Some Insect Updates

ISA Conference November 9, 2017
Drippy Blight of Red Oaks

An unusual association between a scale insect and bacterial pathogen.
The insect partner:

Pin oak kermes

*Allokermes galliformis*

**Contribution:**
Production of wounds at feeding site.

Damaged tissues allow entry (and exit) of bacterial pathogen.
The pathogen partner:

Lqq

*Lonsdalea quercina var. quercina*

**Contribution:** Produces cankers that contribute to twig dieback

Produces viscous ooze that drips from trees
Examples of bacterial cankers developing around scale feeding sites
Twig dieback, flagging

Abscission of twigs
Which leads to:

Reduction in healthy foliage

Progressive dieback of canopy

Invasion by flatheaded appletree borer
Trees that have sustained injury decline and become candidates for removal

Percent of 450 Boulder red oaks

Red Oaks Removed (%)
Important Credit!

The drippy blight work has been done by Rachael Sitz
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The drippy blight work has been done by Rachael Sitz

and supported by the ISA Tree Fund
Allokermes galliformis development

First Instar Crawlers

Settled First Instars

Second Instars

Third Instar Female

Adult Female

JAN FEB MAR APR MAY JUN JULY AUG SEPT OCT NOV DEC
Growing Season
Eggs develop in late August and September.

Eggs hatch from mid-September into November.

Average number of eggs produced?

In 2015 the average was 2488 eggs/female.
In 2016 the average was 4726 eggs/female.
Where do scales overwinter?

- Winter 2014-2015, 3 trees, 55 branches
- Winter 2015-2016, 3 trees, 42 branches
- Branch sections ~50 cm (at least 5 years of growth)
Most of the scales spend winter on wood that is 2-4 years old

<table>
<thead>
<tr>
<th>Year-old wood</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawlers</td>
<td>10%</td>
<td>33%</td>
<td>32%</td>
<td>19%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Percent of 5,480 crawlers
First instar overwintering locations

Bark Fissures 26%

Growth Rings 35%

Percent of 5,480 crawlers
First instar overwintering locations

- Growth Rings 35%
- Bark Fissures 26%
- Callus Tissue 17%
- Bud Scars 13%
- Around Venters 2%
- Buds 1%
- Branch Crotches 6%
- Growth Rings 35%

Percent of 5,480 crawlers
Insect overwintering locations

Majority settle on:
3 to 4 year old growth
Growth rings & bark fissures

Insect feeding locations

Primarily move to:
New growth
Become sessile
Kermes scale feeding locations

Year-old wood

<table>
<thead>
<tr>
<th>Crawlers</th>
<th>Older</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>8%</td>
<td></td>
<td>92%</td>
</tr>
</tbody>
</table>

Percent of 2,041 crawlers
There is a spring migration around bud break as the scales move to the new growth.

At this point they permanently settle.

The female will grow enormously over the next 2-3 months.
Oozing, dripping, and twig dieback/abscission accelerate in late June and peak in July.
Management of Drippy Blight

- Principal Target – the Scale
  - Sprays?
    - Dormant season - target stages on 2-4 year wood
    - Bud break – concentrate at buds
  - Treatments
    - Horticultural oils, Distance, other scale products
- Soil Applied systemics?
Management of Drippy Blight

- Principal Target – the Scale
- Sprays?
  - Dormant season - target stages on 2-4 year wood
  - Near bud break – concentrate at buds
- Treatments
  - Horticultural oils, Distance, other scale products
  - Soil Applied systemics?
Management of Drippy Blight

• Principal Target – the Scale

• Sprays?
  – Dormant season - target stages on 2-4 year wood
  – Bud break – concentrate at buds
  – Treatments
    • Horticultural oils, Distance, other scale products

• Soil Applied systemics?
  – More mobile products (e.g., dinotefuran) may be best?
There are two scale insects on the oaks – and they look kind of alike

Pin oak kermes
*Allokermes galliformis*

Oak lecanium
*Parthenolecanium quercifex*

Photograph courtesy of David Shetlar
Overwintering stages?

Pin oak kermes

Tiny first stage nymphs tucked into cracks on branches

Oak lecanium

Maturing females on twigs

Photograph courtesy of David Shetlar
Around bud break?

**Pin oak kermes**
Overwintered nymphs move to buds, new growth

**Oak lecanium**
Females rapidly mature and swell
Around June?

**Pin oak kermes**

They have settled and are starting to grow

**Oak lecanium**

Production of eggs, then crawlers

Photographs courtesy of David Shetlar
Early summer?

Pin oak kermes

They have settled and are starting to grow

Oak lecanium

Crawlers move to leaves, molt to 2nd stage
Early summer?

