A Review of Some Insect Issues on Woody Plants

Whitney Cranshaw
Colorado State University

AMTOPP Conference
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Flatheaded Borers/Metallic Wood Borers

Coleoptera: Buprestidae
Flatheaded Borer
Metallic Wood Borer
Adult form of a flatheaded borer
Bronze birch borer
*Agrilus anxius*
The full-grown flatheaded borer makes a small chamber under the bark. This is form that survives winter.

In spring the insect transforms to the pupal stage. This is the transition stage to the adult.
Adults chew their way through the bark, creating a D-shaped exit hole that is in the shape of their body.
The adult bronze birch borer is a type of metallic wood borer. After it emerges, the adult feeds on birch leaves for about 10-14 days. During this time, mating occurs and the female matures eggs.
Females lay eggs in cracks/crevices on the bark. About a week later the eggs hatch.

Likely most eggs in Montana would be laid from midJune through midJuly.
The immature stage (larva) of the bronze birch borer is a type of flatheaded borer.
The meandering tunneling by the flatheaded borer damages the cambium
Trees can try to recover from these wounds by producing callus tissue.
The ability of a tree to be able to overgrow wounds with callus tissue is related to the vigor of the tree.

As defenses are depleted, ability to resist borer attacks, and to compensate for injuries, declines.
Thinning of the crown is a common symptom of flatheaded borer infestation.

This is the result of the cumulative effects from the larval tunneling.
Affected birch trees may see progressive thinning of the canopy, branch dieback, and ultimately death of the tree.
Bronze Birch Borer Management

• Biological Controls
• Cultural Controls
  – Use resistant species/cultivars
  – Mulching, provision of even moisture
• Chemical Controls
  – Preventive trunk sprays
  – Systemic insecticides
Adults chew their way through the bark, creating a D-shaped exit hole that is in the shape of their body.
Bronze birch borers emerge from D-shaped exit holes; a natural enemy (parasitoid wasp) comes out of a round hole.
Bronze birch borer has a range of aggressiveness, related to birch species

- **Highly Susceptible**
  - European white birch
  - Jacquemonti birch

- **Moderately Susceptible**
  - Paper birch
  - Yellow birch
  - Whitespire birch

- **Very Low Susceptibility**
  - River/Red birch
Mulching a large area around the birch tree (more than shown on left) can reduce stresses by providing more even moisture to the roots. This increases tree vigor – and ability of the tree to resist bronze birch borer injury.
Preventive insecticide sprays are standard for many types of wood borer (and bark beetles)
Key Timing Point in Wood Borer Prevention

Target exposed life stages (Adults/Hatching Eggs)

Flatheaded borer egg on bark

Clearwing borer eggs on bark
Active Ingredients of Wood Borer Insecticides (Trunk Sprays)

- Permethrin (Astro, Permethrin, etc.)
- Bifenthrin (Onyx)
Permethrin

• Pyrethroid insecticide

• Use rates
  – *Borers that are moths*
    • 1-2 qts/100 gal
  – *Borers that are beetles*
    • 2-5 qts/100 gal

• Maximum use rate 2 lbs a.i./acre
  – Equal to 100 gallons at 2.5 gal product/100 gal rate
Bifenthrin

• Pyrethroid insecticide

• Use rates
  – *Borers that are moths*
    • 6.4 fl oz/100 gal
  – *Borers that are beetles*
    • 12.8 fl oz/100 gal

• Maximum use rate 12.8 fl oz/acre
Key Timing Point in Wood Borer Prevention

Target exposed life stages
(Adults/Hatching Eggs)

Flatheaded borer egg on bark

Clearwing borer eggs on bark
Periods when adult borers are present, which is when eggs are laid, can be generally estimated.

