

# Quality Time with Aphids and Scale Insects



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Whitney Cranshaw  
Colorado State University

**This presentation will be posted at the Insect  
Information Web Site**

- **Housed at Department of  
Bioagricultural Sciences and Pest  
Management**
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# Aphids

Hemiptera: Aphididae





**Aphids can range in size, shape and patterning**



**Aphids associated  
with *Prunus* spp.**



**Aphids associated with *Acer* spp.**



# Rose Aphids





# Linden Aphids





**Aphids associated with willow (*Salix* spp.)**





**Largest Aphid in RM Region – Giant Willow Aphid**

# Giant conifer aphids *Cinara* species



**Different species are present on junipers, spruce and pines**



**Some aphids are covered with finely powdered wax**



**Some aphids – known as “woolly aphids” – have wax that form long filaments and may cover their body**



# Leafcurl Ash Aphid



# Woolly Apple Aphid





**Sugarbeet root aphid**

**Some aphids  
are associated  
with roots of  
plants**



**Rice root aphid**



**Aphids on dandelion roots**



**Root-infesting  
aphids are often  
surrounded by  
wax**



**Aphid life cycles** – All aphids go through three feeding stages, each punctuated with a molting event

Aphids will molt 3 or 4 times in their life, becoming an adult after the last molt

**Diagnostic: Cast skins remain after aphids molt**



Toothache plant infested  
with green peach aphid



Aphids on stem (left)  
and cast skins  
dropped onto leaf  
(right)

**Asexual reproduction – giving live birth to a genetically identical daughter – is the norm for aphid reproduction**





**Aphid  
populations  
can increase  
rapidly**

**Live birth and asexual reproduction are the norm with aphids**



**Adults may be winged  
or wingless**



Developing wing pads  
on aphid nymph



**Adults may be winged  
or wingless**



# How do aphids survive winter in areas with freezing temperatures?



- **Outdoors**

- Eggs that remain dormant through winter
  - Survives on perennial host or crop debris
- Nymphs, adults in continuous reproduction
  - Rare and requires living hosts through winter

- **Indoors**

- Nymphs, adults in continuous reproduction

# Life History of Aphids

- **Holocyclic life cycle**
  - Involves one sexual generation (sexual form female and male)
  - Results in externally laid egg to survive winter
  - Often involves alternation of host plants
    - Winter host (Fall-late Spring)
    - Summer host
- **Anholocyclic life cycle**
  - Continuous reproduction without sexual reproduction or externally laid eggs



Overwintered eggs of rose aphid

**Outdoors, almost all aphids have a holocyclic life cycle and produce eggs in autumn. That is normally the stage that survives between seasons.**



Rose aphids on flower buds

Late September on a hemp leaf

# Sexual forms of cannabis aphid and eggs

Egg producing form  
female mating with  
winged male

Winged male

Egg producing form  
female with recently  
laid eggs

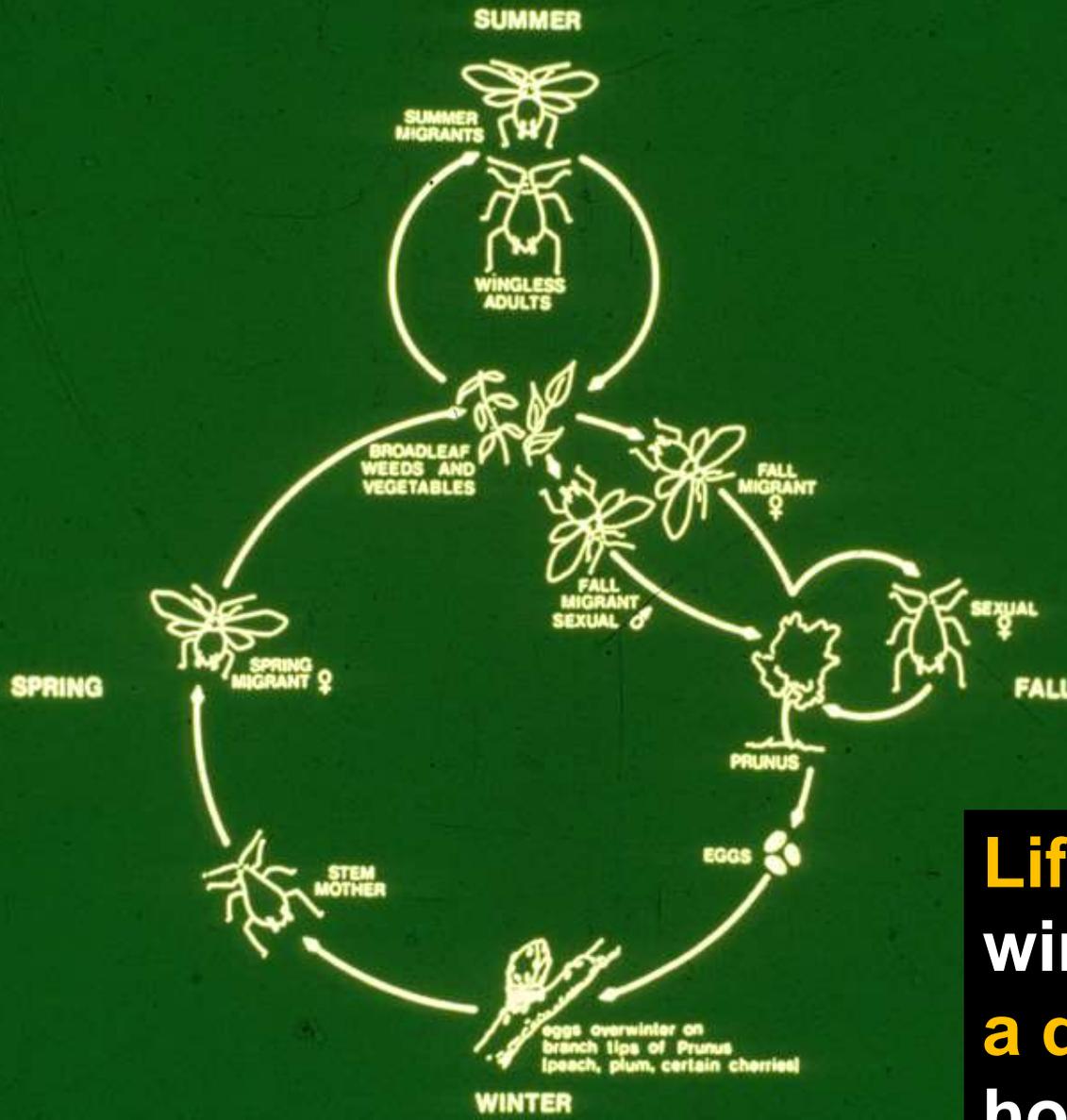


**Most aphids lay the overwintering eggs on a perennial (often woody) plant**





# Holocyclic Life Cycle – *with host alternation*



LIFE CYCLE OF THE GREEN PEACH APHID

**Life cycle involves a winter host plant and a different summer host plant(s)**

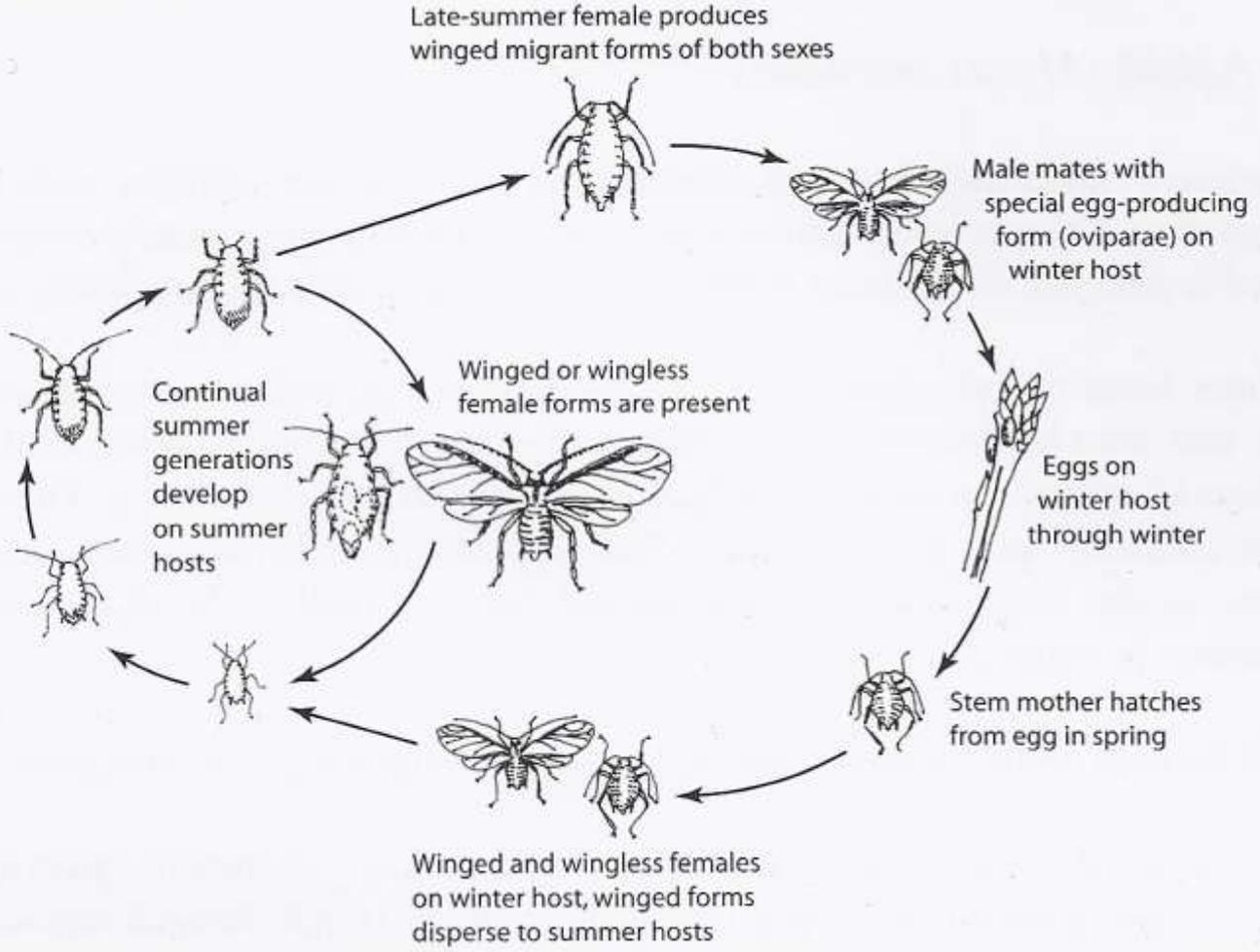


# Green Peach Aphid

*Myzus persicae*

An example of an aphid that undergoes a **holocyclic life cycle** outdoors – *and alternates hosts*





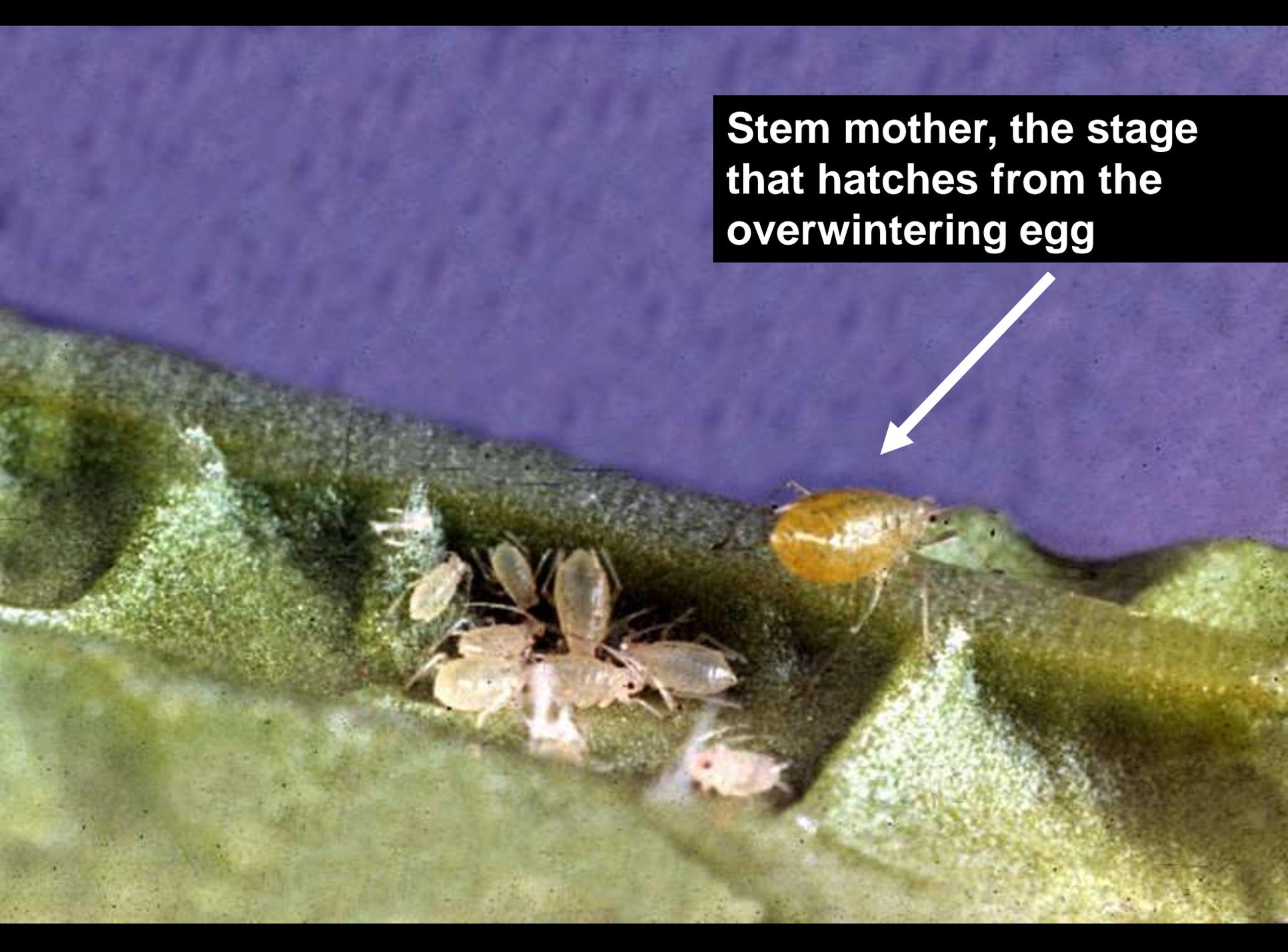
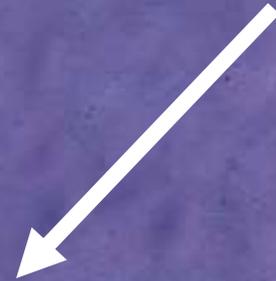


