glossy-smooth black body with irregular white spots (Figs 1-2). Some adults, although generally rare, have yellow spots and newly emerged adults may have a bluish tinge to their feet and antennae (Fig 2). The scutellum, or the triangular segment between the top of the wing covers, is black (a similar looking native insect has a white scutellum - see SIMILAR INSECTS section on page 7).

Fig 2. Adult with a bluish tinge to the legs. Arrow points to black scutellum.

Eggs are roughly the size of a grain of rice (about 1/4 inch in length) (Fig 3). They are mostly flat, creamy-white in color, and are laid individually in an aggregated pattern and in craters (oviposition pits) chewed into the bark by the adult female. Eggs can be found underneath the bark along main branches and the lower crown, but may also be found on the lower trunk.

Larvae are typical of roundheaded beetle larvae. They are cylindrical, ribbed, and light yellow or white (Fig 4). Larvae can reach up to 2 inches in length. Young larvae create galleries just under the bark, but tunnel into the heartwood of the tree as they age.

Pupae are about 1 1/2 inches in length and about the same color as larvae, but have traits that resemble the adult (Fig 5). Pupae darken in color as they develop.

Fig 3. Eggs look like grains of rice.

Fig 4. Various stages of ALB larvae.

Fig 5. Pupa.

LIFE HISTORY

ALB has one generation per year (Fig 6). Adults emerge from host trees in late spring and can be found throughout the summer, up until about the first frost. Adults feed on leaf veins and bark of young twigs for 10–20 days before mating. A female may lay as many as 90 eggs in her lifetime.

Eggs hatch within a couple of weeks and the newly emerging larvae feed on the cambium and sapwood, eventually tunneling deeper into the heartwood. ALB typically overwinters as a larva.

The following spring, larvae begin to chew their way toward the outside of the tree, where they pupate. Pupation lasts about 20 days, with adults emerging from trees during the late spring. Adults may remain on the tree they developed in, or fly short distances to infest new trees.

PLANT HOSTS

ALB infests more than 100 different tree species, making it especially threatening to our forests and incredibly difficult to detect and eradicate. Maple is the preferred host, but there are many other trees

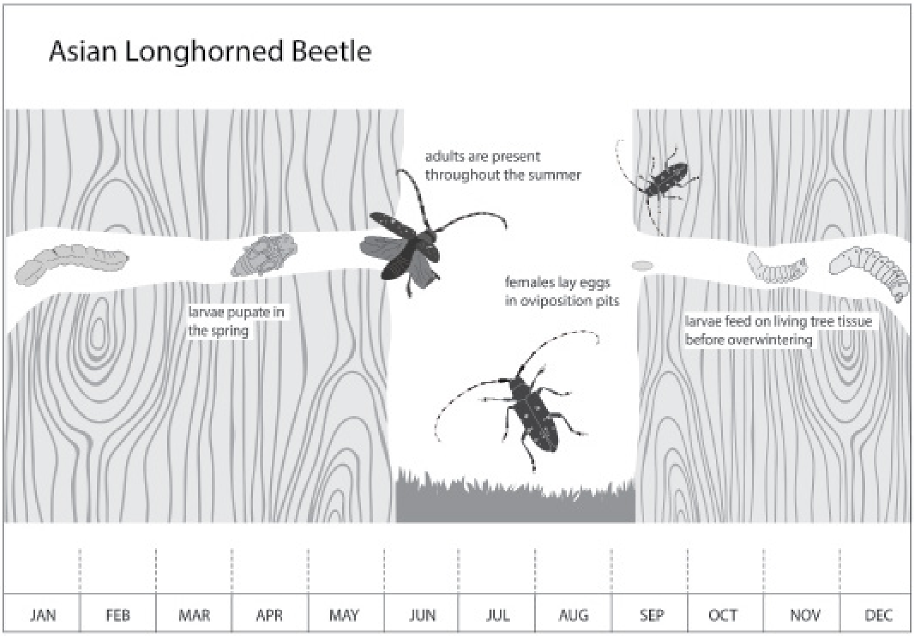

Fig 6. Life history of Asian longhorned beetle.

it will attack, such as ash, birch, elm, poplar, willow, and sycamore. Some trees appear to not be at risk of ALB infestation, including oak and honeylocust. It is unknown if ALB infests conifer species.

DAMAGE SYMPTOMS

Both adults and larvae feed on host trees, although the larvae cause the most damage. Adults will feed on leaf veins (Fig 7), and the females chew craters (oviposition pits) into tree bark, leaving mandibular (mouthpart) marks that can be seen around the edges of the pit (Figs 8-10). Craters are about 1/2 inch in diameter and vary in shape from circular to oval, depending on bark thickness. Freshly chewed pits are easier to see because the inner bark contrasts more sharply with the outer bark. ALB adult exit holes are perfectly round, nearly dime-sized (3/8 inch in diameter), and may ooze sap (Fig 11).

Larvae bore into and feed on the cambium and sapwood, creating large hollow chambers that can be seen in cross-sections of the trunk (Figs 12-14). Deposits of frass (sawdust-like insect waste) may collect at tree trunks and limb bases (Fig 15). Severe larval infestations lead to dead branches and can make tree limbs more likely to break during storms and cause damage to nearby structures. Larval feeding also disrupts the tree's ability to uptake water and nutrients, causing it to slowly die. Infested trees may be associated with drooping leaves and discolored foliage (Fig 16).

Fig 7. Adults feed along the veins of leaves.

Fig 9. Oviposition pits and adult exit holes.

Fig 8. Heavily attacked tree showing fresh and old oviposition pits.

Fig 10. Recent oviposition wound. Note the chew marks that can be seen around the pit edges.

Fig 11. Adult exit hole.

Fig 12. Internal damage to tree trunk caused by ALB development within the tree.

Fig 13. Damage caused by larval feeding.

Fig 14. Damage under the bark.

Fig 15. Frass from larval feeding will often collect at tree trunks and limb bases.

Fig 16. ALB can cause unseasonably discolored foliage.

WHAT CAN YOU DO?

Do not move or transport firewood.
ALB can travel short distances on its own, but larvae and adults can survive within firewood or other wood material containing live ALB.

Be aware of the signs and symptoms of an ALB infestation.
First state detections of ALB have always been made by a member of the public, not by a professional entomologist. If an insect looks suspicious or you see symptoms of infestation, report it immediately to the UPPDL.

Be aware of common and native insects that look like ALB.
For more information about some of these insects, see the SIMILAR INSECTS section on the next page.

Keep trees healthy.
Research suggests that healthy trees are less likely to become infested with pests. Trees should be properly watered and pruned, and fertilized when necessary. Keep at least a 4' foot diameter area around trees free of weeds and grass so that there is no competition for water or nutrients and so trunks do not get damaged by lawnmowers. Your local USU Extension office can help with tree maintenance and planting information or visit http://forestry.usu.edu/htm/city-and-town/tree-care for publications on tree care.

MONITORING AT A GLANCE

Pheromone-baited traps, including interceptor traps (Fig 17), have been used by survey personnel for monitoring ALB.

To date, ALB has been detected primarily by the public or through visual surveys. Therefore, there is a big push towards training volunteers to help with the surveying process (in areas where ALB has been detected) or to keep their eyes open for these pests (in areas where ALB has and has not been detected). Since initital infestations usually occur first in the upper parts of the tree canopy, trees are scanned with binoculars or inspected with bucket trucks. Initial detections of ALB in Utah, however, should focus on the identification of the adult beetle, as the damage symptoms that were described on pages 3-5 can be caused by insects that already occur in Utah.

Fig 17. Interceptor trap.

MANAGEMENT AT A GLANCE

When ALB infestations are found, APHIS and State officials establish quarantines or regulated areas around them. Quarantines help with beetle eradication by restricting the movement of ALB and ALB host materials (known as regulated articles). This minimizes the chance of ALB spreading to new locations. Unfortunately, control options beyond removing and chipping or burning infested trees (Fig 18) are limited.

Several of the known natural enemies (parasitoids and predators) in the native range of ALB affect many different insects and are unlikely to be approved for release in the U.S.

Some systemic insecticides have been used in the U.S. to control various life stages of ALB, but their effectiveness is being disputed by some scientists, and these chemicals can have deleterious impacts on nontarget species. Currently, the most practical approach for controlling ALB is to detect and eradicate it before it spreads over large areas.