<table>
<thead>
<tr>
<th>Table 2. Flight periods and host plants of common wood borers in Colorado</th>
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</thead>
<tbody>
<tr>
<td><strong>Common Name (if any), Scientific Name</strong></td>
</tr>
<tr>
<td><strong>METALLIC WOOD BORERS</strong> (Coleoptera: Buprestidae)</td>
</tr>
<tr>
<td>Flatheaded appletree borer - <em>Chrysobothris femorata</em></td>
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<tr>
<td><em>Chrysobothris texana</em></td>
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<tr>
<td>Emerald ash borer - <em>Agrilus planipennis</em></td>
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<tr>
<td>Bronze birch borer - <em>Agrilus anxius</em></td>
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<tr>
<td>Honeylocust borer - <em>Agrilus difficile</em></td>
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<tr>
<td>Bronze poplar borer - <em>Agrilus ligaros</em></td>
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<td>Bronze cane borer - <em>Agrilus cuprecens</em></td>
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<tr>
<td>Gambel oak borer - <em>Agrilus quercicola</em></td>
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<tr>
<td><strong>LONGHORNED BEETLES</strong> (Coleoptera: Cerambycidae)</td>
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<tr>
<td><em>Cottonwood borer</em> - <em>Plectodera scalator</em></td>
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<td><em>Locust borer</em> - <em>Megacyllene robiniae</em></td>
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<tr>
<td>Poplar borer - <em>Saperda calcarata</em></td>
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<tr>
<td>Redheaded ash borer - <em>Neoclytus acuminatus</em></td>
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<tr>
<td>Pine sawyers - <em>Monochamus</em> species</td>
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<tr>
<td>Blackhorned pine borer - <em>Callidium antennatum</em></td>
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<tr>
<td><strong>WEEVILS</strong> (Coleoptera: Curculionidae)</td>
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<tr>
<td>Poplar and willow borer - <em>Cryptorrhynchus lapathi</em></td>
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<tr>
<td><strong>CLEARWING BORERS</strong> (Lepidoptera: Sesiidae)</td>
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<tr>
<td>Lilac/ash borer - <em>Podosia syringae</em></td>
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<tr>
<td>Cottonwood crown borer - <em>Sesia tibialis</em></td>
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<tr>
<td>Peachtree borer - <em>Synanthedon obliqua</em></td>
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<tr>
<td>Currant borer - <em>Synanthedon tipuliformes</em></td>
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<tr>
<td>Viburnum borer - <em>Synanthedon viburni</em></td>
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</tbody>
</table>
For most borers flight periods can be estimated.

This publication can be seen at the Silent Auction.
Systemic insecticides for wood borers?
Imidacloprid for Borers?

Yes.....but
Imidacloprid will not work well on borers that are the larval stage of moths.
Imidacloprid will not work well if the borer spends much of its life in the heartwood of the plant.
Imidacloprid soil drenches *may work well* against flatheaded borer larvae (aka metallic wood borers)
For prevention of damage by most wood boring insects persistent insecticides are applied as sprays to the trunk and limbs to kill wood borers before they enter the tree.

To control flatheaded borers systemic insecticides can be used, usually applied either to the roots or injected into the lower trunk.
Emerald Ash Borer Control Options

- Soil applications with systemic insecticides
  - imidacloroprid, dinotefuran
- Non-invasive trunk sprays of systemic insecticides
  - dinotefuran
- Trunk injections of systemic insecticides
  - emamectin benzoate
  - azadirachtin
Target Life Stages for flatheaded borers using systemic insecticides

Adults as they feed on foliage

Young larvae that tunnel in the phloem and cambium
Primary method of imidacloprid application – soil applications for root uptake
Applying systemic insecticides to the soil of trees

Soil drench

Photograph courtesy of David Cappaert

Soil injection
Soil Injection Patterns

A circle of 40-ft diameter (i.e., 40-ft canopy spread) covers 1250 sq ft.

Circular Pattern

Injections are made at each "X" spaced apart every 2.5-feet. Rings are also spaced apart by 2.5-feet.

Bird's eye views from above the tree looking through the canopy to the ground. The dark spot represents the trunk, while the irregular grey line represents the border of the canopy (the drip line).
The area around the base of a tree has many feeder roots that can allow good uptake of a soil applied systemic insecticide.
Imidacloprid Soil Drenches for EAB Control

- Best applied in spring shortly after bud break (after flowering)
  - Fall applications are inefficient, waste chemical and provide reduced control
Imidacloprid Soil Drenches for EAB Control

- Best applied in spring shortly after bud break (after flowering)
- **Insecticide mixed with water and drenched around the base of the tree**
  - Rates of use vary with tree size
  - Do not apply if there are flowering plants at the base of the tree!
Soil applications of systemic insecticides *should not be made* if there are flowering plants at the application site.
Modifying DBH-based rates by tree size

With imidacloprid large trees (>15 inch DBH) require a doubling of the rate per inch DBH.
Use rates vary by tree size.