**Overwintering egg  
laid near the bud**



Eggs on  
winter host  
through winter

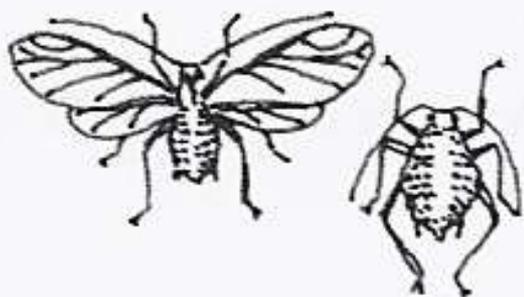
**Stem mother, the stage that hatches from the overwintering egg**





On the winter host plant the first generations may cause leaf curling injuries to the new growth

**Sometime, usually in June, the green peach aphids on the winter host switch to becoming all winged forms – that then disperse to the “summer hosts”**



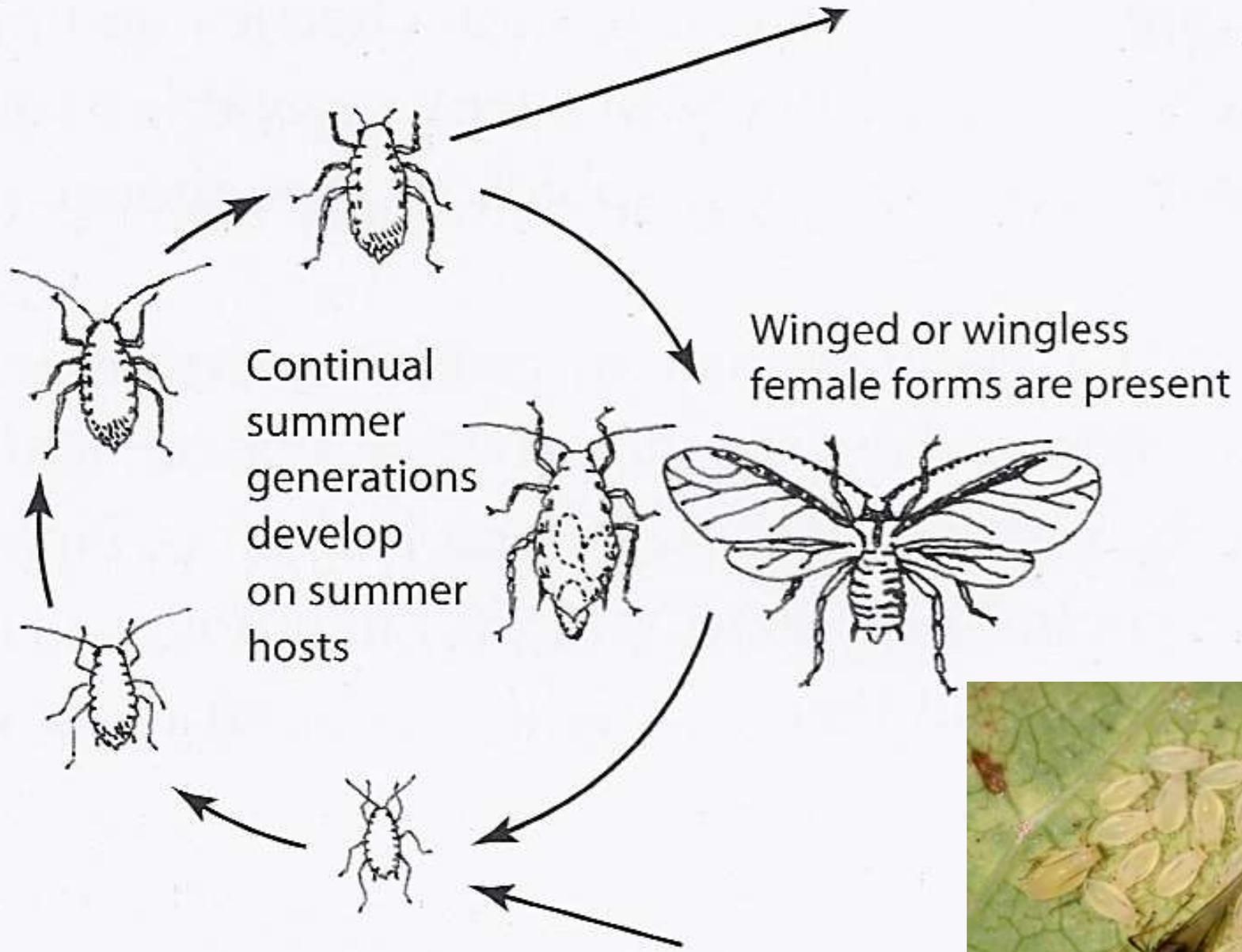
Winged and wingless females on winter host, winged forms disperse to summer hosts



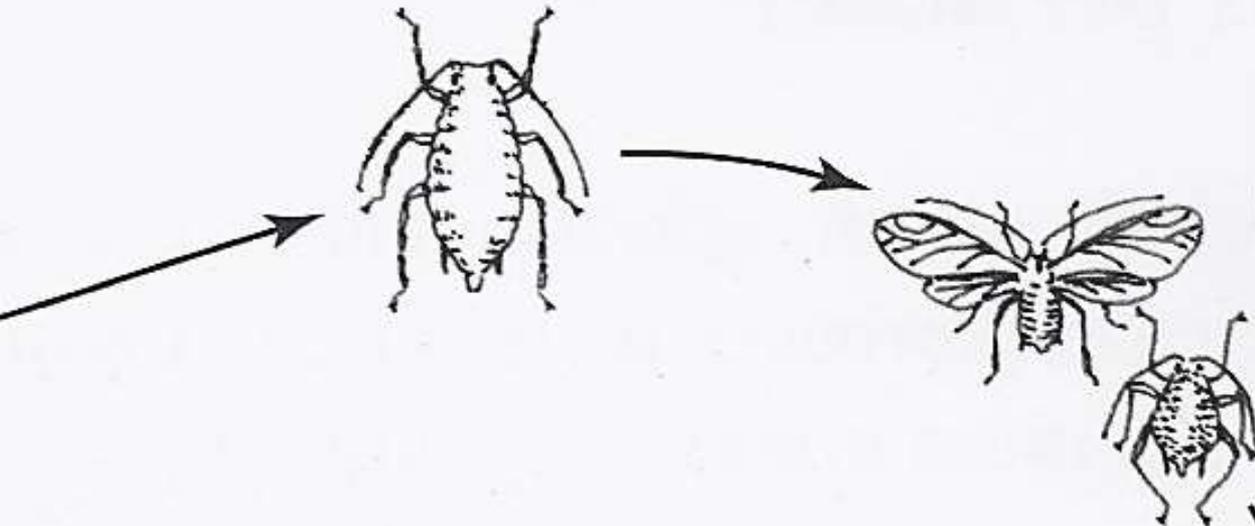
**Summer hosts  
include various  
vegetables and  
weeds**

Spinach, lettuce, peppers,  
potato, cabbage, pigweed,  
and lambsquarters are  
common summer hosts





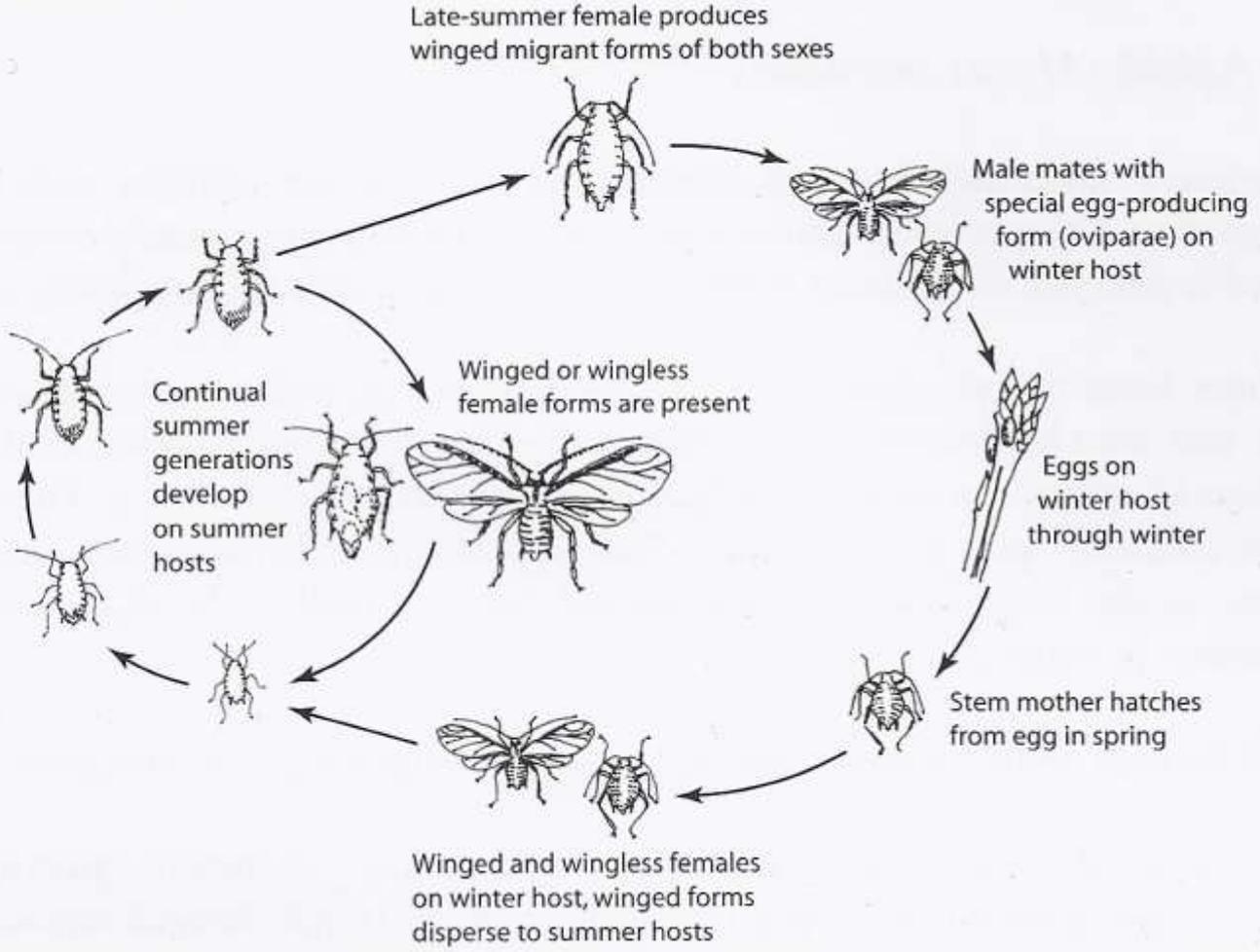
Late-summer female produces winged migrant forms of both sexes



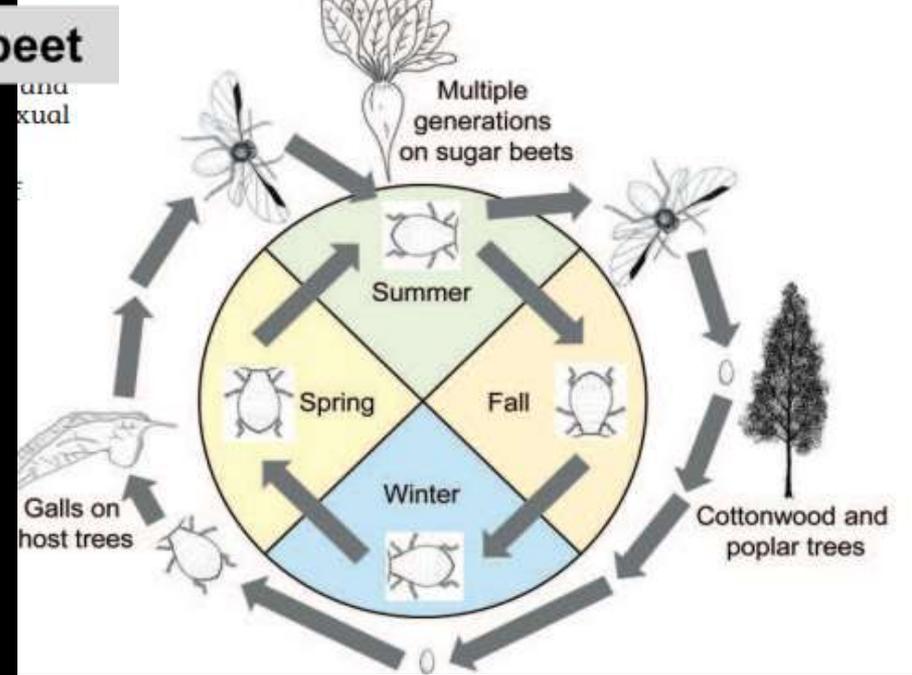
Male mates with special egg-producing form (oviparae) on winter host



Eggs on winter host through winter



## Sugarbeet root aphid on roots of garden beet



## Sugarbeet Root Aphid *Pemphigus populivenerae*

Host alternation between  
poplars/cottonwoods and  
beet family plants



Galls produced on overwintering  
host plant – certain *Populus* spp.