Fig 18. Removal of an ALB infested tree.

SIMILAR INSECTS

White-Spotted Sawyer (*Monochamus scutellatus*)

The white-spotted sawyer is a common beetle found in the U.S., including Utah, and is very often mistaken for ALB. Adults have a dull bronze-black body with variable white markings, faintly banded antennae, and white scutellum (i.e., a white segment located between the top of the wings) (Fig 19).

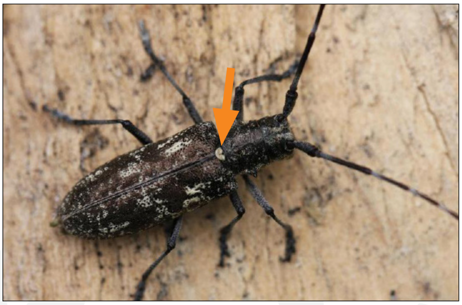

Fig 19. White-spotted sawyer. Arrow points to white scutellum.

Banded Ash Borer (*Neoclytus caprea*)

The banded ash borer is a pest of ash, hickory, elm, linden, mesquite, and oak. Adults are black, and have yellow or cream-colored markings on their wings and antennae that are less than 1/2 the length of their body (Fig 20).

Fig 20. Banded ash borer.

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Post-Planting Tree Care, Utah State University Extension

Questions and Answers: Asian Longhorned Beetle Control Treatments, USDA APHIS

The Use of Volunteers in Exotic Pest Surveys, Cooperative Agricultural Pest Survey (CAPS) Program

Using Traps to Detect Asian Longhorned Beetle, Penn State University

Volunteer Survey Guidelines: Asian Longhorned Beetle, Cooperative Agricultural Pest Survey (CAPS) Program

For more information on ALB, visit these websites: USDA Hungry Pests ALB page (http://www.hungrypests.com/the-threat/asian-longhorned-beetle.php), Don't Move Firewood ALB page (http://www.dontmovefirewood.org/gallery-of-pests/asian-long-horned-beetle.html), USDA ALB Informational Website (http://www.beetlebusters.info), and National Invasive Species Information Center ALB species profile (https://www.invasivespeciesinfo.gov/animals/asianbeetle.shtml).

PHOTO CREDITS

Fig 1. Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org

Fig 2. Michael Bohne, Bugwood.org

Fig 3. Melody Keena, USDA Forest Service, Bugwood.org

Fig 4. Steven Katovich, USDA Forest Service, Bugwood.org

Fig 5. Melody Keena, USDA Forest Service, Bugwood.org

Fig 6. Life cycle by Erin Brennan, Utah State University

Fig 7. Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org

Fig 8. Michael Bohne, Bugwood.org

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Fig 10. Donald Owen, California Department of Forestry and Fire Protection, Bugwood.org

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Fig 18. Thomas B. Denholm, New Jersey Department of Agriculture, Bugwood.org

Fig 19. Steven Katovich, USDA Forest Service, Bugwood.org

Fig 20. David Cappaert, Bugwood.org

Brown Marmorated Stink Bug

Halyomorpha halys Stål

BACKGROUND

Brown marmorated stink bug (BMSB) (Hemiptera: Pentatomidae) is a major pest of many agricultural crops, including fruits, vegetables, and ornamentals. BMSB is also a nuisance pest that will congregate and invade homes and other buildings during the fall and winter.

Originally from Asia, BMSB was first found in the U.S. in Pennsylvania around 1996, but was initially misidentified as a local species. In 2001, after increasing homeowner complaints, BMSB was positively identified as a new invasive species. BMSB has since expanded its range to more than 40 states. Its current distribution can be found at http://www.stopbmsb.org/where-is-bmsb/.

BMSB was first detected in Utah in 2012, and has been found in Cache, Weber, Davis, Salt Lake, and Utah counties as of May 2016.

Fig 1. Adult brown marmorated stink bug.

IDENTIFICATION

Adults are shield-shaped, and about 5/8 inch long and 1/2 inch wide. The term "marmorated" refers to the brown marbled pattern on the adult bodies. Their antennae, legs, and posterior edge of the back have distinct light and dark banding patterns (Figs 1-2). BMSB "shoulders" are rounded and smooth (Fig 3). Adults have undersides that are light gray or tan (Fig 4).

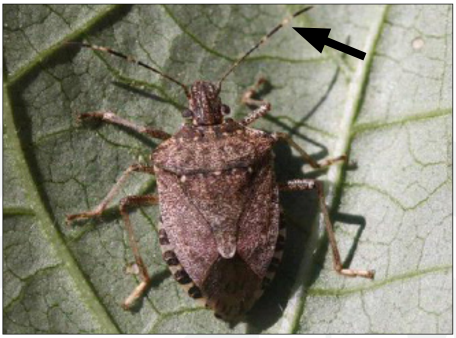

Fig 2. Arrow points to white banding on antennae.

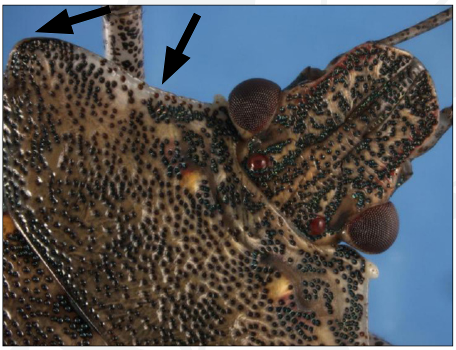

Fig 3. Arrows point to rounded and smooth shoulders.

Fig 4. The adult underside is light gray or tan (not green or yellow - colors typical of some native stink bugs).

Eggs are barrel-shaped, 1/16 inch wide, and translucent to white in color (Fig 5). As eggs mature, dark triangular-shaped spots become visible. Eggs are typically laid on the underside of leaves and in masses of approximately 20-30 (average of 28).

Nymphs vary in color, depending on age. Newly hatched nymphs are tick-like in appearance, have yellow-red backs with black stripes, and tend to huddle near the egg mass (Fig 5). As nymphs mature, they disperse from the egg mass, darken in color, develop wing pads (immature wings), and begin to look similar to adults in color and size (Figs 6- 7). Nymphs range from 1/10-1/2 of an inch.

Fig 5. Egg mass and young nymphs.

Fig 6. Mid-stage nymph.

Fig 7. Two adult BMSBs (left) and a maturing nymph (right).

LIFE HISTORY

BMSB appears to have only one generation per year in Utah (Fig 8), but multiple generations are possible. Adults become active in the spring, and feed on any green, growing plant for about two weeks before mating. A female may lay as many as 400 eggs in her lifetime.

In northern Utah, BMSB egg masses have been detected from late May to late August. In other states, eggs have been observed through September. Eggs hatch within a few days and the development time for each nymphal stage is about 1 week between molts, depending on temperature.

From October to November, adults (and sometimes nymphs) move to protected sites where they mass together for the winter, including under the bark of standing trees, downed and dead trees, and inside buildings, especially in attics and walls. Adult aggregations may be seen on the outside of buildings, and in window seals, air vents, and cracks and crevices in concrete or buildings.

PLANT HOSTS

BMSB is a tree-loving bug, and has a very broad plant host range. Adults and nymphs will feed on vegetative and reproductive plant structures, including stems, leaves, fruits, seeds, pods, buds, and flowers. Plants that bear fruiting bodies (e.g., fruits and vegetables) are especially vulnerable to this pest.

