Insect Update
207 Credit – Ornamental Insects

Whitney Cranshaw
Colorado State University
A native insect acting badly

Gambel oak borer

*Agrilus quercicola*

Photograph by David Leatherman
Gambel oak borer is in the same genus (*Agrilus*) as many of the flatheaded borers one can find in shade trees (e.g., bronze birch borer, honeylocust borer, emerald ash borer)
The adult emerges from a **D-shaped exit hole**, as do other metallic wood borers.
A native insect acting badly

Gambel Oak Borer

This insect is native to Gambel oak but had never been reported to cause injury.

Populations exploded during the 2001-2003 drought years.

In 2003 a massive flight of adult insects colonized and killed red oak trees that were at least 30 miles away.
Large plantings of red oaks killed by Gambel oak borer in 2003.
Gambel oak borer – Postscript

Return of rains in 2003 brought outbreak to an end
The 2003 outbreak in the Denver metro area was thought to be a “one of” event. With the return of rains and end of drought the problem disappeared by 2004.
Gambel oak borer – Postscript

Reemerged since 2017 as a pest of English oak
Several reports of declining English oak, associated with a flatheaded borer, were first received in 2017. It proved to be Gambel oak borer.

Reports since then extend Gambel oak borer damage to English oak as far as Jefferson and Boulder counties.
Will Gambel oak borer develop as a persistent pest of English oak?
Gambel Oak Borer In English Oak

- Cultural Controls
  - Provide adequate watering to plants
- Biological Controls
- Insecticidal Controls
Gambel Oak Borer In English Oak

• Cultural Controls
  – Provide adequate watering to plants

• Biological Controls

• Insecticidal Controls

*Phasgonophora sulcatus* – a wasp that kills the larvae of Gambel oak borer (and other borers)

Note: The wasp emerges from a round exit hole
Metallic wood borers emerge from D-shaped exit holes; a natural enemy (parasitoid wasp) comes out of a round hole.
Gambel Oak Borer In English Oak

**Insecticidal Controls**
- Preventive sprays of permethrin, bifenthrin
  - In place before egg laying (mid June)
- Trunk sprays of dinotefuran
  - June
- Imidacloprid soil drench/injection
  - Applied shortly before adults emerge (late May)
Emerald ash borer
*Agrilus planipennis*

Order Coleoptera (beetles)
Family Buprestidae (metallic wood borers, flatheaded borers)

Photograph by David Cappaert
Photograph by Debbie Miller
Sixth Anniversary!
Emerald Ash Borer in Colorado
Colorado EAB Tree #1

Located near the intersection of 30th and Valmont, Boulder

September 23, 2013
Area of original EAB infestation in Colorado
Areas known to be infested with emerald ash borer in Boulder (original site of Colorado establishment)
Reported emerald ash borer distribution in Colorado – five years after Day Zero

- Original Boulder EAB infestation
- 2016 detection of EAB in Longmont
- 2017 detection in Gunbarrel
- 2017 detection of EAB in Lafayette
- 2018 detection in Lyons
- 2018 detection Superior
Sixth Anniversary!
Emerald Ash Borer in Colorado
Reported emerald ash borer distribution in Colorado – Today

Original Boulder EAB infestation

2019 Detection SW of Berthoud

2019 detection Broomfield

2019 detection Westminster (Adams County)
This is the map you can find of EAB distribution on the Colorado Department of Agriculture (CDA) Web Site.

The newest findings are outside Boulder County, which has been an EAB quarantine zone since 2013.
How will EAB spread once established?

- Wind-blown dispersal of adults
  - Peak period of adult dispersal is late May through late July
- Butt-heads that move wood containing developing stages
EAB likely will emerge sometime in mid-late May.

Most eggs will be laid in June, egg laying will continue through summer.
Wind Direction from Boulder (with wind speed correction) May-August 2013-2015
Reported emerald ash borer distribution in Colorado – Today

- 2018 detection Lyons
- 2018 detection Superior
- Original Boulder EAB infestation
- 2019 detection Broomfield
- 2019 Detection SW of Berthoud
- 2019 detection Westminster (Adams County)
Wind Direction from Boulder
(with wind speed correction)
May-August 2013-2015
How far away is emerald ash borer from your community?
How far away is emerald ash borer from your community?