# Willow-Carrot Aphid

*Caveriella aegopodii*

**Winter Host:** Certain European willows



**Summer Hosts:** Various Carrot Family (Apiaceae) plants (parsley, dill, carrot)



# Lysimachia Aphid

*Thecabius lysimachiae*

Winter Host: Black poplar (*P. nigra*)



Summer Host: *Lysimachia* (moneywort, creeping jenny)



# Cabbage Aphid

*Brevicoryne brassicae*

One of the very few aphids that may survive Idaho winters outdoors as actively developing stages (nymphs, adults)



No eggs are produced no males and mating occurs – anholocyclic life cycle

# How Do Aphids Survive Winter in Areas with Freezing Temperatures?



- **Outdoors**

- Eggs that remain dormant through winter
  - Survives on perennial host or crop debris
- Nymphs, adults in continuous reproduction
  - Rare and requires living hosts through winter

- **Indoors**

- Nymphs, adults in continuous reproduction

# Primary aphid species found in greenhouses



Green peach aphid



Potato aphid



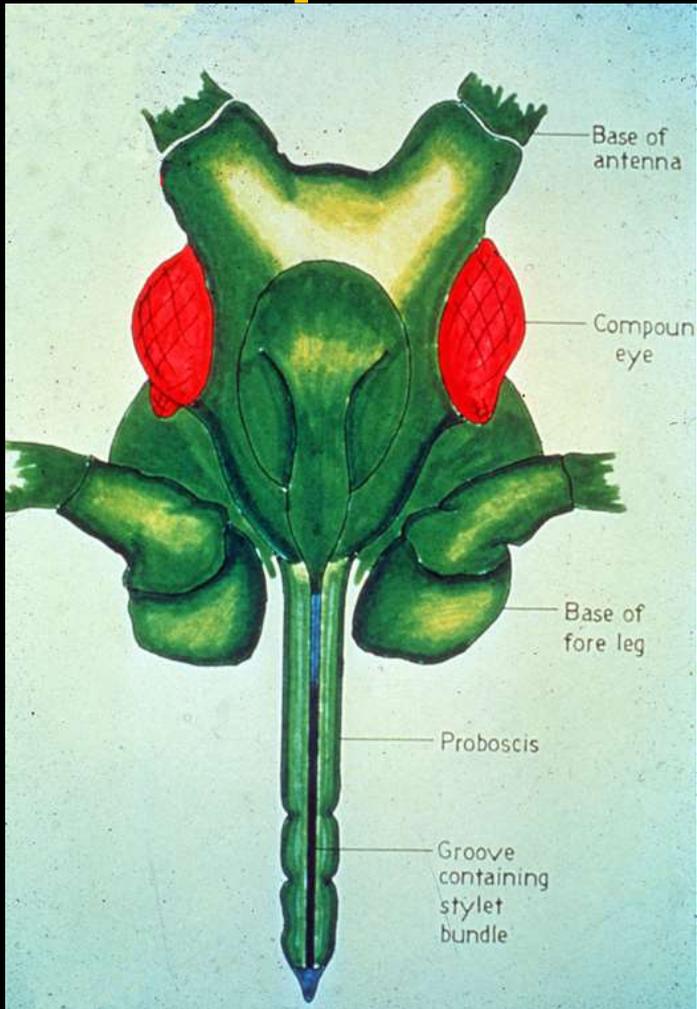
Cotton-melon aphid

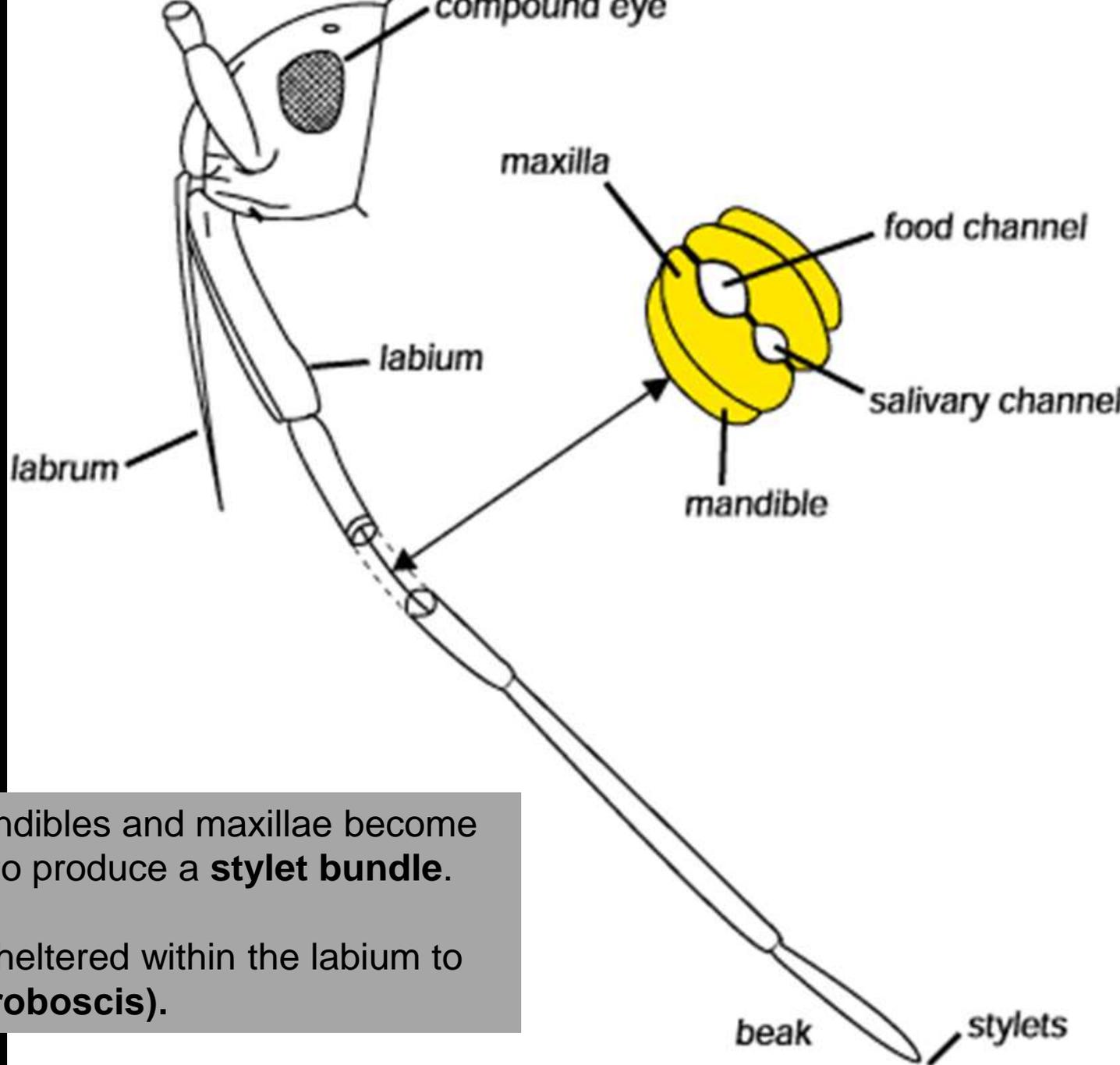
Indoors there is continuous, asexual reproduction. There are no eggs produced, nor sexual forms (males, sexual form females) [anholocyclic life cycle]

# **Plant Injuries Aphids May Produce**

- **Contamination of produce**
- **Reduced vigor from heavy, sustained feeding**
  - **Leaf yellowing, premature senescence**
- **Nuisance problems with honeydew**
- **Leafcurl distortions of new growth**
- **Vectors of some viral diseases**

# Piercing-sucking mouthparts of Hemiptera



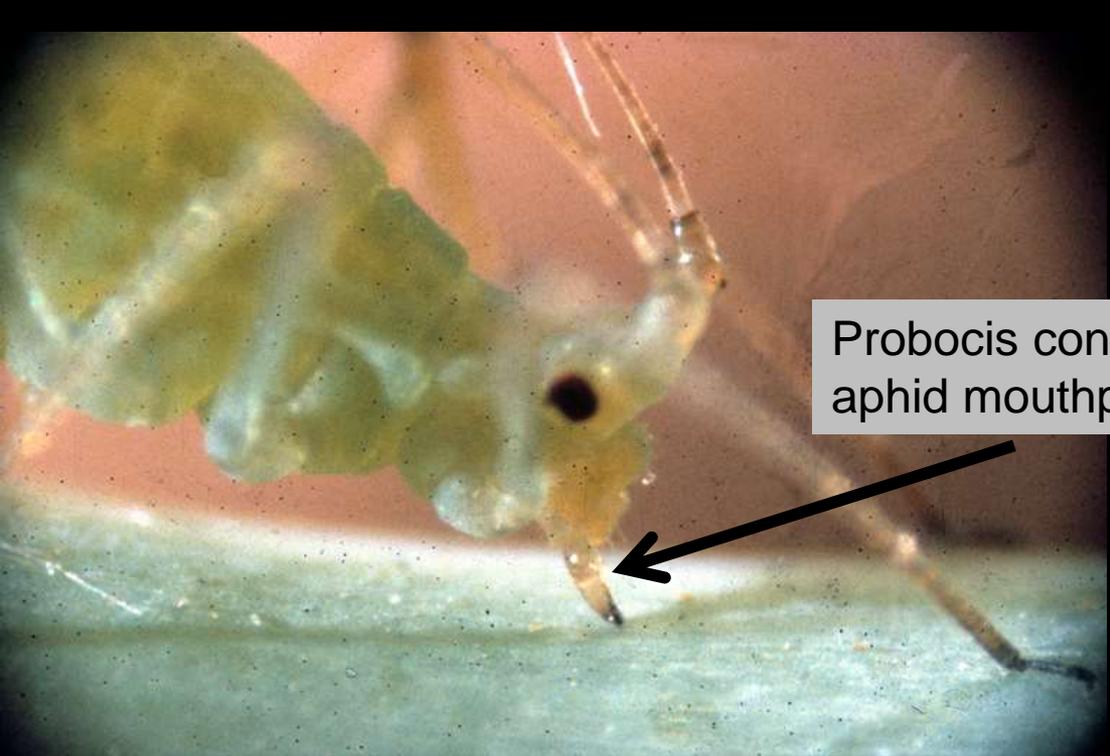


In Hemiptera, the mandibles and maxillae become extremely elongated to produce a **stylet bundle**.

The stylet bundle is sheltered within the labium to produce a “**beak**” (**proboscis**).

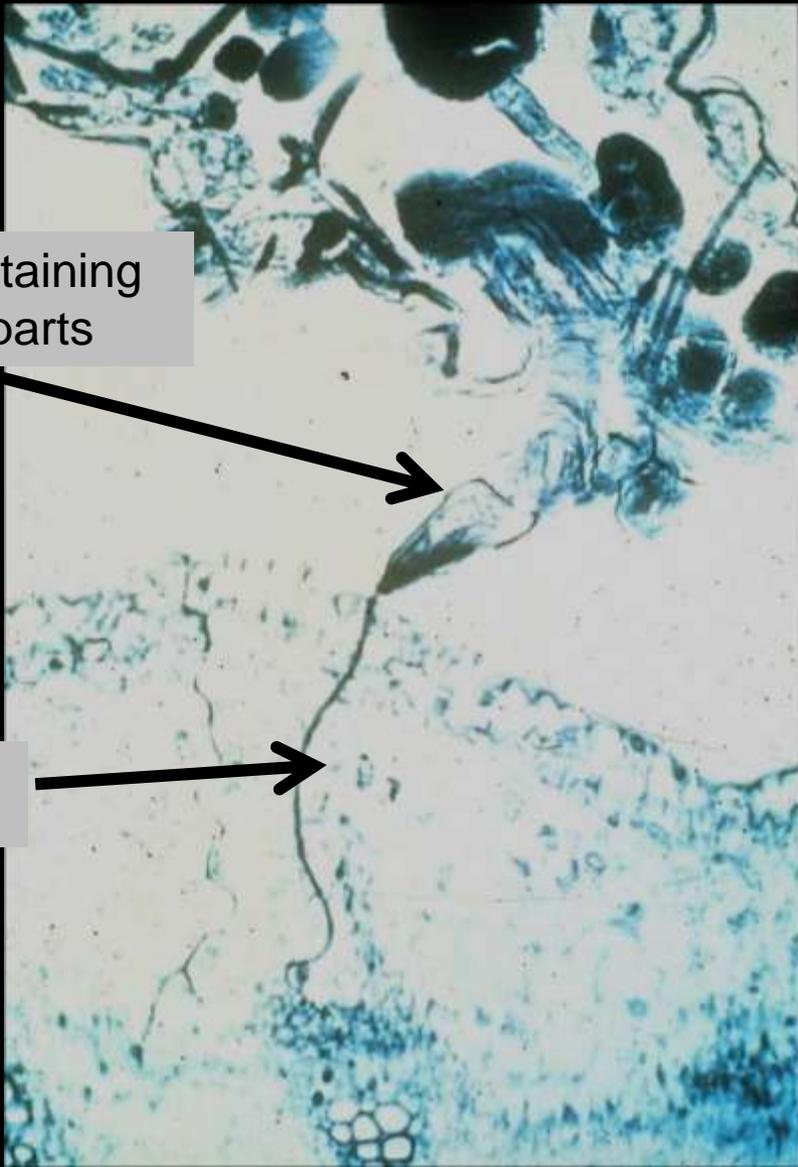


Some sort of  
“beak” is present  
on the underside  
of the head



Proboscis containing  
aphid mouthparts

Stylet bundle (mandibles and maxillae)  
meandering through plant en route to phloem