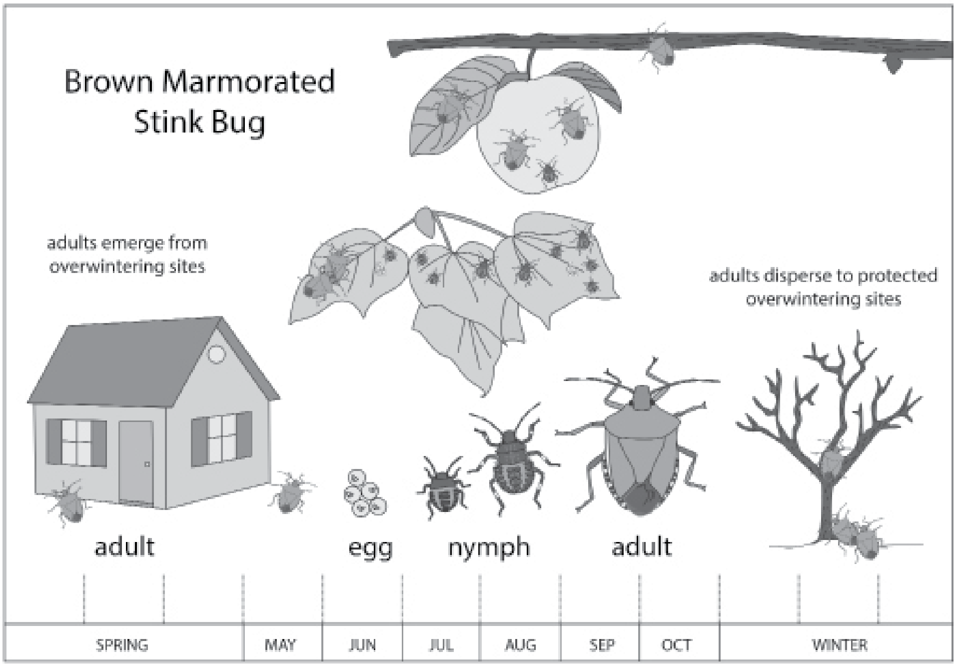

Fig 8. Life history of brown marmorated stink bug.

BSMB prefers stone and pome fruits, berries, and recently has been found to feed on citrus fruits. Vegetables are also highly susceptible to BMSB feeding, especially solanaceous fruits (tomatoes and peppers), legumes, and sweet corn.

In Utah, BMSB has only been found on ornamental woody plants, including catalpa (Fig 9), maple, butterfly bush, honeysuckle, and Siberian pea shrub.

Fig 9. All life stages of BMSB have been found on catalpa trees in Utah.

DAMAGE SYMPTOMS

BMSB, like all stink bugs, has a piercing-sucking mouthpart (Fig 10). Mouthparts are used to puncture plant cells to obtain nutrients in the sap and inject salivary secretions that help break down the plant tissue.

Common feeding damage symptoms include dimples, pits, and discoloration, softening of fruits, "cat facing," and the development of corklike tissue (Figs 11-13). Sometimes there will be no visible external damage to the fruit, but will only be seen underneath the skin.

Although they can be a major agricultural and domestic nuisance, BMSB does not bite, sting, spread mammalian diseases, or bore into or damage wooden structures. It is not directly harmful to people, pets, or buildings.

Fig 10. Arrow points to the piercing-sucking mouthpart.

Fig 11. Fruit scarring.


Fig 12. BMSB damage.


Fig 13. Interior corking injury.

MONITORING AT A GLANCE

Monitoring techniques for BMSB include pheromone-baited pyramid traps (Fig 14), visual surveys, and the use of beating sheets (or trays) (Fig 15). These methods are appropriate for both homeowners and commercial growers. Traps can be purchased online. Beating sheets are helpful for dislodging BMSB adults and nymphs directly from plants, and are highly effective when bug populations are low. Beating trays can be purchased online or constructed from a canvas sheet spread over a square frame, and paired with a beating stick.

Monitoring is usually conducted spring through fall. In spring and fall, when daytime temperatures are cool, BMSB is more active during the afternoon. During the summer, however, it is most active in the morning and evening. BMSB prefers the edges of plantings. Thus, monitoring and trapping should be focused around field and garden perimeters.


Fig 14. Black pyramid trap.


Fig 15. Beating tray.

MANAGEMENT AT A GLANCE

BMSB is a challenging insect to manage. Adults are highly mobile, and easily spread by hitchhiking or flying. They have a tough exoskeleton and can re-invade fields previously treated with insecticides. Both nymphs and adults damage crops, and over time, BMSB may develop resistance to insecticides. For these reasons, insecticidal control of BMSB often requires rotating insecticides from different insecticide classes.

Physical exclusion is one of the best methods to reduce BMSB adult aggregations in buildings and in the field. Exclusion can be accomplished by sealing cracks around windows, doors, and siding. Repair or replace damaged screen doors, screens, and windows in the winter to reduce access points for BMSB adults to enter. Simple attract-and-kill traps, which consist of a pan with soapy water and a light to shine on it, can be used to capture overwintering adults.

Some physical barriers in small acreage situations can be effective in deterring BMSB such as floating row covers, sticky bands around trunks and stems, adhesives such as Tangle-Trap®, or covering fruits with breathable bags or plants with netting.

In the U.S., natural enemies (insect-attacking predators, parasitoids, and pathogens) have not been effective in limiting population growth of BMSB. However, an egg parasitoid wasp native to BMSB's home range, *Trissolcus japonicus* (Fig 16), provides high levels of BMSB population suppression in Asia, and U.S. entomologists are hopeful that it may perform similarly in the U.S.

Fig 16. *Trissolcus japonicus*, a parasitic wasp of BMSB.

SIMILAR INSECTS

Rough Stink Bug (*Brochymena* spp.)

Rough stink bugs are commonly mistaken for BMSB in Utah. Adults can be distinguished from BMSB by having a heavily toothed shoulder and lack alternating dark and light bands on the antennae (Fig 17).

Fig 17. Rough stink bug.

Common Brown Stink Bugs (*Euschistus* spp.)

Brown stink bug adults are generally smaller than BMSB, have a small row of spines on the shoulders, lack banding on the antennal segments, and have a yellowish-green or pinkish underside (Figs 18-19).

Fig 18. Common brown stink bug.

Fig 19. Common brown stink bugs have yellowish-green or pinkish undersides.

Western Conifer Seed Bug (*Leptoglossus occidentalis*)

Western conifer seed bugs, also known as leaf-footed bugs, are minor tree pests in the U.S. They are not considered stink bugs (stink bugs belong to the family Pentatomidae and are all shield-shaped); however, they can be mistaken for BMSB. They have similar coloring and emit unpleasant odors when disturbed. Adults are more elongated (U-shaped) and have much longer and thicker legs than BMSB and other stink bug adults (Fig 20).

Fig 20. Western conifer seed bug.

Squash Bugs (*Anasa tristis*)

Squash bugs are common garden pests and feed on summer and winter squash, melons, pumpkins, and cucumbers. Adults can reach a length of up to 1 inch, are a darkish brown color, and have a more narrow body than stink bugs (Fig 21). Like stink bugs, they emit unpleasant odors when disturbed.

Fig 21. Squash bug laying eggs.

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For more information on BMSB, visit these websites: Stop BMSB (http://www.stopbmsb.org/) and National Invasive Species Information Center BMSB species profile (https://www.invasivespeciesinfo.gov/animals/stinkbug.shtml).

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Fig 4. Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org

Fig 5. David R. Lance, USDA APHIS PPQ, Bugwood.org

Fig 6. Gary Bernon, USDA APHIS, Bugwood.org

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Fig 8. Life cycle by Cami Cannon, Utah State University

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Emerald Ash Borer

Agrilus planipennis Fairmaire

BACKGROUND

Emerald ash borer (EAB) (Coleoptera: Buprestidae) is an invasive wood-boring beetle that has caused the decline and mortality of tens of millions of ash trees (*Fraxinus* spp.) in the U.S. It is considered the most destructive forest pest to ever invade North America.

Originally from Asia and parts of Russia, EAB was first discovered in the U.S. in 2002 in southeastern Michigan. It most likely arrived to the U.S. as larvae or pupae embedded in ash pallets, crates, or packing material transported by airplanes or cargo ships. EAB is now known to occur in 26 eastern and midwestern states, and is rapidly expanding its range. It has NOT YET been found in Utah, but an infestation has been found in neighboring Boulder, Colorado. Information on its most current distribution can be found at http://www.emeraldashborer.info.

Fig 1. Adult emerald ash borer.

IDENTIFICATION

EAB undergoes complete metamorphosis, which includes four distinct stages: adult, egg, larva, and pupa. The immature stage (larva) does not resemble the adult.

Adults are metallic green beetles with bronze heads, short saw-toothed antennae, flattened backs, rounded bellies, and iridescent purple-red abdominal segments beneath their wings. They are bullet-shaped, lack a defined waist, and are about 1/2 inch long and 1/8 inch wide (Figs 1-3).

Fig 2. Adults have purple-red abdomens.

Fig 3. Adults are 1/2 inch long.

Eggs are oval to round, 1/16 inch in diameter, cream-colored when first deposited, and reddish-brown as they develop (Fig 4). Due to their small size, eggs are not easily observed.

Fig 4. Eggs.