One truckload
Detecting Emerald Ash Borer
A Guide for Diagnosing EAB in Colorado

Diagnosing Emerald Ash Borer and Other Ash Tree Damage: A Diagnostic Field Guide

The Colorado Emerald Ash Borer Response Team

Compiled by Micaela Truslove
Recognizing Wood Boring Insects of Ash Trees in Colorado

Fact Sheet No. 5.620

by W.S. Cranshaw*

Ash is one of the most widely planted trees in Colorado, with most plantings involving various cultivars of green ash (Fraxinus pennsylvanica) or white ash (F. americana). Several insects are associated with these plants, including leafcurling aphids, various caterpillars and sawflies that chew the leaves, and wood borers and bark beetles that develop within the trunk and limbs of the tree.

Quick Facts

• Being able to recognize the wood boring insects found in a tree is essential when making informed decisions on the need for control.
• In most of Colorado, the most
Emerald Ash Borer and Colorado Insects of Similar Appearance

Adults of the emerald ash borer (Agrilus planipennis) have an elongate, rather bullet-form body, typical of most beetles in the metallic wood borer/flatheaded borer family Buprestidae. Emerald ash borer is about 9-13 mm in length, large for members of the genus Agrilus, but mid-sized for most other members of this insect family.

Perhaps the most conspicuous feature is that the emerald ash borer has uniformly green bright, metallic wing covers, sometimes with slight purplish hues. The thorax may be more metallic brown and underneath the wing covers the abdomen is purple. Adults are active between late May to mid-August and almost always they would be found on the leaves or bark of an ash tree.
Many metallic colored beetles occur in Colorado that may be mistaken for emerald ash borer.
If EAB is suspected to be present in a new area, **the specimen must be submitted to the Colorado Department of Agriculture**. There is a formal process of confirming the identification that must be followed before there is any release of public information on the finding.
Effects of larval tunneling are cumulative, and ultimately lethal to the tree. Insecticides can interrupt the progress and even allow recovery, if damage is not too far advanced.
Recovery is possible with some insecticides (emamectin benzoate) if EAB-induced canopy thinning has not progressed beyond 30 percent. Photos from Michigan State University.
In the Boulder EAB trials, started in 2014, EAB canopy thinning has not yet hit 30 percent in the untreated checks.

Note: Most trees at this site have been treated for EAB; herd immunity effects are present.
Pigeon Tremex
*Tremex columba*

A wood boring wasp that develops in dying, near-dead hardwoods (maples, elms, ash)
Pigeon tremex is a type of insect known as a **horntail**.

Females have a spike on the end of the abdomen which houses the **ovipositor**.

Photographs courtesy of David Shetlar, The University of Ohio
Females insert eggs into trees using their ovipositor. They select trees that are in end stage decline and of low moisture content.

A fungus, a type of white rot, is injected into the tree along with the egg.
Sometimes dead females can be found still stuck in the tree.
Larva in wood

Adults emerge from perfectly round exit holes in early-mid summer
The most spectacular natural enemy of the pigeon tremex is the giant ichneumon wasp.
Giant Ichneumon Wasp

*Megarhyssa macrurus*

Parasitoid of the pigeon *tremex* larva
A photo from a Denver MG, Linda Coyle, I got last year

A photo from an Arapahoe County MG, Mark Overland, received this year
The female giant ichneumon wasp can detect the presence of a developing pigeon tremex larva – and drills to it with her ovipositor.

Photographs courtesy of Mark McMillan
Two large and bizarre looking insects are commonly associated with dying branches and trunks of several commonly grown hardwood trees. One of these is an insect that develops as a borer within the tree – the **pigeon tremex horntail** (*Tremex columba*). The other is the most common natural enemy of this insect, the **giant ichneumon wasp** (*Megarhyssa macrurus*).
Japanese beetle
*Popillia japonica*

Coleoptera: Scarabaeidae

First U.S. detection – **1916** near Riverton, New Jersey

The Spread of Japanese Beetle in North America, 1908-1998
Japanese beetle adults chew on leaves and flowers of many plants. Japanese beetle damages plants in two distinct ways.
Japanese beetle larvae (grubs) – among the most damaging turfgrass insects in the US.

Japanese beetle affects yard/garden plants in two distinct ways.
Question: Does control of larvae in a yard affect the number of adults in a yard?