**Aphids use their mouthparts to access *the fluids of the phloem.***

**Little, if any, cell injury is produced *by most aphids.***



**Important Note:**  
Presence of aphids  
does not always equate  
to occurrence of plant  
injury!





***Sustained feeding by high populations*** of aphids can produce wilting, leaf yellowing, retarded growth



**Outdoors there are normally *numerous natural enemies* usually control aphids before serious damage occurs**



Flower fly larva



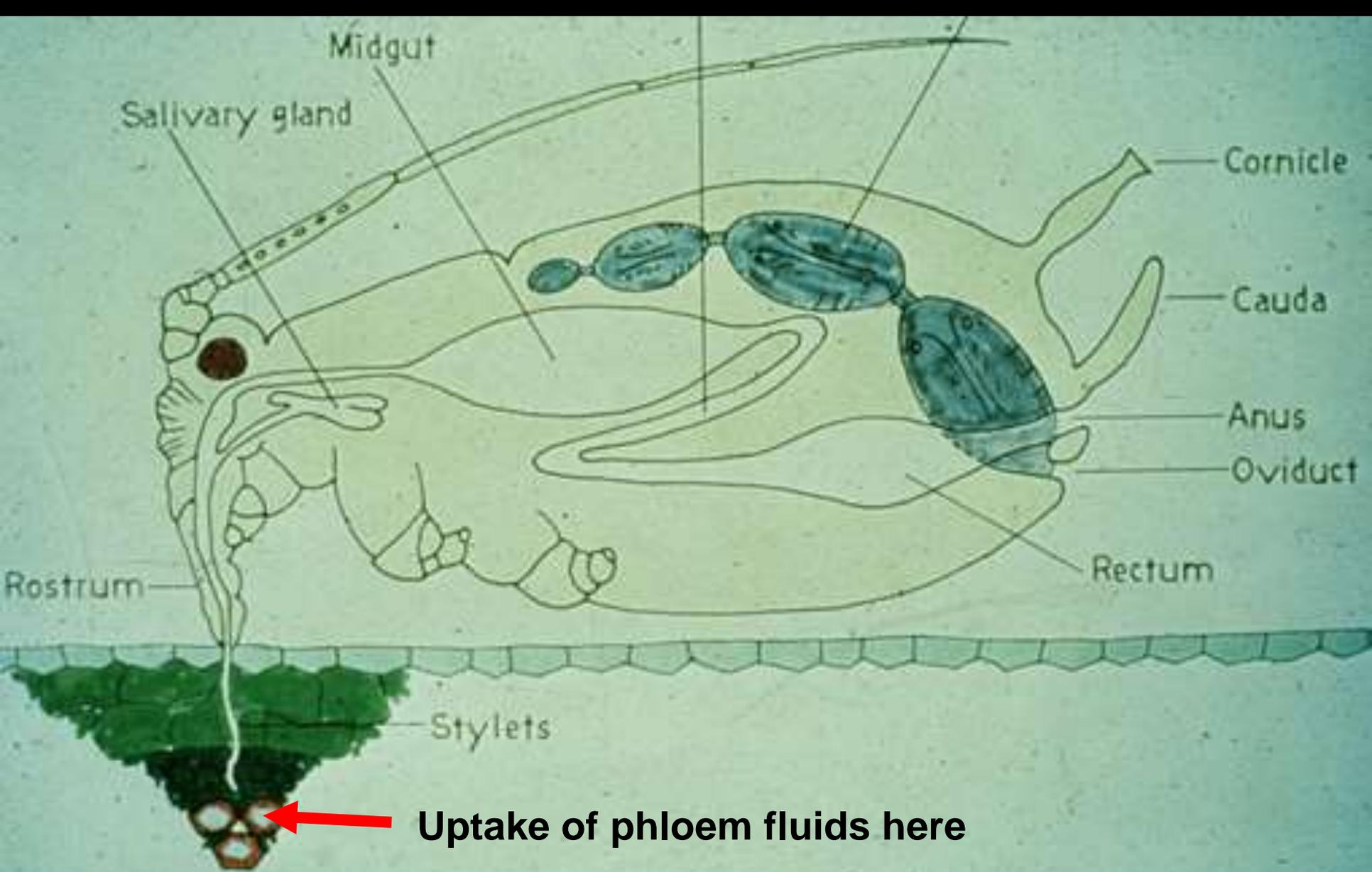
Lady beetle larva

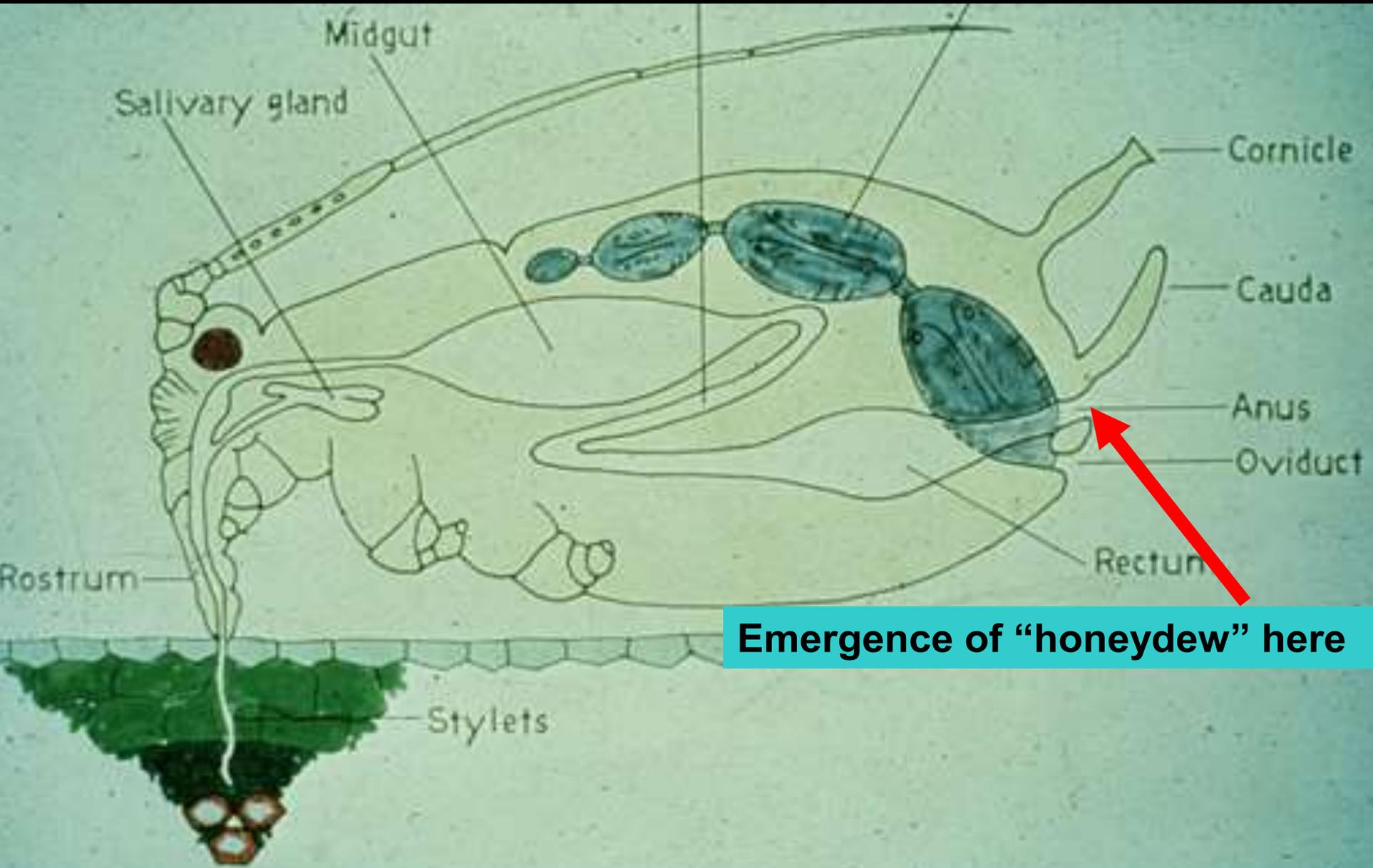


Green lacewing larva

# Honeydew production







# Leaf with sparkles of honeydew – *and* cast skins





The leaf above  
the honeydew –  
*an aphid colony*



**Leaf with sparkles of honeydew – *and* cast skins**



# Honeydew Producing Insects\*

- Aphids
- Soft scales
- Whiteflies
- Mealybugs
- Psyllids (some)
- Leafhoppers (phloem feeding species)



**\*All suck sap from the phloem**



**Mealybugs**  
**Soft Scales**



**Whiteflies**  
**Psyllids (some)**



# Sooty Molds

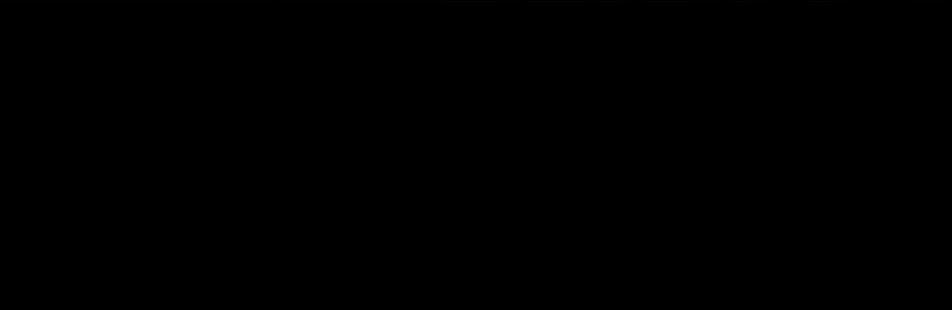
Fungi that grow on honeydew-contaminated surfaces





**Sooty mold  
growing on  
linden aphid  
honeydew**











**Ants are commonly associated with honeydew producing insects**

# Ants and Aphids

## A Mutualistic Relationship



-Aphids provide food – *honeydew*

-Ants provide protection

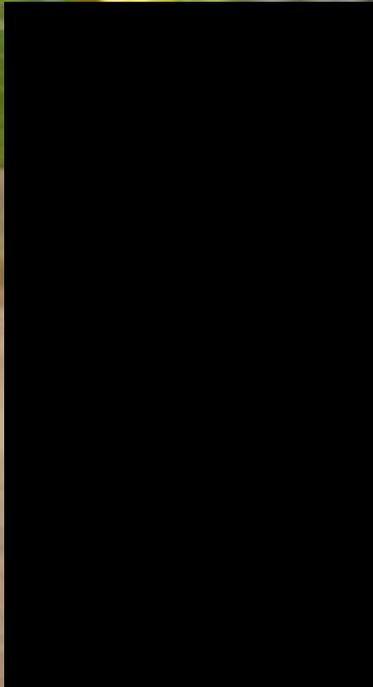


# Leafcurl Injuries

Produced by aphid feeding on emergent growth,  
producing distortion



# Leafcurl Plum Aphid Injury





**Hawthorn**



**Chokecherry**



**Peach**



**Leafcurl Ash Aphid**

**Honeysuckle Witches'  
Broom Aphid**



Leaf curling produced by snowball (viburnum) aphid



## Aphid Control - Scenario One

# Aphids are Exposed on the Plant



# Aphid Control - Scenario One

**Aphids are Exposed  
on the Plant**



# **Different Levels of Control Response to Aphids**

- **Do nothing. Natural controls will ultimately take care of things.**
  - Indoor production will require introduction of natural enemies
- **Treat the plants with a strong jet of water to kill aphids**
- **Use a soap/detergent spray to kill aphids**
- **Use some other effective ‘aphicide’**



**Check for aphid  
natural enemies!**





Photograph courtesy of David Cappaert



UGA2131063

**Diagnostic: Cast Skins Remain after Aphids Molt**





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# Aphid Parasitoids



Parasitized aphids -  
"aphid mummies"



Parasitoid wasp larva  
inside aphid mummy



Parasitoid wasp emerging  
from aphid mummy



Old aphid mummy with exit  
hole made by emerging wasp



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# Lady beetle larvae



Adults



Eggs

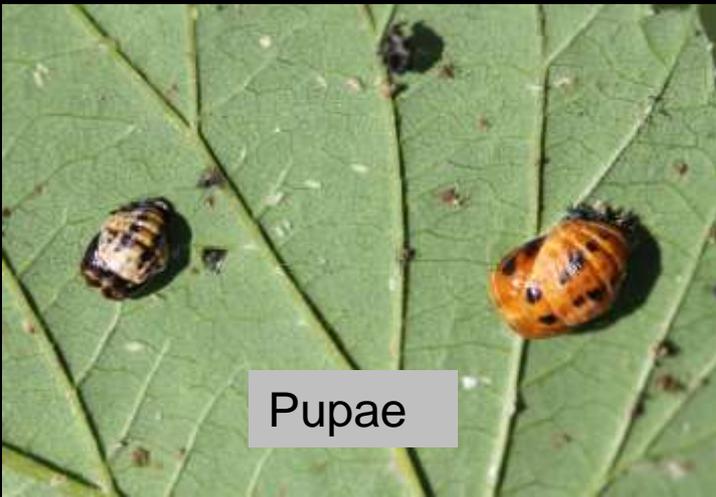


Larvae



# Lady Beetle Life Stages

Pupae





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# **There can be different levels of response to an aphids infestation**

- **Do nothing. Natural controls will ultimately take care of things.**
- **Treat the plants with a strong jet of water to kill aphids**
- **Use an effective 'aphicide'**
  - **Contact sprays**
  - **Systemic insecticides**



**Hosing for aphid control**

# Rose Aphids - Before





# Rose Aphids - After



# Some aphid control products – Exposed Aphids

- **Insecticidal Soaps**
- **Pyrethroids**
  - Bifenthrin, cyhalothrin, cyfluthrin, etc.
- **Neonicotinoids**
  - Imidacloprid
  - Acetamiprid



## Insecticide control options for aphids

# Insecticidal Soap

**MULTI-PURPOSE INSECT KILLER**

- For Use on Flowers, Trees, Shrubs, Ornamentals, Fruits, Nuts and Vegetables
- Kills Aphids, Mites, Mealybugs, Thrips, Whiteflies, and Other Listed Pests

ACTIVE INGREDIENTS	BY WT.
Potassium Salts of Fatty Acids	49.52%
OTHER INGREDIENTS	50.48%
TOTAL	100.00%

KEEP OUT OF REACH OF CHILDREN  
**WARNING** See back panel for Precautionary Statements and First Aid  
5120-2627-RM06330

**Concentrate!**

Makes up to 12 Gallons

NET CONTENTS 32 FL. OZ.