Larvae are cream-colored with 10 body segments and a flattened abdomen. They can reach a length of 1 inch when mature, are tapeworm-like in appearance (Fig 5), and have a pair of brown, pincer-like appendages on the last abdominal segment. Their brown head is mostly retracted, but the mouthparts are visible externally. The last instar larva (pre-pupa) will excavate a tiny chamber and curve back on itself (J-shaped) (Fig 6).

Fig 5. Larvae.

Fig 6. J-shaped larva.

Pupae have the characteristic shape of the adult, with short saw-toothed antennae and a blunt spine at the tip of the last abdominal segment. Newly developed pupae are white, but then take on the adult coloration as they develop (Figs 7-8).

Fig 7. Gradual maturation of pupae to the adult stage.

Fig 8. Pupa in chamber.

LIFE HISTORY

EAB has a one year life cycle (Fig 9). Adults emerge from ash trees in the spring when degree-day (DD) accumulations reach 450-550 DD (using a base temperature of 50°F), which in Utah can occur as early as mid-April in southern Utah or mid-May in northern Utah. Peak emergence is at 900 to 1,100 DDs (mid-to late July). For more information on DDs in Utah, visit https://climate.usurf.usu.edu/traps/.

Adults live 3-6 weeks and will feed on ash leaves for 1-2 weeks before searching for mates. Mated females will lay eggs on bark or in bark crevices. Females can lay 60-90 eggs over the course of their lifetime. Eggs are laid individually or in groups, and hatch after 2-3 weeks.

After eggs hatch, the newly developed larvae bore into the tree, feeding on the phloem and cambium layers, and eventually pass through four larval stages. EAB overwinters as a full-grown larva or pre-pupa in a tiny chamber excavated in the sapwood. They pupate in the spring and repeat the life cycle.

PLANT HOSTS

EAB attacks all North American ash (*Fraxinus*) species. They attack small, large, stressed, and even healthy ash trees.

EAB was previously thought to specialize on ash, but was recently found infesting whitefringe trees (*Chionanthus virginicus*) in Ohio and Illinois. This may indicate that EAB has a wider host range than originally

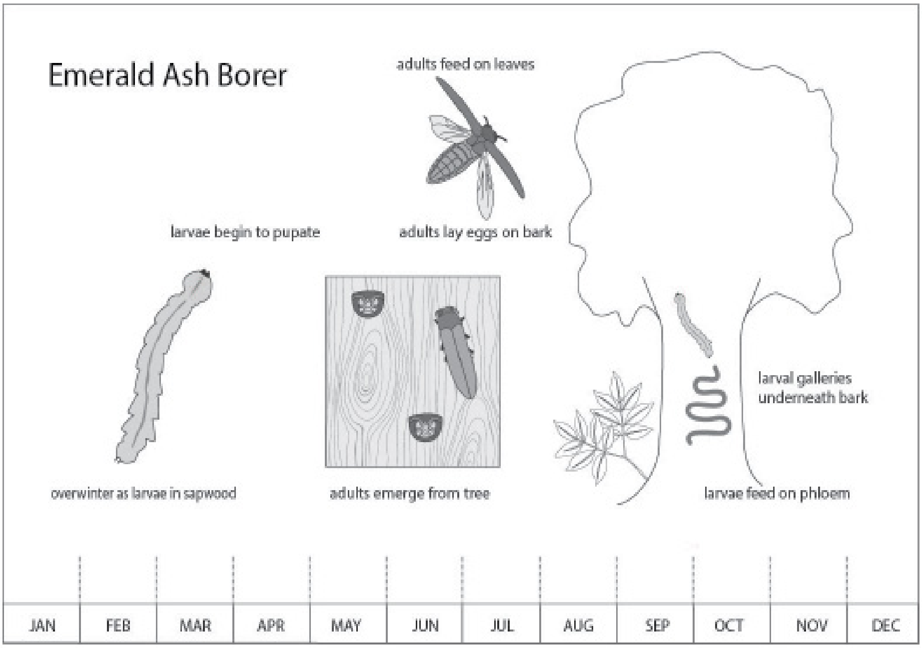

Fig 9. Life history of emerald ash borer.

thought or that it is adapting to utilize new hosts. Both ash and fringe trees are members of the olive family.

Utah has two native ash species that are susceptible to EAB - the small, shrubby singleleaf ash, *Fraxinus anomala*, that occurs sporadically in southern Utah and velvet ash, *Fraxinus velutina*, in SW canyons. Yet, various planted ash species make up a substantial component of our urban forests. Ash comprises up to 30% of the urban canopy in many Utah communities, and all are susceptible to EAB attack.

DAMAGE SYMPTOMS

Larvae are the primary damaging life stage and are responsible for killing trees. They chew through bark into the phloem and sapwood, creating serpentine-shaped and excrement-filled galleries (Fig 10), which disrupt the flow of nutrients and water, starving the tree. Larval galleries curve at near right angles so that the tunnel length, as measured in a straight line from start to end point, is less than half of the actual total tunnel distance (note: any serpentine gallery in an ash tree should be suspect). Galleries are more common in the upper canopy in newly infested trees and increase in size as larvae feed and grow. Galleries, however, can be found lower on the trunk as the infestation progresses.

Larval infestations can also lead to bark splits, canopy dieback, epicormic branching (suckers) at the base of large, dead branches or the base of the tree, and increased woodpecker activity (Figs 11-14). Woodpeckers and other bark foraging birds feed on up to 85% of the EAB in an infested tree.

Adults leave D-shaped exit holes (1/8 inch wide) on tree branches and trunks when they emerge (Fig 15). Adults feed on ash foliage (Fig 16), but cause little damage overall to the tree.

When EAB densities are high, small trees can die within 1-2 years of becoming infested, whereas large trees are killed within 3-4 years. Unfortunately, EAB infestations are difficult to detect, especially during the early stages of invasion, and are nearly always fatal to the tree unless insecticides are used to protect trees.

Fig 10. Larval gallery.


Fig 11. Bark splits.


Fig 12. Canopy dieback.


Fig 13. Epicormic suckers.


Fig 14. Woodpecker feeding damage on trunk and epicormic sprouts on ground.


Fig 15. Adults emerge from D-shaped exit holes.


Fig 16. Adult feeding on ash foliage.

WHAT CAN YOU DO?

Do not move or transport firewood.
EAB can travel short distances on its own, but it is introduced to new, distant locations via infested firewood or other wood material containing living EAB. National quarantines of infested counties are in place to further prevent the human-assisted spread of EAB, and many agencies have initiated campaigns to raise awareness about the dangers of moving firewood (Fig 17). For example, the Don't Move Firewood campaign, which was first launched by the Nature Conservancy in July 2008, has played a major role in slowing the spread of invasive tree-killing diseases and insects, including EAB.

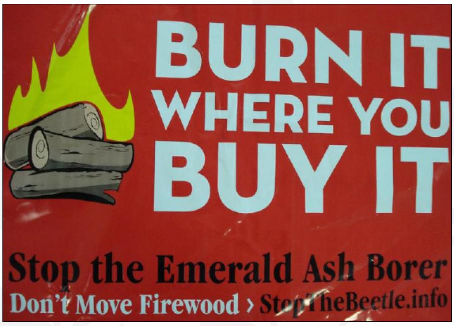

Fig 17. Campaign efforts have helped raise awareness of EAB.

Be aware of the signs and symptoms of an EAB infestation.
If you think an insect looks suspicious or you see signs of damage, contact the UPPDL to inspect the tree in question. The earlier we can detect it, the more management options will be available to us.

Know which trees could be infested.
Learn to identify the trees in your yard and neighborhood. If they are ash trees and look like they are suffering, investigate why. For information on ash tree identification, see the IS MY TREE AN ASH or the REFERENCES & ADDITIONAL RESOURCES sections below.

Be aware of established pests that can be confused with EAB.
There are several insects, including other beetles, that look like EAB or that tunnel in ash trees and cause similar damage. For more information about some of these insects, see the SIMILAR INSECTS section on pages 30-31.

Keep trees healthy.
Research suggests that healthy trees are less likely to become infested with EAB. Trees should be properly watered and pruned, and fertilized when necessary. Keep at least a 4' foot diameter area around trees free of weeds and grass so that there is no competition for water or nutrients and so trunks do not get damaged by lawnmowers. Your local USU Extension office can help with tree maintenance and planting information or visit http://forestry.usu.edu/htm/city-and-town/tree-care for publications on tree care.