Answer: Very likely, NO
Some Highly Mobile Insects

- Corn earworm (adults)
- Grasshoppers
- Japanese beetle (adults)
- Crucifer flea beetles
- Potato/tomato psyllid
Adult beetles feed on both flowers and leaves of many ornamental plants as well as garden vegetables and herbs.
Skeletonizing injuries produced by Japanese beetle adults feeding on leaves
Flowers are often a favored plant part targeted by adult Japanese beetles.
Overlap of adult feeding on flowers – and use of those flowers by pollinators

Issue of unusually important concern with Japanese beetle
Uber-host Plants Favored by Japanese Beetle Adults in CO

- Roses (most)**
- Linden (most)*
- Virginia creeper*
- Silver lace**
Other Plants Commonly Grown in CO that are Highly Favored by Japanese Beetle

Ornamentals
- Hollyhock*
- Gaura**
- Rose-of-Sharon**
- Crabapple
- Canna lily**
- Japanese maple
- Peking cotoneaster

Food Crops
- Beans (green, edamame)
- Basil
- Raspberry*
- Grape

* JB populations overlap with flowering
** JB populations overlap >alot< with flowering
The curious phenomenon of geranium toxicity to Japanese beetle
Geranium Toxicity to Japanese Beetle

• Beetles become paralyzed within a couple of hours after feeding on flowers of zonal geraniums
  – Often recover in lab, rarely outdoors

• Toxin is present in flowers, but not leaves
Recommendations for Japanese Beetle Adult Control

• Physical/Cultural Controls
  – Traps
  – Hand Picking

• Chemical Controls
Japanese beetle controls

Hand Picking
Primary benefit from handpicking

Reduction in volatile attractants produced by plant wounding
Handpicking may be more effective for infestations on foliage versus flowers.

Some flowers (e.g., rose) can produce high levels of volatile attractants - without wounding - and may possess attractive colors.
Can time of day when you hand pick have effects for JB management?

Possibly yes. It may be more effective to *handpick in the evening* than at other times of the day for reducing numbers of beetles on the plants.
Japanese beetle traps are excellent for detecting presence of the insect in an area.
Japanese beetle traps are minimally useful - at best - for control of existing Japanese beetle infestations!
If you insist on using a Japanese beetle trap

- Do not place them anywhere near (at least 30 feet away from) any plant on which Japanese beetles feed
- Avoid placing them in a site where they are likely to draw beetles from long distances
If you insist on using a Japanese beetle trap

• Do not place them anywhere near (at least 30 feet away from) any plant on which Japanese beetles feed
• Avoid placing them in a site where they are likely to draw beetles from long distances

....and preferably give the trap to your neighbor!
Do you have >alot< of Japanese beetles in your trap??

There are about 836 Japanese beetles per cup.
Citronella candles attracting Japanese beetle to a final end

Photographs courtesy of JoAnne Henson!
Chemical Controls Most Effective for Control of Japanese Beetle Adults

- Most pyrethroids (e.g., cyfluthrin, permethrin, bifenthrin)
- Carbaryl
- Acetamiprid
- Imidacloprid
- Chlorantraniliprole

Do not treat plants with flowers in bloom!
Overlap of adult feeding on flowers – *and use of those flowers by pollinators*

*Never apply persistent insecticides to plants that are in flower and attractive to pollinators!!*
Chemical Controls Most Effective for Control of Japanese Beetle Adults

- Most pyrethroids (e.g., cyfluthrin, permethrin, bifenthrin)
- Carbaryl
- Imidacloprid
- Acetamiprid
- Chlorantraniliprole
  - Acelepryn

*Do not treat plants with flowers in bloom!*
Pollinator hazard warning statement regarding use of Tristar 8.5 SL (acetamiprid)

This type of warning statement allows use of this product on a plant in flower <strong>only during times of day when pollinators are not visiting the plant</strong>
Labeled for use on turfgrass and landscape ornamentals

Environmental hazards statements do include warnings for aquatic organisms.

They do not have any pollinator warning statements
Btg - *Bacillus thuringiensis* var. *galleriae*

Sold as **beetleGONE!** in commercial/ag markets

Sold as **beetleJUS** in gardener market

 зрелый контроль

Btg-susceptible Insects

*Weevils*  
*Scarab Beetles*
**Bacillus thuringiensis** (Bt)

- Derived from a widely distributed soil bacterium
- Active ingredient a toxic protein crystal that destroys cells of the midgut
- Used as a stomach poison
- Several different strains – each effective against different insects
Several Bt strains are present, each with specific activity

Caterpillars – kurstaki, *aizawi* strains
Leaf beetles – *tenebrionis* strain
Gnat, mosquito larvae – *israelensis* strain
Treated Foliage Consumed
Feeding Inhibition (1 Hour)

- Toxin Crystals Dissolve in Gut.
- Larvae Stop Feeding.
- Growth Stops.
Death (2–5 Days)

- Starvation
- Gut Disruption
New biological control for Japanese beetle - and other grubs?