## Insecticidal Soaps for Aphid Control

- **Strictly contact activity** – *must* cover aphid at time of application
- **No residual activity**
  - May reduce initial control
  - Well conserves natural enemies

# Pyrethroids for Aphid Control



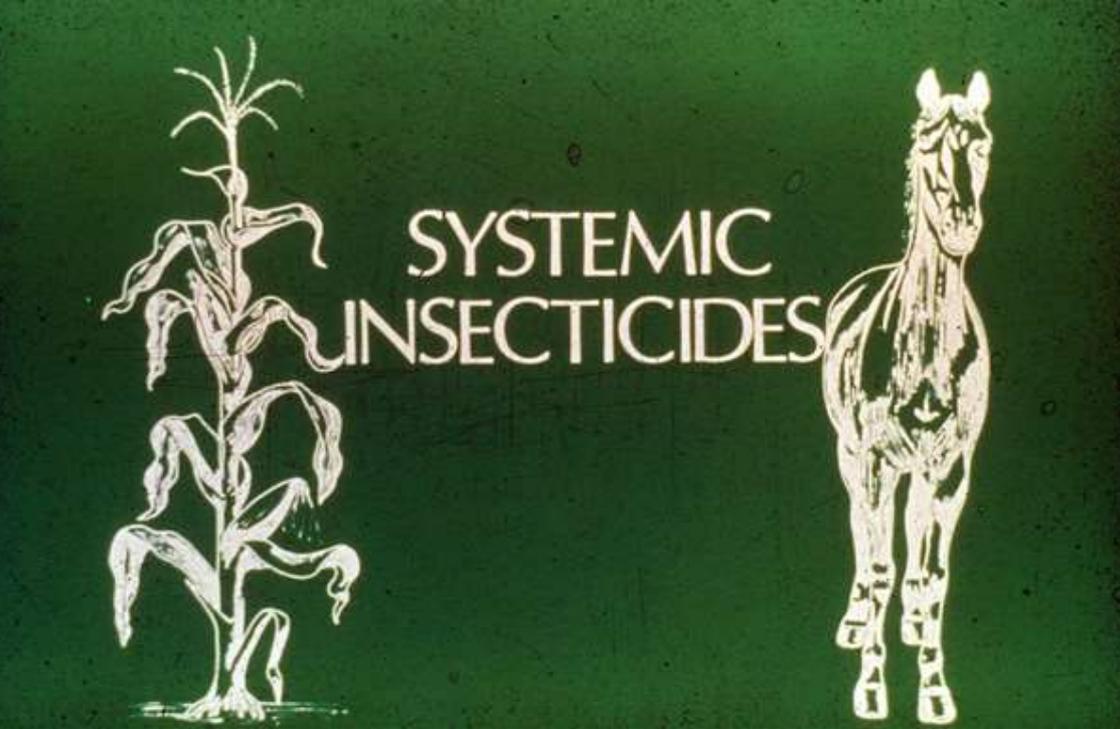
- **Strictly contact activity**
- **Extended residual activity**
  - May kill aphids for hours-days
  - Often devastates natural enemies



**Aphids have  
already produced  
a leaf curl?**

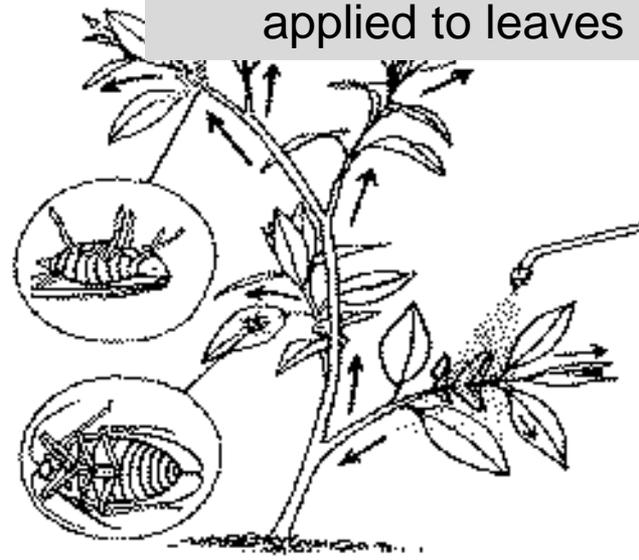
Insects that work by  
contact will not  
control this problem –  
*and can easily make  
it worse*



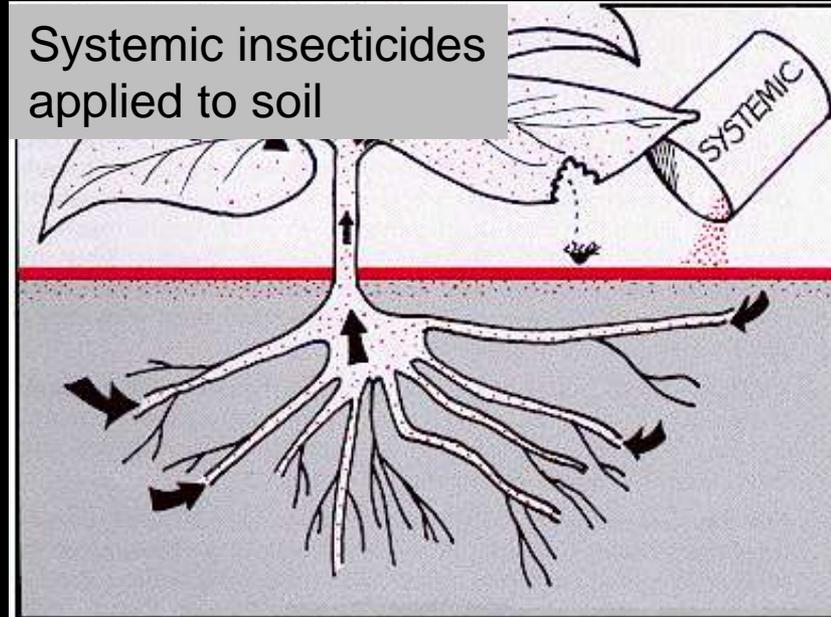


For control of aphids in existing leafcurls only an insecticide that moves systemically in plants will provide control

Systemic insecticides applied to leaves



Systemic insecticides applied to soil



# Acetamiprid for Aphid Control



- **Best used as a spray**
- **Has systemic activity in plant**
  - May kill through ingestion or contact
- **Extended residual activity**
  - May kill aphids for days-week?
  - Fairly conservative of natural enemies



Retail formulation

# Acetamiprid formulations

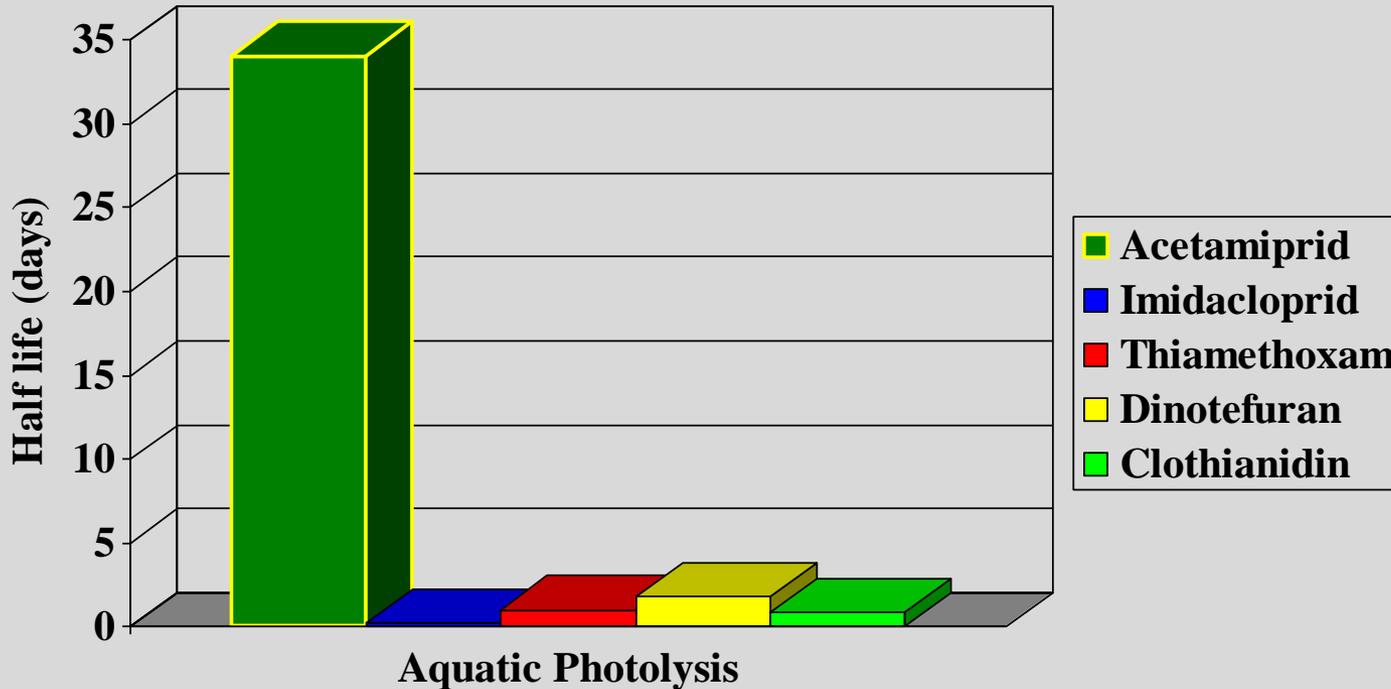
Commercial formulation for ornamentals



Commercial formulation for fruits and vegetables



# Comparison of UV Stability among Neonicotinoid Insecticides



Data obtained from published EPA registration documents

# UV Stability

Neonictoinoids are generally not UV stable. Foliar persistence can be shortened by this feature.

**Acetamiprid** is an exception.



# Acute Toxicity of Neonicotinoids to Adult Honey Bees (Oral LD50 – micrograms/bee)

• Acetamiprid	14.53
• Imidacloprid	0.005
• Dinotefuran	0.056
• Thiamethoxam	0.005
• Chlothianidin	0.0003



**Insecticide control options for aphids**

## **Imidacloprid for Aphid Control**



- **Best used as a soil application**
- **Has systemic activity in plant**
- **Slow uptake/Extended residual activity**
  - **May kill aphids for weeks- months?**
  - **Conservative of some natural enemies**

# Dormant Oils?

May manage many spring aphid problems – *if they spend winter as eggs on the plant*

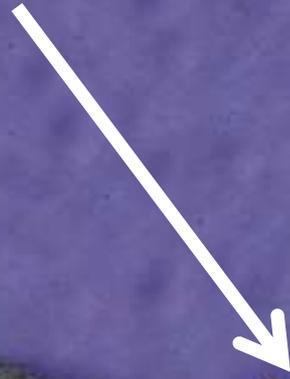


Oils can kill overwintering eggs of aphids. The application must cover the egg, which can then be killed by suffocation.



Aphid  
egg

**No overwintered egg  
– no stem mother**



**No overwintering egg, no spring leaf curl**



# Scale Insects

**Order: Hemiptera**

**Families: Diaspididae  
(armored scales), Coccidae  
(soft scales), Eriococcidae  
(Felt scales), others**



# Scale Insect Basics

- Scale insects feed on plant fluids using 'piercing-sucking' mouthparts
  - Insect order Hemiptera
  - Related insects include mealybugs, aphids and whiteflies



Willow aphids



Longtailed mealybug

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Pine needle scale –  
an armored scale



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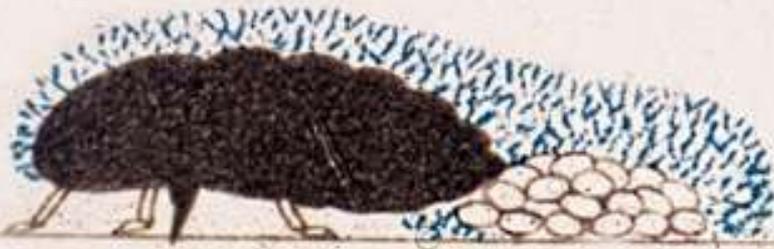
Pine tortoise scale –  
a type of soft scale



Flipped to show underside

# There are two general types of scale insects:

**'Soft' Scales**



**Armored Scales**



# Armored Scales



- Covering completely encloses, but is not attached to, the body
- Covering made up primarily of proteins and some waxes
- Two primary body forms (elongate, circular)

Pine needle scale



Oystershell scale



## Armored Scales Family Diaspididae

Poplar/willow scale



Black pineleaf scale



# Soft Scales



- Covering is attached to body; underside is not covered
- Covering made up of waxes
- Body forms tend to be elongate-oval, more rounded at maturity