Do not include ash in new plantings.
Remove any ash that is not in optimal health or in poor sites. Treebrowser.org can be used to select a variety of ash alternatives.

MONITORING AT A GLANCE

There are a number of monitoring techniques state and federal survey personnel use for detecting EAB, including traps, branch sampling, girdled (trap) trees, and biosurveillance. Some of these may be suitable for homeowners.

Purple prism traps or *Lindgren funnel traps* (Figs 18-19) are used during statewide detection trapping programs, but are not available freely to the public. Traps are purple prism or green funnel traps baited with a lure made of oils that mimic chemicals released by stressed ash trees. They are placed in trees during the spring and summer, and then taken down in the fall. Traps are for detection or monitoring purposes only - they are not used to control EAB populations.

Fig 18. Purple prism trap.

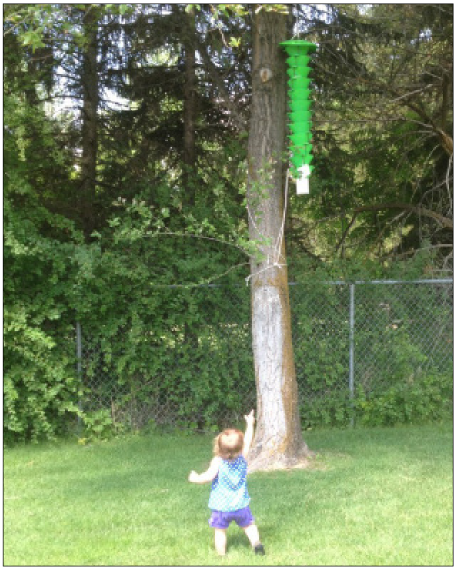

Fig 19. A budding entomologist pointing to a Lindgren funnel trap.

Branch Sampling is recommended for both homeowners and survey personnel, and is most valuable in urban and other high-risk areas. The best time to collect branches is in the fall, after larvae can be detected. Use the following steps to inspect branches:

1. Choose an ash tree that is 20-60' tall with a large, open canopy.
2. Collect two branches (1-4" in diameter) from the middle canopy, if possible. Remove branches using proper pruning safety procedures and precautions.
3. Remove lateral branches.
4. Use a drawknife to peel back the bark in thin strips (Fig 20).
5. Carefully examine the branch for EAB galleries and/or larvae.

Fig 20. Bark peeling with drawknife.

Girdled (trap) trees are considered effective EAB detection tools. Trees are girdled by removing the outer layer of bark and cambium layer around the entire circumference of the trunk (Fig 21). The tree is then forced into a state of stress, which is highly attractive to EAB. In areas known to be infested with EAB, girdled trees are removed within a few weeks and destroyed, and a large number of EAB larvae are destroyed with it. This is known as a "population sink." In areas where EAB has not been detected, the tree is removed at the end of the season and remaining bark is stripped to check for EAB galleries and larvae.

Fig 21. Girdled tree.

Biosurveillance refers to the tracking and observation of native, stingless predatory wasps (Fig 22) as they return to their nests with prey. Learn more about biosurveillance at www.cerceris.info.

Fig 22. Predatory wasp.

MANAGEMENT AT A GLANCE

EAB has NOT been detected in Utah, so there is no current need for control of this insect. Insecticides (preventative or curative) should only be considered when EAB has been detected within 10-15 miles of your residence.

Insecticide treatment options include cover sprays, systemic soil drenches, trunk injections, and basal bark applications. Treatments may need to be repeated annually or biannually to protect trees during EAB invasions. Insecticides are not 100% effective due to the difficulty of managing insects under tree bark. Some chemicals can kill larvae underneath the bark; however, 30-50% canopy decline is the "cutoff" for this to work. For more information, refer to the Multistate EAB Insecticide Fact Sheet.

USDA has also been working to develop biological control agents to help slow down EAB. Utah has already received the permits needed to release the tiny parasitoid wasps (Fig 23) when EAB arrives.

Fig 23. Parasitoid wasp.

IS MY TREE AN ASH?

Some trees, such as box elder (*Acer negundo*) and black walnut (*Juglans nigra*), can be mistaken for ash trees. Characteristics for identifying ash trees include:

Opposite branching: Branches, buds, and leaflets are directly across from each other (Fig 24). Keep in mind that buds and limbs die, so not every branch will have an opposite mate.

Compound leaves: Ash leaves are compound with 5-11 leaflets (Fig 24). Leaflet margins may be smooth or toothed.

Bark: The bark of young ash trees is smooth, whereas mature trees have diamond-shaped ridges (Fig 25).

Seeds: Seeds are oar-shaped, typically occur in clusters, and hang on the tree until fall or early winter (Fig 26).

Fig 24. Ash leaf with 7 leaflets. Note that leaflets (and branches, etc) are directlly opposite of each other.

Fig 25. Mature ash bark.

Fig 26. Ash seeds.

SIMILAR INSECTS

There are several insects that look similar to EAB, and other types of insects that tunnel in ash trees. We highlight some of these “look-alike” insects below.

Flatheaded, Metallic Beetles (*Agrilus*)

The honeylocust (*A. difficilis*) and bronze birch (*A. anxius*) borers are related to EAB, but are pests of honeylocust and birch, respectively. They do not infest ash trees, but do cause similar D-shaped exit holes when they emerge from hosts. Honeylocust borers have black bodies with white or yellow spots alongside their abdomen (Fig 27). Bronze birch borers are mostly bronze (Fig 28).

Fig 27. Honeylocust borer.

Fig 28. Bronze birch borer.

Lilac Ash Borer (*Podosesia syringae*)

The lilac ash borer is a clearwing moth that, as an adult, mimics a paper wasp. Larvae are caterpillarlike (Fig 29) (EAB larvae are tapeworm-like). Exit holes are irregularly round and about 1/4 inch in diameter (Fig 30). When the adult emerges from pupation, the pupal skin extrudes from the adult exit hole (Fig 31). EAB leaves its pupal skin in a pupal chamber within the tree.

Fig 29. Lilac ash borer larva.

Fig 30. The lilac ash borer emerges from irregularly round exit holes.

Fig 31. Lilac ash borer pupal skin.

Ash Bark Beetle (*Hylesinus* spp.)

Ash bark beetle adults are small (1/8 inch), oval beetles that have a variegated white and brown body and clubbed antennae (Fig 32). The larvae are legless, about 1/6 inch long when fully grown, and have white bodies and brown heads. Adult females construct transverse egg galleries (horizonal to wood grain), and larvae create longitudinal feeding tunnels (parallel to wood grain) (Fig 33). Exit holes are circular, about 1/8 inch in diameter, and are found in clusters or "shotgun" patterns (Fig 34).

Fig 32. Ash bark beetle.

Fig 33. Ash bark beetle galleries.

Fig 34. Ash bark beetle shotgun exit holes.

Banded Ash Borer (*Neoclytus caprea*)

The banded ash borer is a common ash borer in Utah. Adults are dark brown to black, and have a line of fine, white or yellowish hairs on their midsection and four bands across the wing covers (Fig 35). Adults are 1/2 to 1 inch long and emerge from oval exit holes (1/4 inch in diameter).

Fig 35. Banded ash borer and exit hole.

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For more information on EAB, visit these websites: USDA Hungry Pests EAB page (http://www.hungrypests.com/the-threat/emerald-ash-borer.php), Don't Move Firewood EAB page (http://www.dontmovefirewood.org/gallery-of-pests/emerald-ash-borer.html), and the EAB Information Network site (http://www.emeraldashborer.info/).

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Fig 9. Life cycle – Erin Brennan adapted from Fig 15. - Debbie Miller, USDA Forest Service, Bugwood.org

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Fig 34. Whitney Cranshaw, Colorado State University, Bugwood.org

Fig 35. Whitney Cranshaw, Colorado State University, Bugwood.org

GYPSY MOTH

Lymantria dispar Linnaeus

BACKGROUND

Gypsy moth (GM) (Lepidoptera: Erebidae) is an invasive defoliating pest that is a serious threat to U.S. forests. There are two related subspecies of concern to the U.S., the European GM (*Lymantria dispar dispar*) and the Asian GM (*L. dispar asiatica*). The two subspecies can only be distinguished from each other by DNA tests. Both pose a threat to U.S. forests, however, although the Asian GM poses a greater threat than the European GM because it has a broader host range than the European GM, and the females can fly 20-25 miles per day (European GM females do not fly).