For large trees, over 15-inch diameter, rates need to be doubled.

Over-the-Counter imidacloprid formulations do not have labels that allow the higher rate.
Imidacloprid Soil Drenches for EAB Control

- Best applied in spring shortly after bud break (after flowering)
- Insecticide mixed with water and drenched around the base of the tree
- **The site must be watered after application**
  - The soil must be kept moist for the roots to pick up the insecticide and move it

Water moves the insecticide into the roots and allow transport through the tree
Imidacloprid Soil Drenches for EAB Control

- Best applied in spring shortly after bud break (after flowering)
- Insecticide mixed with water and drenched around the base of the tree
- The site must be watered after application
- Expect it to take 2, probably 3 weeks to be present in sufficient quantity in plant tissues to kill the insect
Target Life Stages for flatheaded borers using systemic insecticides

Adults as they feed on foliage

Young larvae that tunnel in the phloem and cambium
Adult bronze birch borers are likely starting to feed on birch leaves in early June (Target #1).

Most young larvae will likely be present in trees in late June-July (Target #2).
Basal trunk spray with dinotefuran (Safari, Zylam, Transtect)
Dinotefuran Trunk Sprays for EAB Control

• Best applied in spring about time adults first begin to emerge

• Insecticide mixed with water and sprayed on trunk
  – Insecticide can move into tree directly through thin areas of the bark

• Uptake more rapid than with imidacloroprid
  – Week? Uptake dependent on respiration of the tree
Relative Water Solubility of Neonicotinoids:

Water Solubility (Active Ingredient)

Milligrams A.I./liter

327 500 2950 4100 39830

0 10000 20000 30000 40000

Clothianidin Imidacloprid Acetamiprid Thiamethoxam Dinotefuran

Information sources
Clothianidin (Celero), Acetamiprid (Tristar), Dinotefuran (Safari) – EPA Pesticide Fact Sheet
Imidacloprid (Marathon), hiamethoxam (Flagship) – MSDS for Products

Slide information courtesy J. Chamberlin
Water Solubility

There is a wide range of water solubility among the neonictinoids. Dinotefuran is highly water soluble.
$K_{oc}$ Values of Neonicotinoids:

- Clothianidin: 440
- Imidacloprid: 267
- Acetamiprid: 245
- Thiamethoxam: 26

Source Data: EPA Pesticide Fact Sheets
There is a wide range of Koc values (measure of adsorption to organic matter) among the neonicotinoids. This affects mobility within plants. **Dinotefuran** has a much lower Koc value than do other neonicotinoids
Involved use of dinotefuran, applied shortly before bloom. Treatment timing produced high residues during bloom.
Trunk injection with emamectin benzoate
Trunk injection with azadirachtin (TreeAzin, Azasol, AzaGuard, etc.)
Trunk Injections

Probably not great on thin-barked trees such as birch

This is a standard treatment for emerald ash borer
Some common *Agrilus* species metallic wood borers

- Bronze cane borer/Rose stem girdler
- Bronze birch borer
- Honeylocust borer
- Honeysuckle borer
A flatheaded borer that is minimally aggressive

**Honeylocust borer**

*Agrilus difficilis*

Attacks are almost always limited to areas of the tree killed by sunscald, wounds or damaged by fungal cankers.
In established trees, honeylocust borer is almost never found except in areas of the tree that has been damaged or infected by fungal cankers.

Newly transplanted trees may be successfully invaded by honeylocust borer.

Photograph courtesy of Utah State University.
Emerald ash borer
_Agrilus planipennis_

An insect that defines a highly aggressive wood borer

Photograph by Debbie Miller

Photograph by David Cappaert
How does Emerald Ash Borer compare to the borer we already have in ash - Lilac/Ash Borer?

Lilac/ash borer, a clearwing borer moth

Emerald ash borer, a metallic wood borer/flatheaded borer
Emerald ash borer

* Agrilus plannipennis *

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

Photograph by David Cappaert
Lilac/Ash Borer
*Podosesia syringae*

Order: Lepidoptera *(Moths and butterflies)*
Family: Sesiidae *(Clearwing borers)*

Lilac/ash borer (*Podosesia syringae*) is a common wood borer associated with ash throughout Colorado and a species that is native to North America. Damage is caused by the larvae which tunnel into the trunks and lower branches of ash trees. These feeding injuries produce irregular gouging wounds under the bark and tunneling frequently extends deeply into the heartwood.
Emerald ash borer larvae create meandering tunnels in the cambium that produce girdling wounds.