Oak lecanium



European elm scale



## Soft Scales

Families Coccidae, Eriococcidae

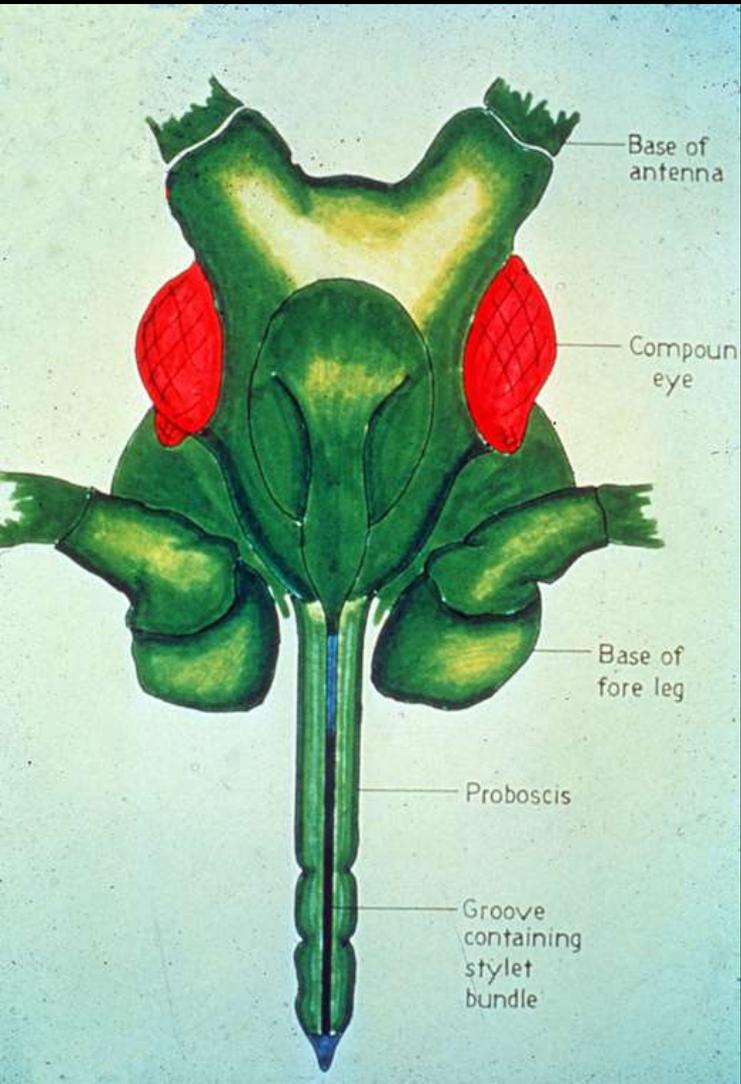
Pine tortoise scale



Cottony maple scale

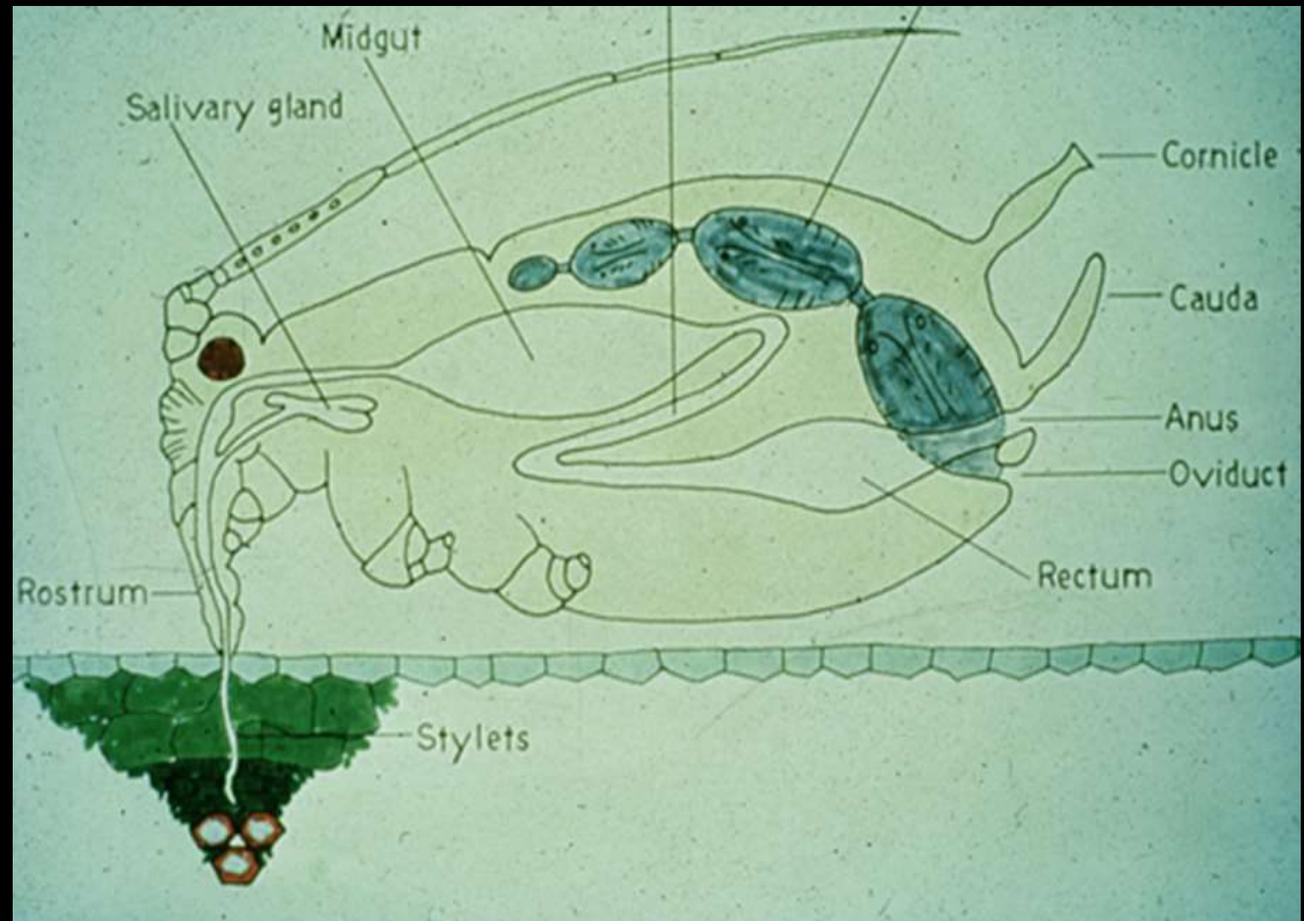


# Piercing-sucking mouthparts



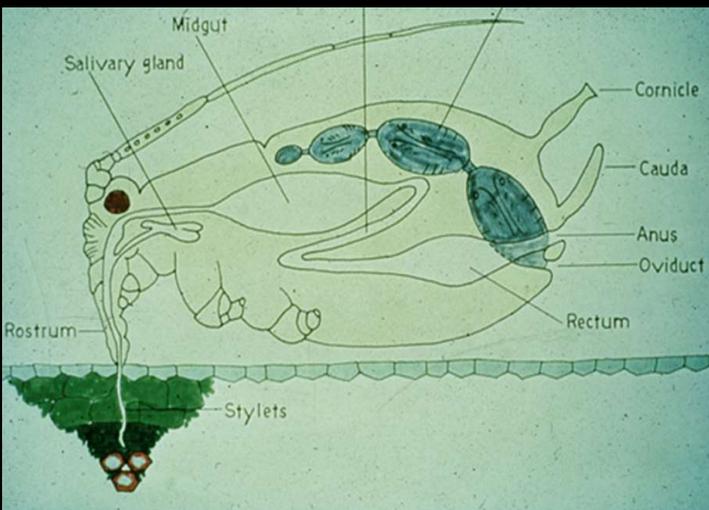
# Scale Insect Feeding

- **Soft scales feed on the fluids of the phloem**



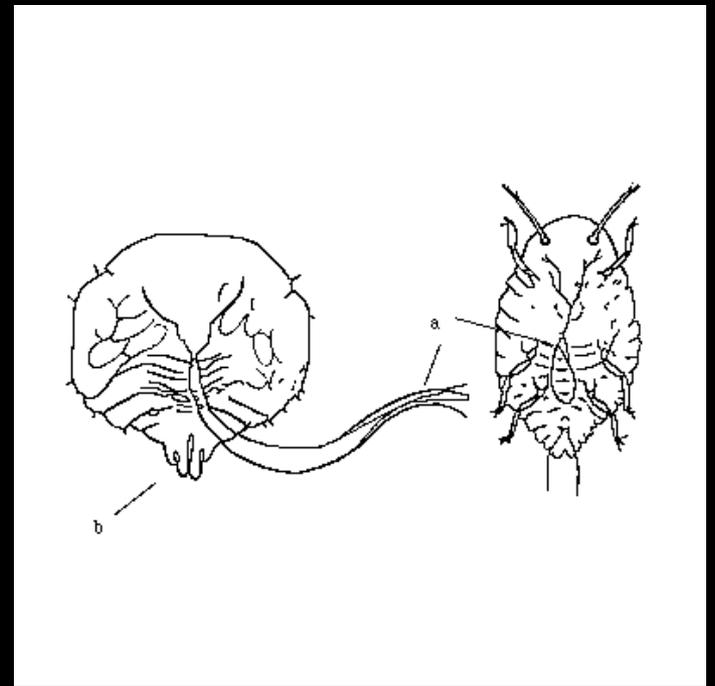
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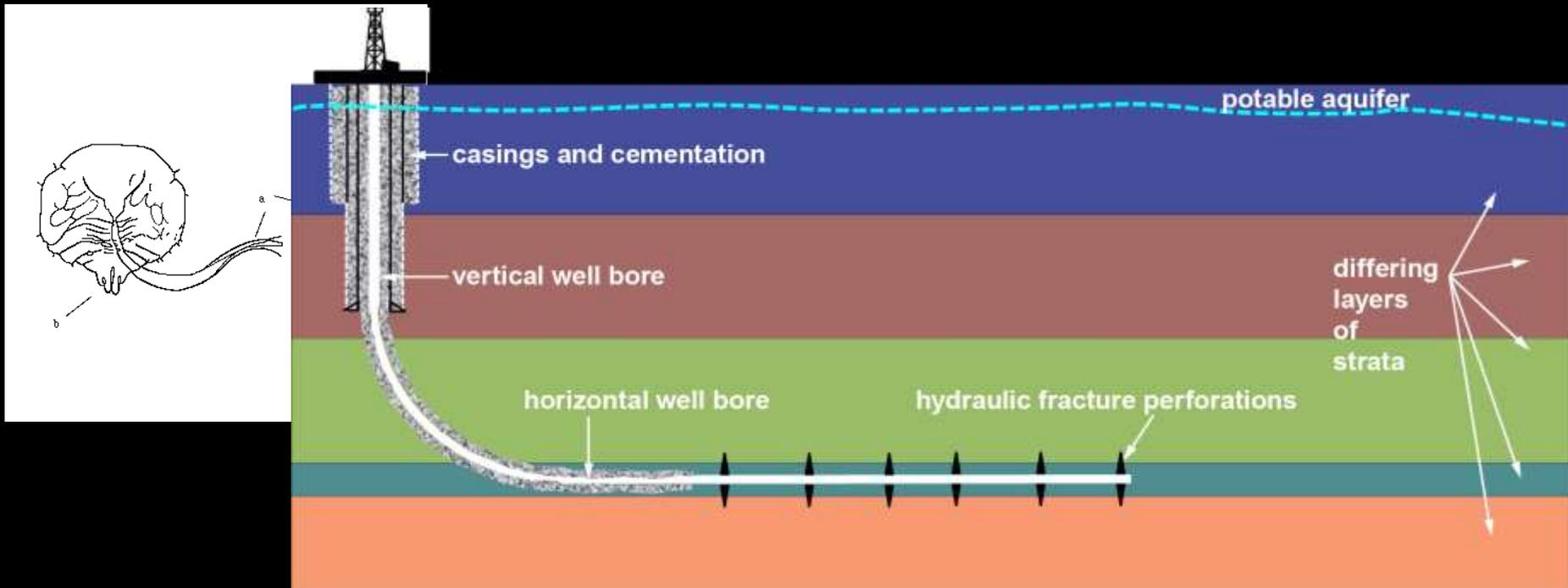
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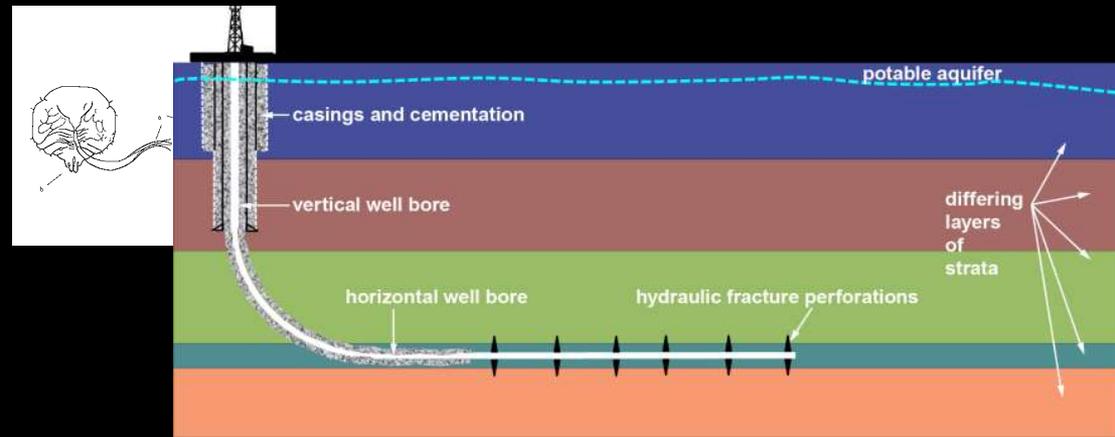


# Scale Insect Feeding

- Soft scales feed on the fluids of the phloem
- Armored scales feed on cell contents, often in cambium



*No honeydew!*



# Males?



Some scale insects rarely or never produce males

If they do the **males** are much smaller than the **females**.