The European GM was first brought to the U.S. in 1869 to start a silkworm industry. It is now well-established in the eastern U.S., and has been detected in many other parts of the country, including Utah. Populations of European GM have been found and successfully eradicated twice in Utah (1988 and 2008).

The Asian GM was first detected in the U.S. in 1991, and likely arrived on ships infested with egg masses traveling from Russia. In recent years, there have been several introductions of Asian GM to the U.S., including Washington, Oregon, Georgia, and South Carolina in 2015. The Asian GM has not been detected in Utah.

IDENTIFICATION

Adult males are grayish-brown moths with feathery antennae and a wingspan of about 1 1/2 inches. Adult females have creamy white wings with black wavy markings, thread-like antennae, and a wingspan of about 2 1/2 inches (Fig 1). Both males and females have an inverted V-shape that points to a dot on the wings.

Fig 1. Adult male (left) and female (right) gypsy moths.

Eggs occur in conspicuous, velvety masses that are 1-2 inches long, tan in color, and firm to the touch (Figs 2-3). The eggs inside are black and pellet-like. Egg masses may contain between 100-1,000 individual eggs, and can be found on many outdoor surfaces, including trees, houses, patio furniture, and vehicles.


Fig 2. Adult female with egg mass.


Fig 3. Egg masses can be found on many outdoor surfaces, including trees.

Larvae go through 5-6 growth stages. Young larvae are small (1/8 inch long), black caterpillars with long, black hairs on the body, and may have irregularly shaped yellow marks visible on the upper body surface. Older larvae are more easily identifiable. They have long, tan bristles, five pairs of blue spots followed by six pairs of red spots lining the back, and yellow spots along the sides of the body (Figs 4-5). Mature larvae can reach 2 1/2 inches in length. GM larvae do not produce silken tents or have extensive webbing.


Fig 4. Mature larva.

Pupae are teardrop shaped, about 2 inches long, dark brown, and have hardened shells covered in small hairs (Fig 5). They can be found in bark crevices or other cryptic locations.

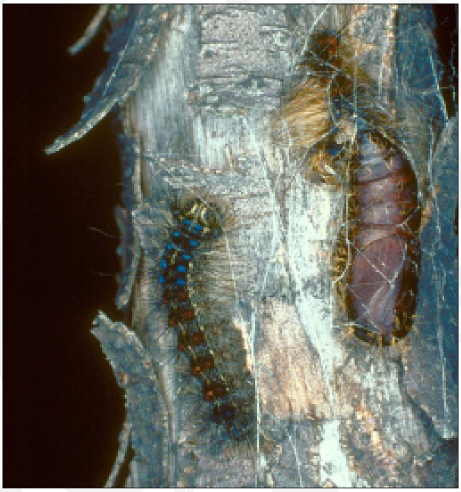
Fig 5. Mature larva (left) and pupa (right).

LIFE HISTORY

GM has one generation per year (Fig 6). Adults emerge from pupal cases anywhere between late June and early August, with peak emergence in mid-July. Females will remain on the tree and release pheromones to attract mates. Egg masses are deposited by females in July or August and are found on trees and other outdoor substrates. The eggs are the overwintering stage, and will hatch the following spring (April through early May). Young larvae climb to the tops of trees, where they feed and dangle from silk strands until they are dispersed by wind. Young larvae feed during the day in the upper canopy, whereas mature larvae feed at night but move to the base of trees or bark crevices to hide during the day. Pupation takes place between July and August.

GM populations go through cycles in which the populations increase for several years, then decline, and then increase again. GM outbreaks can take place for up to 10 years.

PLANT HOSTS

Larvae feed on the foliage of hundreds of tree species. The most preferred hosts include oak, aspen, apple, birch, and poplar, but they will also infest walnut, cherry, elm, hickory, honey locust, maple, and several western conifers. Asian GM larvae tend to feed on evergreen and deciduous trees, whereas European GM larvae feed primarily on deciduous trees.

Least preferred hosts include ash, dogwood, and lilac, but some research suggests that GM may be able to adapt to unsuitable host plants.

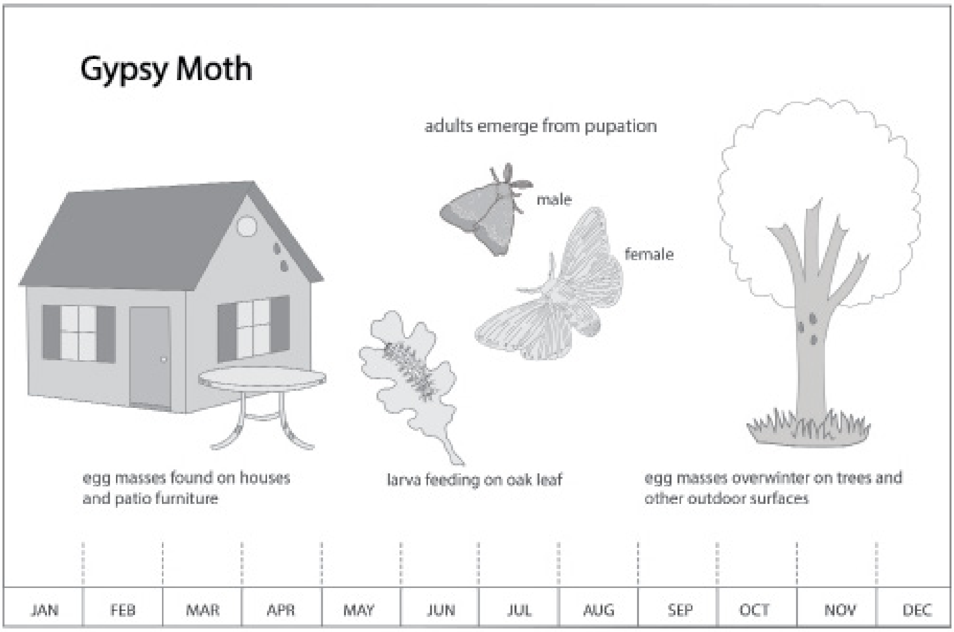

Fig 6. Life history of gypsy moth.

DAMAGE SYMPTOMS

Larvae are the damaging life stage. They defoliate trees, leaving trees weakened, more susceptible to drought, diseases and other pests, and can eventually kill trees and entire forests (Figs 7-10). GM larvae lower property values in infested urban areas, and their debris (frass or insect excrement, egg masses, and pupal casings) can be a nuisance to homeowners (Fig 11).

Healthy trees can usually tolerate 1-2 years of GM attack; however, repeated infestations will weaken the tree to a point to which it cannot recover.

Fig 9. GM damage.

Fig 7. Larva feeding on oak leaf.

Fig 10. Aerial view of GM damage.

Fig 8. Larvae defoliate trees.

Fig 11. GM larvae (on clay pot) can be a nuisance to homeowners.

WHAT CAN YOU DO?

Do not move or transport firewood. Like Asian longhorned beetle (pages 1-9), emerald ash borer (pages 21-33) and several other pests, GM can spread to new areas on infested firewood and other wood materials. In general, do not transport firewood outside county boundaries.

Learn to identify all life stages of GM. Keep an eye open for GM life stages on and near your home, and keep your lawn and woodlot clean and free of hiding places (e.g., woodpiles, trash, unused equipment). Inspect buildings, fences, trees and shrubs, and rock gardens. Larvae and egg masses are more observable than adult moths.

Maintain tree health. In general, healthy trees are less susceptible to pests. Trees should be properly watered and pruned, and fertilized when necessary. Keep at least a 4' foot diameter area around trees free of weeds and grass so that there is no competition for water or nutrients and so trunks do not get damaged by lawnmowers. Your local USU Extension office can help with tree maintenance and planting information or visit http://forestry.usu.edu/htm/city-and-town/tree-care for publications on tree care.

MONITORING AT A GLANCE

There are a number of monitoring techniques state and federal survey personnel use for monitoring GM, including larval and adult trapping (Fig 12). These techniques, however, are more suitable for federal and state agencies that are involved in detection and delimiting surveys than for homeowners. For more information about monitoring for GM, see the REFERENCES & ADDITIONAL RESOURCES section below.

Fig 12. Trap used by survey personnel for detecting GM.