*Bacillus thuringiensis var. galleriae*

Sold as *beetleGONE!* in commercial/ag markets

Sold as *beetleJUS* in gardener market
beetleJUS treated

Water check
Provides **good reduction in feeding** injury by Japanese beetle

Provides **fair mortality** of Japanese beetles and mortality is slow

Persistence of effects probably a few days
None. You can apply this product to plants in bloom when bees are visiting.
After application:

Are they dead? *(probably not)*

Are they still feeding? *(probably not)*
Japanese Beetle Biological Control Program
Natural Enemies of Japanese Beetle Exist Elsewhere in the US

- *Paenibacillus popilliae* (Milky spore)
  - Bacterium
- *Istocheta aldrichii*
  - Tachinid fly
- *Tiphiia species*
  - Parasitic wasps
- *Ovavesicula popilliae*
  - Microsporidium (fungus)

* Species involved in Colorado Japanese Beetle Biological Control Program
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

*Tiphia vernalis* (Spring *Tiphia*) – parasitoid was of late stage Japanese beetle grubs

Photograph by David Shetlar, The Ohio State University
Adults of the Spring Tiphia emerge in May. The adults feed on nectar and honeydew.

The availability of nearby sources of nectar and honeydew is important in the success of this insect as a biological control of Japanese beetle.
Dan Potter, University of Kentucky, spraying sugar water on foliage to attract spring tiphia for collection.

A source of spring tiphia was developed in 2019, near Lexington, Kentucky.
The 2019 wasps were released at a golf course site in Boulder. This site was chosen since it had high numbers of grubs and nearby sources of nectar and honeydew.
Female wasps dig into the soil to locate Japanese beetle grubs that are nearly full-grown. They then lay an egg on the grub.

The developing larva of the wasp feeds on and kills the grub.

It then pupates. The adult emerges next spring.
Status of *Tiphia vernalis* Releases

- **Boulder**
  - 1 Release Site (2019)

- **Littleton (CDA)**
  - 1 Release Site (2018, 2019)
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

*Istocheta aldrichi* – tachinid fly parasitoid of Japanese beetle adults
*Istocheta aldrichii* requires accessible nectar/pollen resources when the adults are active – late June-July
*Istocheta aldrichii* ("winsome fly") lays eggs on adult Japanese beetles in July.
The egg(s) hatches and the larva of the fly enters the beetle. Ultimately the beetle is killed. The larva then migrates out of the beetle and moves into the soil where it pupates. The adult emerges the following year.
Status of *Istocheta aldrichii* Releases

- **Boulder**
  - 1 Release Site (2019)

- **Pueblo**
  - 1 Release Site (2018)

- **Denver/Littleton**
  - 2 Release Sites (2018)
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

*Ovavesicula popilliae* – a microsporidian (fungal) disease of Japanese beetle larvae

Main observed effects from infection – reduced fecundity, reduced winter survival
The **Malpighian tubules** of insects filter wastes from the blood, functioning somewhat like what the kidney does in humans.
Heavy *O. popilliae* infection of Malpighian tubules of Japanese beetle

Source: David Smitley, Michigan State University
Status of *Ovavesicula popillae* Releases

- **Boulder**
  - 1 Release Site, 2015)
  - Confirmed established
- **Pueblo**
  - 3 Release Sites (2015, 2018)
- **Denver/West Arapahoe Counties**
  - 6 Release Sites (2018)
If the Japanese Beetle Biological Control Project works, what would be considered success?

In 10-15 years there would only be three Japanese beetles on your rose, instead of ten.
Miscellaneous topics until I run out of time

• Rose midge
• Hawthorn mealybug
• Two gall wasps on bur oak
A trial to find a rose midge control product
Rose Midge
*Dasineura rhodophaga*
Diptera: Cecidomyiidae

A tiny fly that damages the developing flower buds of rose
The adult midge lays eggs on developing shoots, flower buds

Jim Baker, North Carolina State University

Rose midge larvae are tiny cream colored maggots that slash the buds as they feed

© Robin Rosetta, Oregon State University

David Shetlar photo
This results in a variety of symptoms that produce destruction or distortion of developing flower buds.
A site was identified in 2019 for a trial to determine if any of the newer insecticides available to a rose grower might be effective for control of rose midge.