# Males?

Cocoons of  
males scales



Winged adult male



Maturing  
female scales



# Scale Insect Life Cycles

- Eggs are laid under the cover of the mother scale



# Scale Insect Life Cycles

- Eggs are laid under the cover of the mother scale

Pine needle scales  
on pine needle



Pine needle scale adult



Female producing eggs



Pine needle scale mother  
with eggs

Pine needle scale exposed  
from under cover

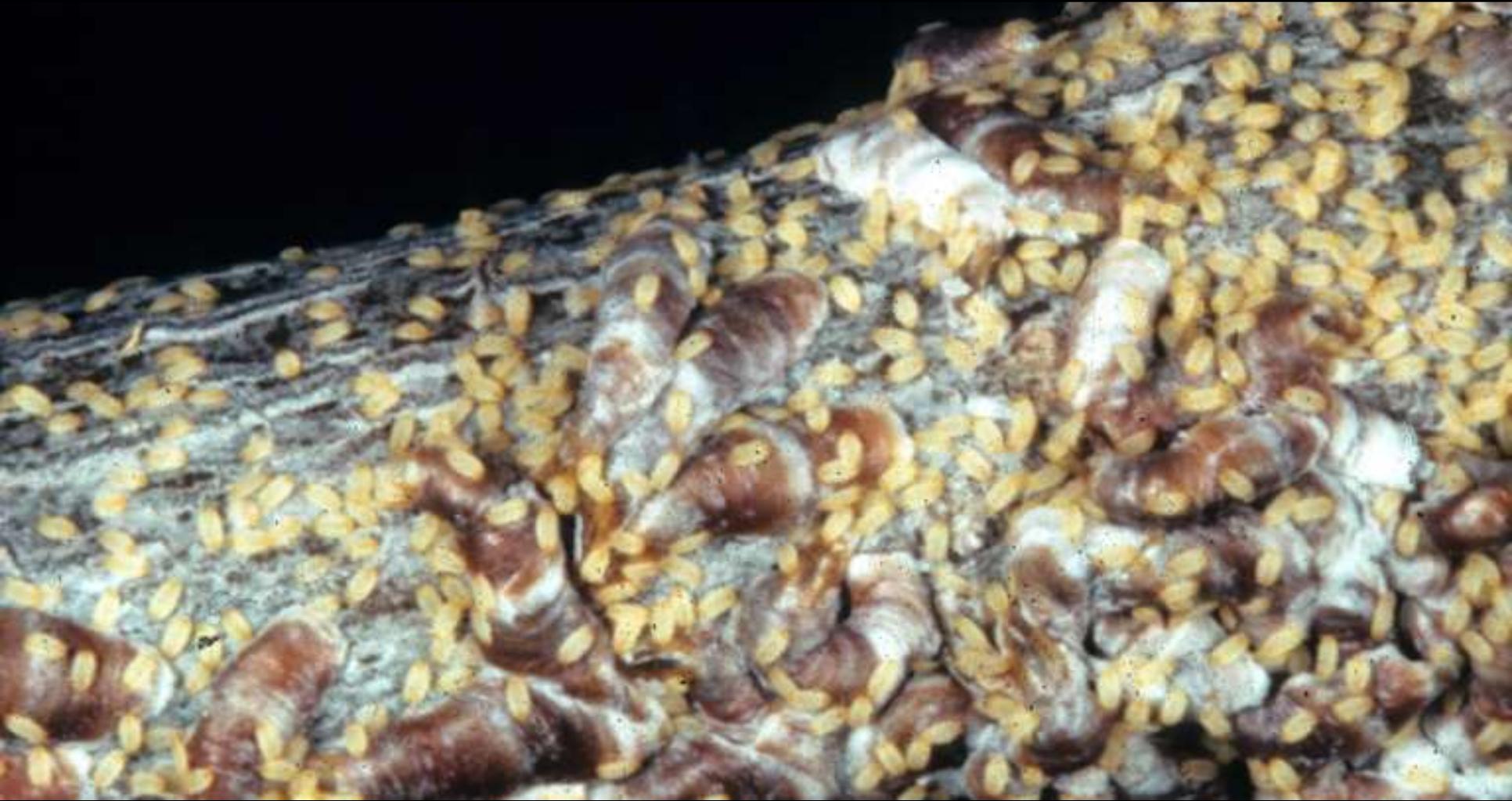
# Scale Insect Life Cycles

- “Crawlers” - 1<sup>st</sup> stage nymphs that hatch from the eggs
  - Most mobile period of all scale insects
  - *Only mobile period* of armored scales



**The crawler stage of oystershell scale usually occurs in late May and early June. It lasts for about a week.**

**It is the only mobile stage of the oystershell scale – and all other armored scales.**





**Within about a week the crawlers have either settled in one place and begun to feed – or have died.**

**Armored scales lose their legs – and mobility – after their first molt**



Settled crawlers of pine needle scale on needles



# Pine needle scale in mixed stages of development



Crawler

Soft scales lay more eggs, and have a much more extended period of egg hatch/crawlers than armored scales



Eggs hatch and crawlers of **striped pine scale** are present from early June through early July (about a month).



Crawlers of  
**European elm scale**  
appear in midJune  
and are present for  
about a month



***Crawler stages of scale insects are highly vulnerable to insecticides!***



# Natural Enemies of Scale Insects

- **Predators**

- Lady beetles (scale specialists)
- Generalist insect predators

- **Parasitoids**

- Numerous parasitoid wasps





*Coccidiphilus* species,  
predator of pine needle scale

*Hyperaspis* species, predator  
of poplar/willow scale

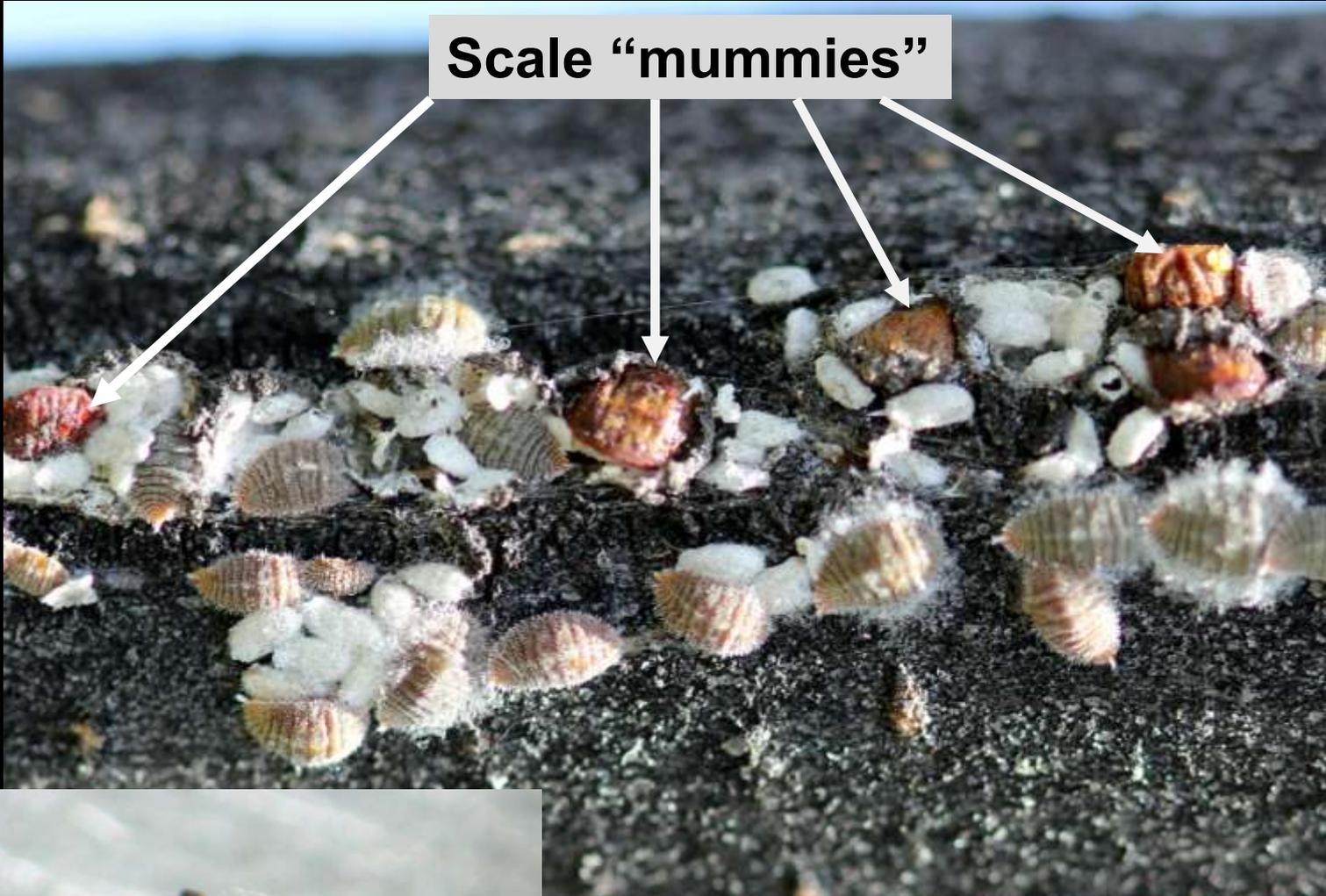


Twicestabbed lady beetle,  
predator of armored scales



There are many kinds of lady beetles  
that specialize on scale insects

Scale "mummies"



European elm scale  
parasitoid wasps

# Round holes in scale cover? Parasitoid wasps



# Soft Scales vs. Armored Scales



**Soft scales produce honeydew**

**Armored scales do not produce honeydew**



# Soft Scales vs. Armored Scales



**Soft scales retain mobility through their lifetime, moving from foliage to twigs**

**Armored scales are only active during the crawler period**



# Soft Scales vs. Armored Scales



**Soft scales typically produce several hundred eggs**

**Armored scales typically produce a couple of dozen eggs**



# Soft Scales vs. Armored Scales



**Soft scales typically produce crawlers for several weeks in late spring and early summer**

**Armored scales typically produce crawlers for a week or two in spring**



# Principles of Scale Control

- **Hand removal**
- **Sprays directed at crawlers**
- **Oils**
  - **Dormant season treatment**
  - **Post-crawler treatment**
- **Systemic insecticides**



## Scraping oystershell scale







# Crawler treatments



***Crawler stages of scale insects are highly vulnerable to insecticides!***



# Crawler Treatment Strategies

- Apply insecticides with long residual activity *when crawler period is expected to begin.*
- Apply insecticides with short residual activity *at peak period of crawler activity*

# Monitoring for Scale Insect Crawlers Using Double-sided Sticky Tape



Photographs courtesy of University of California Statewide IPM Program

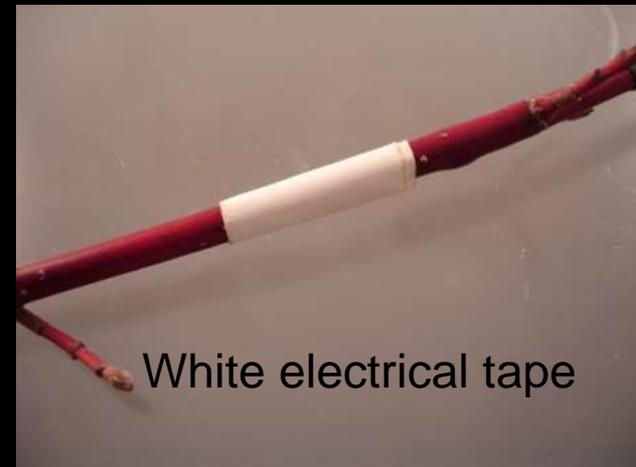
# Monitoring for Scale Insect Crawlers Using Double-sided Sticky Tape



Photographs courtesy of University of California Statewide IPM Program

# Scale Monitoring Using Sticky Tape

- Use double-sided sticky tape or electrical tape (black, white) covered with petroleum jelly
  - Chose color with good contrast for the scale crawler of interest



# Scale Monitoring Using Sticky Tape

- Use double-sided sticky tape or electrical tape (black, white) covered with petroleum jelly
- Flag the branch
  - Check several times/week starting 10-14 days before expected crawler emergence



# Crawler Treatments with Residual Activity (weeks)

- **Persistent pyrethroids**
  - Bifenthrin (Onyx, Talstar)
  - Permethrin (Astro, etc.)
  - Cyfluthrin (Tempo)
- **Carbaryl (Sevin)**
- **Pyriproxifen (Distance, Fulcrum, etc.)**
- **Acetamiprid (TriStar)**
- **Dinotefuran (Safari, Zylam, etc.)**



**Insecticides that kill  
many insect species  
and are sprayed on  
foliage slaughter  
natural enemies!**



# Scale Crawler Treatments with Long Residual Activity

- Bifenthrin (Onyx, Talstar, etc.)
- Permethrin (Astro, Permethrin, etc.)
- Cyfluthrin (Tempo)
- Carbaryl (Sevin)
- Pyriproxifen (Distance, Fulcrum)
- Acetamiprid (TriStar)
- Dinotefuran (Safari, Zylam, Transtect)

# Residual Scale Crawler Treatments *that Conserve Natural Enemies*

- Bifenthrin (Onyx, Talstar, etc.)
- Permethrin (Astro, Permethrin, etc.)
- Cyfluthrin (Tempo)
- Carbaryl (Sevin)
- **Pyriproxifen (Distance, Fulcrum)**
- Acetamiprid (TriStar)
- Dinotefuran (Safari, Zylam, Transtect)