*Note:* Attacks can occur throughout the crown and on the trunk of the tree.

Photograph by Eric Day
Lilac/ash borer larvae create irregular gouging wounds that extend often into the heartwood.

Attacks are concentrated at the lower trunk of the tree.
EAB adults chew through the bark, producing D-shaped exit holes.
Chewing of the exit hole is done by the larva of the lilac/ash borer – the adult stage cannot chew.
Lilac/ash borer emerges from irregularly round holes. The pupal skin is pulled out when the adult emerges.
After emergence, emerald ash borer adults feed on ash foliage for a couple of weeks, and eggs mature.
EAB likely will emerge sometime in midMay.

Most all eggs will be laid in June and into early July.
Adults of the lilac/ash borer are present in mid-late spring. Most eggs are generally laid in May through early June.

Adult stages of the lilac ash borer do not feed on any parts of the ash tree.

Male flying to a pheromone trap
Eggs of both species are laid on the bark of the host tree.
Damage potential to its host

10 – EAB now defines an aggressive tree killing insect in North America.
Damage potential to its host

2, maybe 3 – Lilac/ash borer has far lower ability to seriously damage its host
Effects of larval tunneling are cumulative, and ultimately lethal to the tree. Most trees are dead within 5 years after the initial colonization.
Symptoms of EAB injury are expressed as progressive thinning of the crop canopy.
EAB larval injuries progress to tree death, if the tree is not effectively treated to control the insect.
Important note regarding EAB control!

Present controls can allow trees to recover if EAB-induced crown thinning has not exceeded 30%, perhaps 50%.
Important note regarding EAB control!

This will take years to happen after EAB has first started colonizing a tree.

Emamectin benzoate (Tree-AGE/Mectinite) has shown good ability to provide a rescue treatment.
Known distribution of Emerald Ash Borer a Few Months Ago

Colorado is the only area west of the High Plains where EAB is established
Colorado EAB Tree #1

Located near the intersection of 30th and Valmont, Boulder

September 23, 2013

How did it get to Colorado?
This is the known distribution of EAB in North America at the time it was first found in Colorado in 2013.
Important difference with Colorado infestation – Colorado has geography!
Unlike states to the east, Colorado is well compartmentalized due to its geography.

Within Colorado the current infestation is an infestation of the South Platte River drainage, not the State of Colorado.
Montana has internal geographic barriers that will retard spread of EAB within the state.
Within the next five years, emerald ash borer will move out of Boulder into the surrounding counties.

This is a slide I have been using since January 2014. The title should now read, “After 6 years, emerald ash borer has moved into the edge of adjacent counties.”
Over time the South Platte River Drainage will be colonized by emerald ash borer
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 – four years after Day Zero.
Sixth Anniversary!
Emerald Ash Borer in Colorado
Reported emerald ash borer distribution in Colorado – Today

- 2018 detection Lyons
- Original Boulder EAB infestation
- 2018 detection Superior
- 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

- Original Boulder EAB infestation
- 2018 detection Lyons
- 2019 detection SW of Berthoud
- 2018 detection Superior
- 2019 detection Broomfield
- 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
Entertaining visitors from the East this year? – Tell them you will provide all the firewood they need.
PROTECT TREES, FORESTS & WILDLIFE HABITAT

The transportation of invasive insects & diseases on firewood is destroying trees in prime hunting, fishing & recreation areas.

DONT MOVE FIREWOOD

Visit dontmovefirewood.org/MT

BUY IT WHERE YOU BURN IT

dontmovefirewood.org

Reporting Hotline: 1-866-INVASIVE oregoninvasiveshotline.org

Leave Your Firewood At Home

Buy It Where You Burn It
Don’t Give Bugs a Free Ride!
European Elm Scale – and resistance to neonicotinoid insecticides
European Elm Scale is the key pest of elms that have American elm parentage.
Winter is spent on twigs and small branches. Still immature, development completed in spring.
Females swell with eggs in May and June
Crawlers are present in late June and July.
European elm scale crawlers
European elm scale nymphs on leaves in summer
Honeydew is excreted. Where it lands and persists, sooty molds grow.
Crawlers return to twigs in late summer for overwintering.
Prior to about 1995 European elm scale was controlled by spraying elm trees with insecticides in spring to kill overwintering stages on the twigs.
European elm scale was one of the first shade tree insects against which the new insecticide imidacloprid was tested (ca 1993). The results were fantastic. Soil injection of elm was embraced rapidly by the Colorado tree care community.
Insecticide resistance develops by selecting individuals that have genetic traits that allow the insect to resist effects of the pesticide.
Recipe for Resistance