MANAGEMENT AT A GLANCE

GM is not currently found in Utah, so there is no need for control of this insect. There are no quick fixes that will get rid of GM once it has become established. Management efforts usually target the egg and larval stages, as early life stages are more susceptible to treatments.

One of the most common methods for controlling GM is aerial spraying of a bacteria-based pesticide called Btk, named after the bacterium, *Bacillus thuringiensis kurstaki*. Btk is harmful to moths and butterflies only during their caterpillar stage of development. Caterpillars eat vegetation sprayed with Btk, and then spores become activated in their stomachs, causing the catepillars to die in 7-10 days.

GM is susceptible to attack by natural enemies, such as predators, pathogens (fungi and viruses), and parasitic wasps (parasitoids), including the egg parasitoid, *Ooencyrtus kuvanae,* the larval parasitic fly, *Blepharipa pratensis*, and the braconid wasp, *Aleiodes indiscretus* (Fig 13).

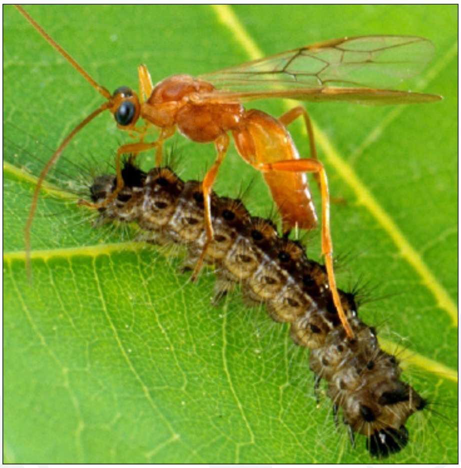

Fig 13. *Aleiodes indiscretus* wasp parasitizing a GM caterpillar.

Other management options include mating disruption (pheromone applications that prevent male moths from finding mates), destroying egg masses with soapy or oily water, and placing sticky barrier bands on tree trunks (Fig 14). Barrier bands prevent caterpillars from crawling up trunks and into tree canopies where they feed on foliage, thereby protecting trees from defoliation. Note, however, that GM larvae can be dispersed by wind.

Fig 14. Barrier bands prevent GM larvae from crawling up tree trunks.

SIMILAR INSECTS

Some caterpillar defoliators that are common in Utah can be confused with GM caterpillars. We highlight two of these insects below.

Western Tent Caterpillar (*Malacosoma californicum*)

The western tent caterpillar is a defoliator of broadleaf trees and shrubs throughout the western U.S. Adults are heavy bodied moths with wingspans of 1-2 inches, and vary in color from dark red-brown to yellow, tan, or gray (Fig 15). Egg masses are covered with a hardened, glossy material that is dark brown or pale gray (Fig 15). Young larvae are about 1/8 inch long and dark brown to black in color with white hairs (Fig 16). Mature larvae can reach 2 inches in length and are highly variable in color. They usually have a pale blue head and body, are speckled with black markings, have a mid-dorsal stripe edged by two bands that are black or yellowish orange and bordered with black, and are covered with orange-brown hairs with white tips (Fig 17). Caterpillars create and feed inside extensive silken tents.


Fig 15. Female western tent moth with egg mass.


Fig 16. Young western tent caterpillar larvae.


Fig 17. Mature western tent caterpillar larvae.

Fall Webworm (*Hyphantria cunea*)

The fall webworm is a common defoliator moth of ornamental and fruit trees in Utah. The adult moth has a wingspan of 1-2 inches and is primarily white in color, but can have black spots on the wings. Egg masses are white and contain several light yellow eggs. Young larvae are pale yellow with two rows of black marks along their bodies. Full grown larvae are about 1 inch long and have highly variable coloration (Fig 18). They are usually greenish with a broad, dusky stripe along the back, a yellowish stripe along the side, and are covered with long whitish hairs that originate from black and orange bumps. Larvae feed inside silken tents (Fig 19).

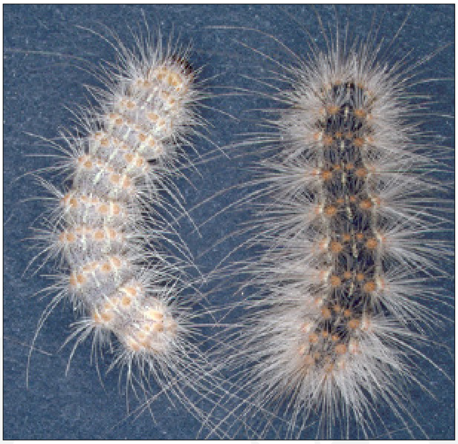
Fig 18. Fall webworm larvae are variable in color.


Fig 19. Fall webworm larvae are gregarious and feed inside silken tents.

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For more information on GM, visit these websites: USDA Hungry Pests GM pages (http://www.hungrypests.com/the-threat/asian-gypsy-moth.php and http://www.hungrypests.com/the-threat/european-gypsy-moth.php) and Don't Move Firewood GM pages (http://www.dontmovefirewood.org/gallery-of-pests/asian-gypsy-moth.html-0 and http://www.dontmovefirewood.org/gallery-of-pests/european-gypsy-moth.html).

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Japanese Beetle

Popillia japonica Newman

BACKGROUND

Japanese beetle (JB) (Coleoptera: Scarabaeidae) is an invasive insect that has an extensive plant host range. Plant damage is inflicted by both adult and immature life stages. Adult JB feeds on the foliage of many plant species, while the immature stage, larva (white grub), primarily feeds on the roots of turf grasses.

JB was first found in the U.S. in 1916 in a New Jersey nursery. It was likely introduced from Japan in shipments of ornamental plants. Since the 1970s, JB has been found throughout many western states, including Utah in 2006. An eradication program directed by the Utah Department of Agriculture and Food was successful in eliminating JB from Utah. Recent monitoring traps have detected extremely low adult activity (e.g., in 2015, two beetles were found in Salt Lake City).

Fig 1. Adult Japanese beetle.

IDENTIFICATION

Adults are about 1/4 inch wide and 1/2 inch long, oval shaped, and have a metallic green head and mid-section with copper-brown wing covers (Fig 1). They have five pairs of white hair tufts along the sides of the abdomen and another pair on the last abdominal segment (Fig 2). Their legs have prominent spines (Fig 3) and the underside of their body is metallic green and copper-brown.

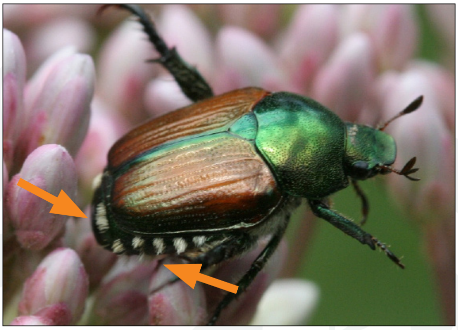

Fig 2. Arrows point to the 5 pairs of white tufts along the sides of the adult body and another pair on the last abdominal segment.

Fig 3. Arrow points to the prominent spines on the legs.

Eggs are about 1/16 inch in diameter, cylindrical when first deposited, but nearly round and 1/8 inch in diameter when mature (Fig 4).

Fig 4. Eggs.

Larvae, or "white grubs," are creamy white with a grayish-brown hind end. They have a yellow-brown head with dark mandibles (Fig 5), and range in size from 1/8 inch in length upon hatching to 1 inch at maturity. Larvae have three pairs of underdeveloped legs and long brown hairs dispersed with short, blunt spines on the body. Larvae form a "C" shape when at rest. Many scarab beetle larvae, such as May/June beetles and chafers, look just like JB larvae. Suspect larvae should be submitted to the UPPDL for screening.

Fig 5. Larva.

LIFE HISTORY

JB has one generation per year (Fig 6). Most of the JB life cycle is spent underground, only emerging as adults to feed, mate, and lay eggs during the summer.

Adults emerge from pupae in the soil during June and July, and feed on a wide range of crop, garden, and ornamental plants over a 6-8 week period. Mated females will fly to turf grass and burrow 2-3 inches underneath the soil to lay eggs. Each female can lay up to 60 individual eggs.

Larvae feed on plant roots in the spring, summer, and fall. Most larvae overwinter as 3rd instars and burrow at a soil depth of 2-6 inches to spend the winter. The following spring, they continue to feed, then pupate and emerge as adults. Pupation takes place in an earthen cell made by the final larval instar.