Dave Ingram of the Denver Rose Society was partnered on this project.
The products chosen had to be available for retail sale, have high safety to bees, and were known to be effective against some kinds of other fly/midge pests.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. Damaged Terminals/Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinosad</td>
<td>0.85</td>
</tr>
<tr>
<td>Acetamiprid</td>
<td>0.85</td>
</tr>
<tr>
<td>Untreated Check</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Bottom Line: Both treatments tested provided about 70 percent control
Hawthorn Mealybug

Phenococcus dearnessi
A range of resistance appears to exist among hawthorn species.

- **Highly Susceptible**
  - English hawthorn
  - Arnold hawthorn
  - Thornless cockspur
- **Less Susceptible**
  - Snowbird hawthorn
  - Russian hawthorn
  - Macracantha hawthorn
- **Apparentely Resistant**
  - Cordata Washington
Today, hawthorn mealybug is spending the winter on cracks of the bark.

It is very small, an immature stage. Whitish wax indicates where the insects have aggregated.
Soon they will resume activity. Looking closely you may sometimes see a male (they are winged).
By early May the overwintered females migrate to the twigs.

Many settle near the base of the emergent buds.
These ones settled, and developed, underneath some flagging tape on the branch.
During May the females swell with eggs.
Hawthorn mealybug secretes a lot of honeydew

Honeydew on leaves

Sooty mold on bark
Crawlers migrate to the leaves and feed there for a couple of months.
In midsummer the mealybugs move from the leaves and settle in crevices on older wood and the trunk.

They remain in these sites, dormant, until the following spring.
No. Hawthorn is an early season flowering plant that is heavily used by honey bees for nectar and pollen.
Pyriproxifen as a mealybug treatment

- Trade names: Distance, Fulcrum, Endeavor
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects (like mealybugs)
- Very little effect on natural enemies of insect pests
- Compatible with pollinators
Pyriproxifen as a mealybug treatment

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Dormant Oils?

Target the overwintering stages on the trunk/larger branches.

Pyriproxifen applications with/without oils should also be very effective at this time.
Gall Wasps
Hymenoptera: Cynipidae
Most gall wasps on oak have two generations that produce two different types of galls.

- *Disholcaspus quercusmamma*
- *Callirhytis flavipes*
Oak rough bullet gall wasp
Old Story

Adults emerge from galls in mid-October to mid-November and lay eggs in buds......

This is an all-female generation
The eggs from this hatch in spring to produce a generation within a budgall
A spring stage gall is produced. Adults from this lay eggs in the growing stems of branches.

Spring stage adults are much smaller than those observed in fall.

Spring stages consist of both males and females.
A spring stage gall is produced. Adults from this lay eggs in the growing stems of branches. Spring stage adults lay eggs in the emergent twig growth.
New galls begin to erupt in late spring/early summer. They become full-sized by late summer.
These galls exude honeydew
The honeydew on the galls attracts many kinds of insects.
Oak rough bulletgalls produce a sweet exudate that is attractive wasps.
Stunting produced by oak rough bulletgall wasp

There is a wide range in susceptibility to this insect. Some trees are highly susceptible, some highly resistant, many somewhat in between.
A Collage Made of Galls from Oak Twigs

Artist: Crystal Cooke
Oak rough bulletgall wasps eaten by woodpeckers
An interesting gall wasp-woodpecker interaction on bur oak
The gall wasp *Callirhytis flavipes* develops under the bark of twigs, branches, and the trunks of oak.
They are small and develop within small chambers. There are dozens of these chambers in the above photo.
Downy woodpeckers work the bark and extract the developing gall wasp larvae in winter and early spring.
This can result in extensive debarking of trunks, branches
This can lead to dieback of limbs and the upper trunk
After this gall wasp emerges from the trunks/branches, it moves to new leaves. The summer generation develops within an irregularly shaped gall of the midrib.
One group of gall makers that is never well controlled with insecticides

Gall wasps on woody parts of the plant
Go to Sign-out for your Credits!