Sustained applications of neonicotinoids have been applied to almost every scale-infested elm over large areas in Colorado for almost 2 decades.
European Elm Scale in Colorado – *A poster child example of how to develop insect resistance in a shade tree pest*
Some Neonicotinoid Insecticides Used for Woody Plants

- **Imidacloprid** (Merit, Xytect, Marathon, many generics)
- **Clothianidin** (Arena)
- **Thiamethoxam** (Flagship, Meridian)
- **Dinotefuran** (Safari, Transtect, Zylam)
- **Acetamiprid** (Tristar)

*If resistance develops to one of these insecticides – it develops in all of these insecticides!*
European Elm Scale Options in a Post-Neonicotinoid Period?

• Soil/Trunk Injections
  – Acephate
  – Azadirachtin

• Foliar Applications
  – Horticultural Oils
  – Insect growth regulators
    • Pyriproxifen (Distance)
Elm Scale trial at the CSU Oval - 2014
2016 Evaluations European Elm Scale

- **Highest EES numbers**
  - Imidacloprid (Zenith) applied in 2014
    - 48 scales per foot of twig
  - Untreated check (no insecticide since 2012)
    - 33 scales per foot of twig
Most Promising “Plan B” Treatments from Elm Scale Trial

- **Pyriproxifen (spray)**
  - Trade names: Distance, Fulcrum
- **Azadirachtin (trunk injected)**
  - Trade names: Azasol, Azaguard, others
- **Acephate (trunk injected, soil injected)**
  - Trade names: ACE-Jet (trunk inject); Lepitect (soil drench)
Pyriproxifen as a scale insect treatment

- **Trade names** Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects
- Very little effect on natural enemies of insect pests
Pyriproxifen as a scale insect treatment

• Trade names Distance, Fulcrum

• Acts on hormones insects use in development (IGR)
  – Juvenile hormone mimic

• Mostly works on scales, aphids and related sucking insects

• Very little effect on natural enemies of insect pests
Pyriproxifen as a scale insect treatment

- Trade names Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects
  - Fungus gnats, mosquitoes are other markets
- Very little effect on natural enemies of insect pests
Pyriproxifen as a scale insect treatment

- Trade names Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects
- Very little effect on natural enemies of insect pests
  - Allows integration of biological controls with chemical controls
There are natural enemies that can complement chemical controls of European elm scale.

Larvae of green lacewings

Parasitoid wasps that develop within scales

Lady beetles that eat some young scales
Primary EES Predators

Convergent lady beetle

Sevenspotted lady beetle

Larvae of green lacewing
Relative Susceptibility of Elm Cultivars to European Elm Scale

- **Highly Susceptible**
  - Lewis & Clark, Valley Forge, Patriot, Princeton
  - *Ulmus davidiana*

- **Moderately Susceptible**

- **Little/No Susceptibility**
  - Commendation, Accolade, Vanguard
American elms resistant to the scale insect?
Ulmus americana
‘Scale Buster’

Discovered by Tim Buchanan, City Forester, Fort Collins
Typical American elm
‘Scale Buster’
The long-term future for American elm in the West?

It will depend on developing *scale-resistant* cultivars.
Douglas-fir Tussock Moth

*Orygia pseudotsugae*
Whitemarked tussock moth

Rusty tussock moth

Western tussock moth

Sycamore tussock moth

Caterpillars of some Tussock Moths
Douglas-fir, spruce and true firs are host of the Douglas-fir tussock moth
Winter is spent in the egg stage, within an egg mass.

Photograph by William Ciesla
Eggs hatch shortly after bud break
Dispersal?