PLANT HOSTS

JB attacks over 300 species of ornamental and crop plants. Adults chew on the leaves, flowers, fruit, and in some cases, stems of plants. Preferred hosts of adult JB include rose, maple, elm, grape, apple, stone fruits (cherry, plum, peach), blackberry, raspberry, asparagus, bean, and corn.

JB larvae prefer fescues, perennial ryegrasses, Kentucky bluegrass, and bentgrass. The larvae also feed upon roots of young ornamental trees and shrubs, and garden crops such as corn, peas, beans, tomato, and onion.

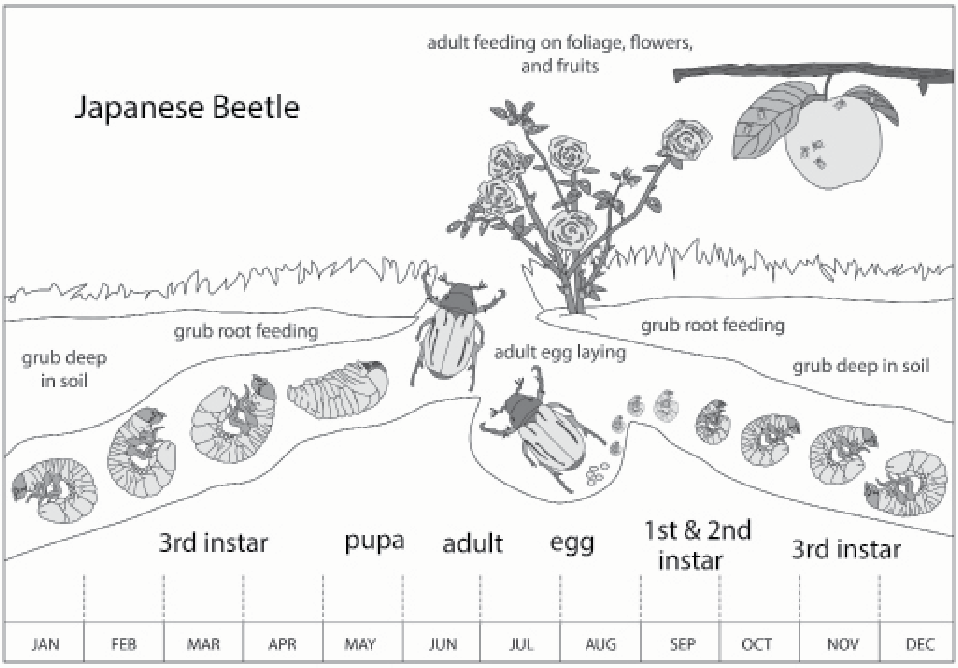

Fig 6. Life history of Japanese beetle. Adapted from drawings by J. Kalisch (University of Nebraska) and Joel Floyd (USDA-APHIS).

DAMAGE SYMPTOMS

Adults chew on the leaves, flowers, fruit, and in some cases, stems of plants. They are voracious feeders. Adults skeletonize leaves, chewing away softer tissue, and leaving the veins (Figs 7-8). They also chew holes in flower buds and petals, soft fruits, and corn silks (Fig 9-11). The adult beetles congregate (Fig 12) and can destroy crops in just a few days before moving on. They also wreak havoc on ornamental plants (Fig 13).

The larvae attack plants below ground and feed on the roots of grasses and some trees, shrubs, and vegetables. Large plantings of turf grasses (e.g., lawns and athletic fields) are especially attractive as egg-laying sites.

While damage to grasses is initially difficult to detect, it becomes apparent during late summer and early fall when grubs are large. The compromised grass roots are inefficient in uptake of water and nutrients, and eventually turn leaves and stems yellow and brown. Severely injured turf will die. Feeding damage appears as patches of dead and dying plants mixed with healthy, unaffected grass (Fig 14). Turf with damaged roots is easily pulled back from the soil surface to reveal the grubs underneath (Figs 15-16). The damaged turf will also feel spongy and soft under-foot.

Fig 7. Adults skeletonize leaves.

Fig 8. Skeletonized leaf.

Fig 9. Adults chew holes in plants, including flowers.

Fig 10. Damage.

Fig 11. Adults feeding on corn.

Fig 12. Adults mass together to feed.

Fig 15. Turf can be pulled back to reveal larvae.

Fig 13. Damage.

Fig 16. Larvae.

Fig 14. Larval feeding causes patches of discolored turf. Other animals damage turf even further as they search for grubs to eat.

MONITORING AT A GLANCE

Effective monitoring is critical for determining when, where, and what JB can feed on. The techniques described below are appropriate for both homeowners, commercial growers, and survey personnel.

Scout for adults in the summer by inspecting susceptible plants, such as rose, apple, stone fruits, basswood/linden, crabapple, asparagus, and birch. JB prefer warm, sunny conditions, so monitoring should be done during the day and on the sunny side of the plant. Adults begin to feed at the top of plants, moving downward as the leaves are consumed.

Collect soil and root samples from damaged turf where JB is suspected to occur (Fig 17). Begin monitoring for larvae in the spring. Pull apart the roots and soil to look for mature larvae.

Examine turf grass for feeding injury and larvae. Turf grass that has been fed upon will be yellow to brown, and dying or dead. Leaves and crowns of grass plants will pull away easily from the roots. Grubs may be visible in the soil underneath damaged sod.

Another clue to the presence of white grubs in sod is predator digging activity, such as from birds, skunks, badgers, and other grub-eating predators. Inspect disturbed areas of turf for damage and grubs.

Fig 17. A soil corer can be used to collect soil and root samples.

MANAGEMENT AT A GLANCE

Control of JB can be difficult, as adults and larvae often occur on different host plants. Additionally, adults are highly mobile and can easily infest new areas.

Keep plants healthy by following a recommended irrigation and fertilization schedules. Include a mix of plants that adult beetles avoid such as lilac, forsythia, dogwood, magnolia, and American holly to discourage adult aggregations on ornamentals.

Mass-trapping can be an effective way to reduce small and localized populations of JB. For best effect, place the traps near attractive plants of lower value (Fig 18). For example, an old or over-grown planting of roses will be highly attractive to JB, but can be "sacrificed" as a mass-trapping location.

Fig 18. Trap for detecting JB.

Removing JB by hand can be an effective method for small-scale, localized population reduction. Beetles can be easily removed by shaking plants or plant parts over a container filled with water and a few drops of dish soap. Dish soap helps facilitate the capture of the beetles by breaking the water tension, allowing beetles to sink into the water and drown rather than escape. Adults can also be hand-picked from small plants.

Conservation and encouragement of beneficial insect populations in landscapes, gardens, and agricultural fields can help suppress pest insects, including JB. Ants and ground beetles are common predators of JB grubs. Avoid the use of broad-spectrum insecticides, and grow diverse flowering plants to provide nectar and pollen food resources to enhance populations of beneficial insects and natural enemies.

SIMILAR INSECTS

False Japanese Beetle (*Strigoderma arbicola*)

False Japanese beetles, also called sandhill chafers, rarely cause economic damage to crops. They are very similar to JB in size and body shape. The false JB, however, has wing covers that are dull in color compared to the shiny/metallic bronze wings covers of the true JB (Fig 19). The true JB has five distinct white tufts of hair along both sides of the abdomen, and one tuft on the hind end (Fig 2). The white tufts of hair on the false JB, however, blend into one another and are therefore not as distinct.

Fig 19. False Japanese beetle.

Hairy Bear Beetle (*Paracotalpa granicollis*)

Hairy bear beetles are also known as “little bear” beetles and feed on tree buds, blossoms, and leaves. They look very similar to JB, but can be distinguished by the prominent fuzz on their abdomen (Fig 20).

Fig 20. Hairy bear beetle.

Bumble Flower Beetle (*Euphora inda*)

Bumble flower beetles are not considered pests of great concern. Adults feed on overripe, damaged, or dying fruit and vegetation. Larvae feed on dead and decaying plant matter. Adults are furry with yellowish brown hairs on the front of their backs and bellies, and have mottled gray and brown wing covers (Fig 21). They are about the size of a nickel (about 3/4 inch in diameter). The common name of this beetle originated because adults often fly close to the ground and emit a loud buzzing sound similar to that of a bumble bee.

Fig 21. Bumble flower beetle.

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EXTENSION

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