Pin oak kermes

Bacterial ooze is often produced at feeding site

Oak lecanium

Honeydew continues to be excreted

Photograph courtesy of Jim Kalisch
Late summer

Pin oak kermes
Females mature and are producing eggs and crawlers

Oak lecanium
Migration back to branches and overwintering stage

Photograph courtesy of David Shetlar
Management of Oak Lecanium

- **Sprays**
  - Dormant season (developing females on twigs)
    - Pyriproxifen
    - Horticultural oils

- **Soil-applied systemics**
  - Neonicotinoids (imidacloprid, chlothionidan, dinotefuran)
European Elm Scale – and resistance to neonicotinoid insecticides
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, Criterion, Marathon, many generics)
- **Clothianidin** (Arena, Poncho)
- **Thiamethoxam** (Flagship, Meridian)
- **Dinotefuran** (Safari)
- **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
2016 Evaluations European Elm Scale

- **Lowest EES numbers** *
  - **Distance** (applied spring 2014)
    - 7 scales/foot of twig (with oil)
    - 12 scales/foot of twig (w/o oil)
  - **ACE-Jet** (acephate) (trunk injection 2015)
    - 10 scales/foot of twig
  - **AzaGuard** (azadirachtin) (trunk injection 2015)
    - 11 scales/foot of twig
  - **Lepitec** (acephate) (soil injection late spring 2015)
    - 14 scales/foot of twig
  - **Azasol** (azadirachtin) (trunk injection 2015)
    - 19 scales/foot of twig

* Control had 33 scales/foot
2016 Evaluations European Elm Scale

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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
What kinds of natural enemies work on European elm scale in Colorado?
Primary EES Predators

Convergent lady beetle

Sevenspotted lady beetle

Larvae of green lacewing
Lady beetles mostly seem to be grazing when there are large numbers of crawlers
What about parasitoids?
What about parasitoids?
We collected up to 11 different kinds of wasps on the European elm scale-infested branches
Most activity of natural enemies is from mid-May through mid-July.
Consider extra caution when using insecticides when natural enemies show peak activity.
American elms resistant to the scale insect?
Ulmus americana
‘Scale Buster’

Discovered by Tim Buchanan, City Forester, Fort Collins
‘Scale Buster’
One untreated tree had the lowest numbers of scale of all trees.

Scales that were present were confined to wound sites/callous tissue.
One other tree on campus was also found to never have much scale.
The long-term future for American elm in the West?

It will depend on developing scale-resistant cultivars
Featured Insect

Hawthorn Mealybug

*Phenococcus dearnessi*
Today, hawthorn mealybug is in its overwintering stage – immature mealybugs packed in crevices of bark on the trunk.
In early spring development resumes.

Adult males emerge and mate with the females.

The females then migrate to twigs.
Later, in May, the females swell enormously filled with eggs.
Crawlers hatch from the eggs over a period of several weeks. They settle and feed on leaves for a couple of months. They molt to the second stage at this time.
In August they migrate back to the trunk and other protected areas where they will overwinter.
Many hawthorn cultivars produce flowers that are heavily visited by pollinators in spring.
Spraying stages on trunks during non-blooming periods avoids risk to pollinators. Oils and several insecticides can be used for this.
Insect growth regulators that disrupt egg production and crawler production can be used on developing females in spring.

Pyriproxifen works well for this and has low hazard to honey bees.
Systemic insecticides?

They work well but pose some risk to pollinators if applied prior to bloom.

*Use is recommended only after bloom.*
Japanese Beetle

*Popillia japonica*
Uber-host Plants Favored by Japanese Beetle Adults in CO

- Roses**
- Linden*
- Virginia Creeper*
- Silver lace**
Overlap of adult feeding on flowers – and use of those flowers by pollinators

Issue of unusual concern with Japanese beetle
Japanese Beetle Life Stages

- Egg
- 1st instar larva
- 2nd instar larva
- 3rd instar larva
- Pupa
- Adult

Life Stages:
- April-May
- June-July
- August and September
Overlap of adult feeding on flowers – and use of those flowers by pollinators.

Never apply any insecticides to plants that are being visited by pollinators!!
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
Bacillus thuringiensis

• 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 strains are present, each with specific activity

- *kurstaki, aizawi* strains (leaf feeding Lepidoptera larvae)
- *tenebrionis* strain (leaf beetles)
- *israelensis* strain (mosquito, gnat, black fly larvae)
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
beetleJUS for adult Japanese beetle?

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)
Should we now consider trying to introduce natural enemies of Japanese beetle into Colorado?
Natural enemies of Japanese beetle exist elsewhere in the US

- *Paenibacillus popilliae* (Milky spore)
  - Bacterium
- *Istocheta aldrichi*
  - Tachinid fly
- *Tipha* species
  - Parasitic wasps
- *Ovavesicula popilliae*
  - Microsporidium
Milky Spore for Japanese Beetle?

Used to permanently establish a biological control organism – not useful for immediate control.
Milky Spore for Japanese Beetle?