- The early stage larvae may be wind blown
Eggs hatch shortly after bud break
Larvae first consume the current season needles
Late stage larvae are generalist defoliators
Defoliation typically occurs in a top-down pattern
Douglas-fir, true firs and spruce are common hosts for Douglas-fir tussock moth.
Douglas-fir tussock moth defoliation near Missoula - 2019

Aerial photo by Scott Sontag, USDA Forest Service
Outbreak areas of Douglas-fir tussock moth in Idaho, eastern Oregon and western Montana

Figure courtesy of Tom Eckberg, Idaho Department of Lands
Full-grown larvae wander. They may pupate on the plant or in the nearby vicinity.
Males are winged.

Females are wingless and lay eggs where they pupated.
“Hangers”

DFTM caterpillars killed by a virus disease

(NPV/nuclear polyhedrosis virus)

Photograph courtesy of Tom Eckberg, Idaho Department of Lands
When the NPV disease kicks in, and hangers are readily seen, the outbreak is over – for years.
Assessing potential for next season injury by DFTM

Are egg masses easy to find?

Were “hangers” present the previous season?
DFTM Insecticides are Applied as Sprays

• **Urban/Residential Trees**
  – Any pyrethroid (permethrin, cyfluthrin, cyhalothrin.....)
  – Chlorantraniliprole (Acelelepryn)
  – Spinosad (Conserve)

• **Forest Trees**
  – *Bacillus thuringiensis* (Foray)
  – Tebufenozide (Mimic)
  – Diflubenzuron (Dimilin)
Two odd gall wasps on bur oak
Oak Rough Bulletgall Wasp

*Disholcaspis quercusmamma*
Then in October, wasps from the twiggalls emerge.
Old Story

Adults emerge from galls in mid-October to mid-November and lay eggs in buds......
Oak rough bulletgall wasp – fall generation eggs are laid in fall in dormant buds.....
Females after emerging from galls in autumn, laying eggs in dormant bud.

Photograph by Crystal McEwen
These result in tiny budgalls in spring.
Males and females are present, mate and females insert eggs into new growth twigs.
... and eggs are again laid (spring generation) in developing twigs associated with new leaves
New galls begin to erupt in late spring/early summer. They become full-sized by late summer.
Rough bulletgalls attract many kinds of insects
Oak rough bulletgalls produce a sweet exudate that is attractive wasps.
Insecticides to control oak rough bulletgalls?

Good luck with that!
There is a wide range in resistance among bur oak to the oak rough bulletgall wasp
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 trunk/branches, it moves to new leaves. The summer generation develops within an irregularly shaped gall of the midrib.
There are at least a dozen kinds of gall wasps on bur oak in North America.
Ready....

Set....
On to the next talk!
This presentation will be posted at the Insect Information Website

• **Housed at** Department of Bioagricultural Sciences and Pest Management
  – **Search** “BSPM CSU”

• **Within** “Entomology”

• **“Insect Information”**
  – Extension presentations are posted at the bottom of the page, most recent at end
Insect Information

Arthropods of Colorado Fact Sheets
This is a listing of about 200 downloadable fact sheets related to insects and other "bugs" found in in Colorado. It contains fact sheets that are written for the Colorado Arthropods of Interest series and the Extension fact sheets that are related to insects.

Some Entomology Hot Links:
- Colorado Hemp Insect Website
- Western Colorado Entomology Website
- IPM Images/Bugwood (Craneshaw)
- IPM Images/Bugwood (Pears)
- Entomology Resources List
- Honey Bee Swarm Hotlines

Miscellaneous Insect Information
This contains a variety of downloadable fact sheets and pamphlets on diverse miscellaneous subjects, from "Bug Mugs" and "Life in a Colorado Water Garden" to "Mystery Bites and Itches" and "Commercially Available Sources of Biological Control Organisms: Sources and Uses in Colorado."

Resources

Hemp Insect Information
This links directly to the Hemp Insect Website, which includes information being developed to better recognize and manage insects associated with industrial hemp.

Master Gardener Information
This includes the handouts and PowerPoint presentations (as PDF) used in Master Gardener Entomology training. These will get updated annually at the end of the winter/spring training programs.

Handouts
PowerPoint Presentations Used in 2018

Recent Extension Presentations
This is a listing that provides the PowerPoint presentations (as PDF) of most Extension entomology programs conducted during the past 12 months.

PowerPoint Presentations/Webinars
Bulletin 506A

This is offered as a Silent Auction item