*Long term: May help* produce some reduction in numbers of larvae surviving to adulthood. However, infections typically only affect a small percentage of population.
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

*Ovavesicula popilliae* – a microsporidian disease of Japanese beetle larvae

Main observed effects from infection – reduced fecundity, reduced winter survival
Japanese beetles collected from Michigan that were infected with *Ovavesicula popilliae* were shipped to us in late July 2015. The beetles were frozen, so no live beetles were introduced, but the pathogen should still be viable.
2015 releases of *Ovavesicula popilliae* – It took!

Positive infections confirmed from both Flatirons Golf Course (Boulder) and Pueblo Zoo release sites.
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

_Tipha_ wasps – parasitic wasps (2 species) of Japanese beetle larvae
Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

*Istocheta aldrichi* – tachinid fly parasitoid of Japanese beetle adults
Should we now consider trying to introduce natural enemies of Japanese beetle into Colorado?

Yes!
Thousand Cankers Disease of Walnut

Caused by the effects of two organisms - bark beetle and a fungus

*Geosmithia morbida*  
*Pityophthorus juglandis*
Walnut Twig Beetle

*Pityophthorous juglandis*

Steve LaValley, Oregon Dept. Agriculture
The fungal partner – *Geosmithia morbida*
Growth of the fungus beyond the inoculation site creates a dead region (canker) in the cambium.
Thousand Cankers Status in 2017

Red arrows – “Hot Spots”
Black arrows – Eastern Range Extension records

Brush was a 2017 range extension record
Metallic Wood Borer in the News

Emerald Ash Borer
Area of original EAB infestation in Colorado
Areas known to be infested with emerald ash borer in Boulder end of 2015
How will EAB spread in Colorado?

• Wind-blown dispersal of adults
  – Peak period of adult dispersal is late May through late July

• Butt-heads that move wood containing developing stages
New 2016 detection of EAB in Longmont

Boulder EAB infestation
Wind Direction from Boulder (with wind speed correction)
May-August 2013-2015
2016 detection of EAB in Longmont

Boulder EAB infestation

New 2017 detection of EAB in Lafayette
Main Points About Emerald Ash Borer in Colorado Today

- All known infestations remain confined within Boulder County.
- In time it will spread throughout South Platte drainage.
- Treatments are available that can protect individual trees once they first become infested.
  - Each treatment option involves decisions balancing costs, environmental hazards, effectiveness, and ease of application.
Emerald Ash Borer Control Options

• Soil applications with systemic insecticides
  – imidaclorpid, dinotefuran

• Non-invasive trunk sprays of systemic insecticides
  – dinotefuran

• Trunk injections of systemic insecticides
  – Emamectin benzoate, azadirachtin, imidaclorpid
Painted Lady/Thistle Caterpillar *Vanessa cardui*
Painted lady female lays her eggs on thistle

Larva can be damaging to thistle family plants
Painted lady larvae are sometimes known as “thistle caterpillars”
In spring the Painted Lady migrates annually into Colorado from overwintering areas in Baja California.

In fall they migrate south/southwest in a return migration.
70-Mile-Wide Butterfly Migration Detected on Radar in Colorado
The Weather Channel
Bulletin 506A

Available at for sale at this conference!
This second edition of *Garden Insects of North America* solidifies its place as the most comprehensive guide to the common insects, mites, and other “bugs” found in the backyards and gardens of the United States and Canada. Featuring 3,300 full-color photos and concise, detailed text, this fully revised book covers the hundreds of species of insects and mites associated with fruits and vegetables, shade trees and shrubs, flowers and ornamental plants, and turfgrass—from aphids and bumble bees to leafhoppers and mealybugs to woollybears and yellowjacket wasps—and much more. This new edition also provides a greatly expanded treatment of common pollinators and flower visitors, the natural enemies of garden pests, and the earthworms, insects, and other arthropods that help with decomposing plant matter in the garden.

“An exceptionally well organized and complete text on garden insects... Almost every insect is illustrated, with well over 1,000 full-color photographs showing them in various life cycle stages. Its very simple but complete...”
Garden Insects of North America, 2nd Edition

- Complete revision
- Co-authored (with David Shetlar, Ohio State University)
- Contains over 3000 photos, most all new
- Retail price $35
Discount Introductory Offer

30% discount through December 15
Must use code EX213 at checkout for discount
Estimated cost, delivered – less than $22?

Garden Insects of North America
The Ultimate Guide to Backyard Bugs
Second Edition
Whitney Cranshaw & David Shetlar

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This presentation will be posted at the Insect Information web site

- **Housed at** Department of Bioagricultural Sciences and Pest Management
  - Search “BSPM CSU”
- **Within** “Extension and Outreach”
- “Insect Information”
  - Extension presentations for 2017 posted at bottom of page
New Online Horticultural Entomology Course!

- BSPM 356 – Horticultural Entomology
- 2nd year Spring Semester 2018
- Comprised of three 1-credit modules
  - 356A Basics of Entomology, Basics Identification, Basic Management
  - 356B Entomology of Food Crops
  - 356C Entomology of Ornamentals, Woody Plants, and Turfgrass