# 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

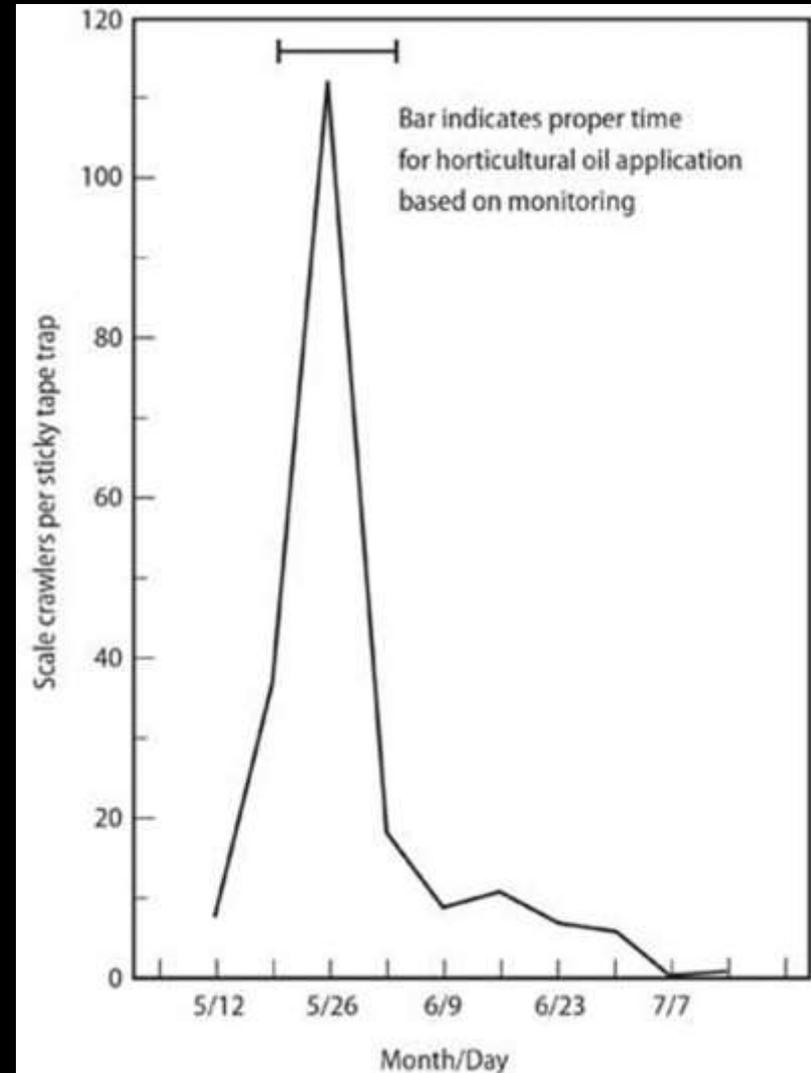
- Trade names Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects
- **Very little effect on natural enemies of insect pests**
  - ***Allows integration of biological controls with chemical controls***



# Contact Treatment *without* *Residual Effects*

- Horticultural oils
- Insecticidal soaps

Timing: *Around peak period of crawler activity*



# Soaps vs. Oils against young scales



# Oils: Better on armored scales



# Soaps: Better on soft scales





Current horticultural oils can be used on trees with foliage.

Crawlers and young settled scales are targets.



TRUSTED SINCE 1926  
**BONIDE**

**All Seasons**<sup>®</sup>  
Horticultural & Dormant **Spray Oil**

*C.o.n.c.e.n.t.r.a.t.e*  
MAKES 12 GALLONS

ACTIVE INGREDIENT	Petroleum Oil (Superior type U.S. No. 22)	99.00%
OTHER INGREDIENTS		1.00%
TOTAL		100.00%

KEEP OUT OF REACH OF CHILDREN  
**CAUTION**  
(See Back Panel for Additional Precautionary Statements)

Net Contents 16 FL. OZ. (1 Pt.) (473 ML.)

Kills Insects by Smothering.

For use on...

- Fruit Trees
- Shade Trees
- Evergreens
- Ornamentals
- Flowers
- House Plants

Use Year-Round

218



Oils used during the dormant season can help control scales – *with very little impact on natural enemies*

# Systemic Insecticides and Scale Insects?

- **Soil applications**
  - Dinotefuran (Safari, Zylam, Transtect)
  - Imidacloprid (Merit, Mallet, Zenith, etc.)
    - *Soft scales only*
- **Trunk spray applications**
  - Dinotefuran (Safari, Xylam, Transtect)

# Scale insect control

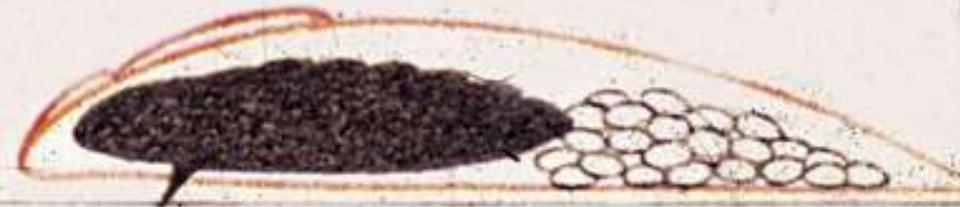
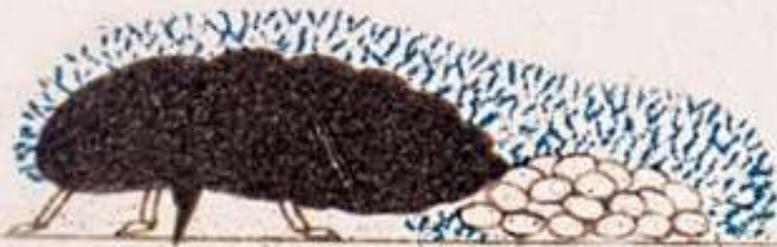
## Imidacloprid applied as soil drench?



**Systemic insecticides applied to the soil for root uptake are primarily effective against phloem-feeding soft scales**

**‘Soft’ Scales**

**Armored Scales**



# Soft Scales vs. Armored Scales

European elm  
scale a soft scale



**Feeding Site: Phloem**

**Soft scales produce  
honeydew**

**Feeding Site: Cells,  
often of the cambium**

**Armored scales do not  
produce honeydew**



Pine needle scale,  
an armored scale



Pine tortoise scale and striped pine scale – soft scales on pines

## Imidacloprid Control Range for Scale Insects

**Yes – Soft Scale**



Pine needle scale, black pineleaf scale – armored scales on pines

**No – Armored Scale**



# Soil Systemic Insecticides and Scale Insects?

– Imidacloprid (Merit, Mallet, Zenith,  
etc.)

- *Soft scales only*

– Dinotefuran (Safari, Zylam,  
Transtect)

- *Soft scales and armored scales*



Retail formulation

# Dinotefuran formulations

## Commercial formulations for ornamentals

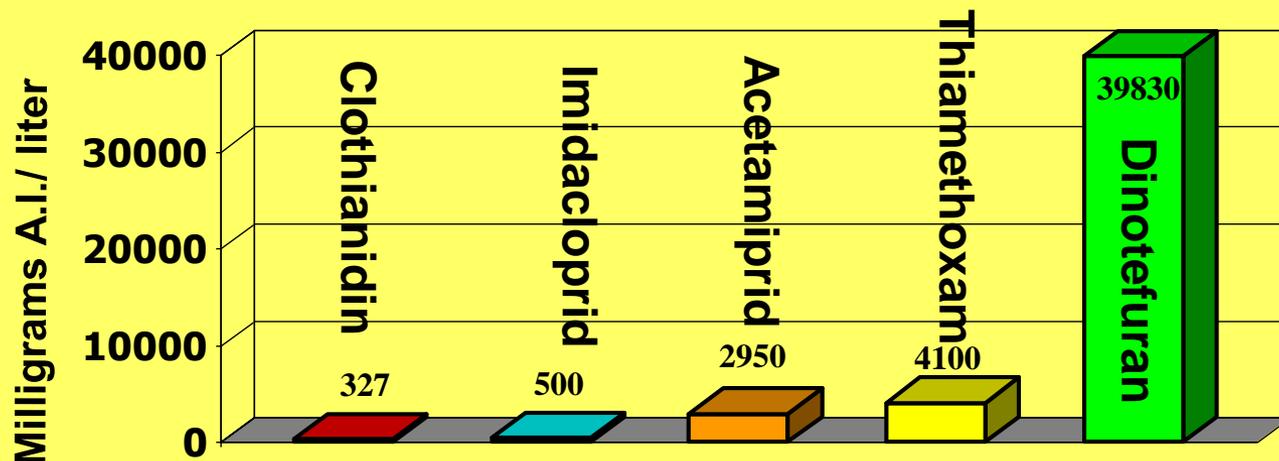


DoMyOwnPestControl.com



# Relative Water Solubility of Neonicotinoids:

## *Water Solubility (Active Ingredient)*



### ***Information sources***

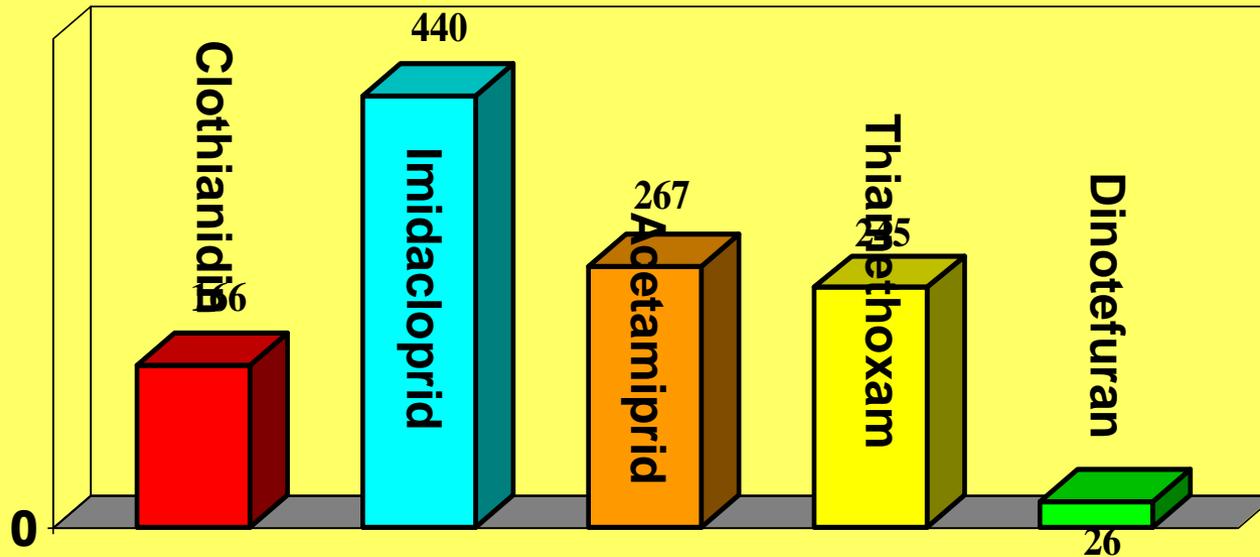
***Clothianidin (Celero), Acetamiprid (Tristar), Dinotefuran (Safari) – EPA Pesticide Fact Sheet  
Imidacloprid (Marathon), thiamethoxam (Flagship) – MSDS for Products***

Slide information courtesy J. Chamberlin



*Longwood  
Gardens*

# $K_{oc}$ Values of Neonicotinoids:



Source Data: EPA Pesticide Fact Sheets



# Dinotefuran (Safari, Transtect, Zylam)

- **Neonicotinoid insecticide**
- **Primarily labeled to control insects that suck sap (Order Hemiptera)**
  - Aphids
  - Soft scales
  - ***Armored scales***
- **Has systemic activity in plants**
  - ***More mobile in plant than other neonicotinoids***



**Basal trunk spray with  
dinotefuran (Safari, Transtect,  
Zylam)**



**Whole tree sprays produce surface residues on all foliage. Natural enemies are killed. Natural controls are wasted.**



**Treatment area limited to bark of lower trunk. Impacts on natural enemies are minimized**



**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.**

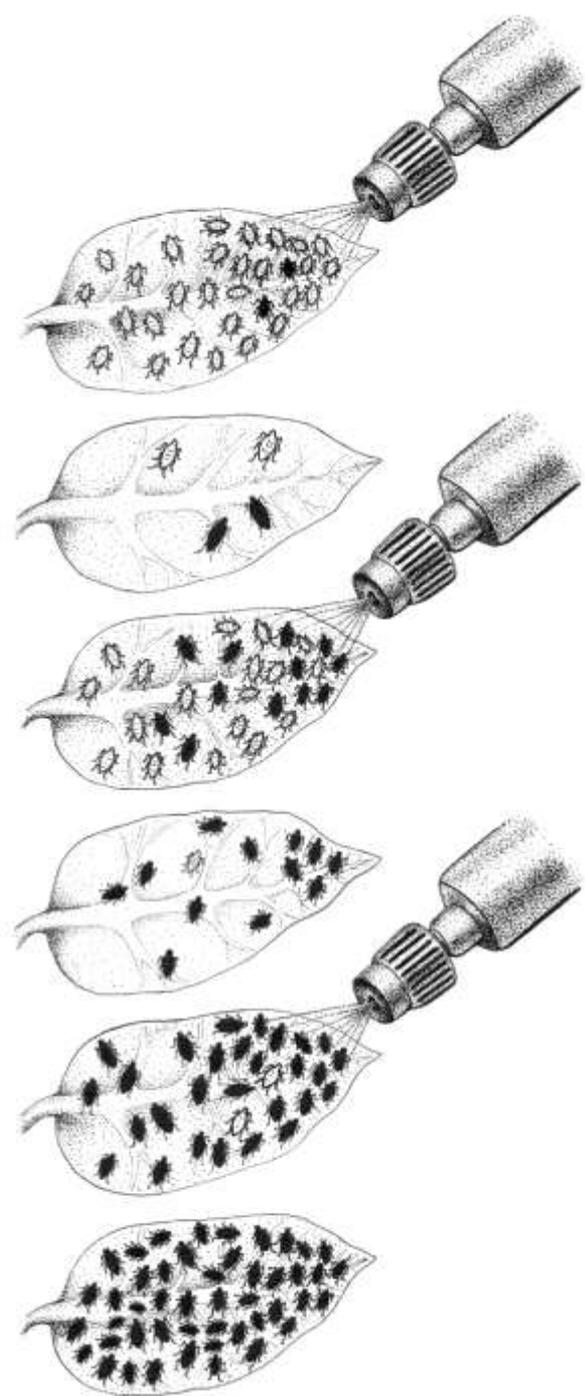


**European elm scale was one of the first shade tree insects against which the new insecticide imidacloprid was tested (ca 1993).**

**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, Zenith, Mallet, Marathon, etc.)
- **Clothianidin** (Arena)
- **Thiamethoxam** (Flagship, Meridian)
- **Dinotefuran** (Safari, Transtect)
- **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?

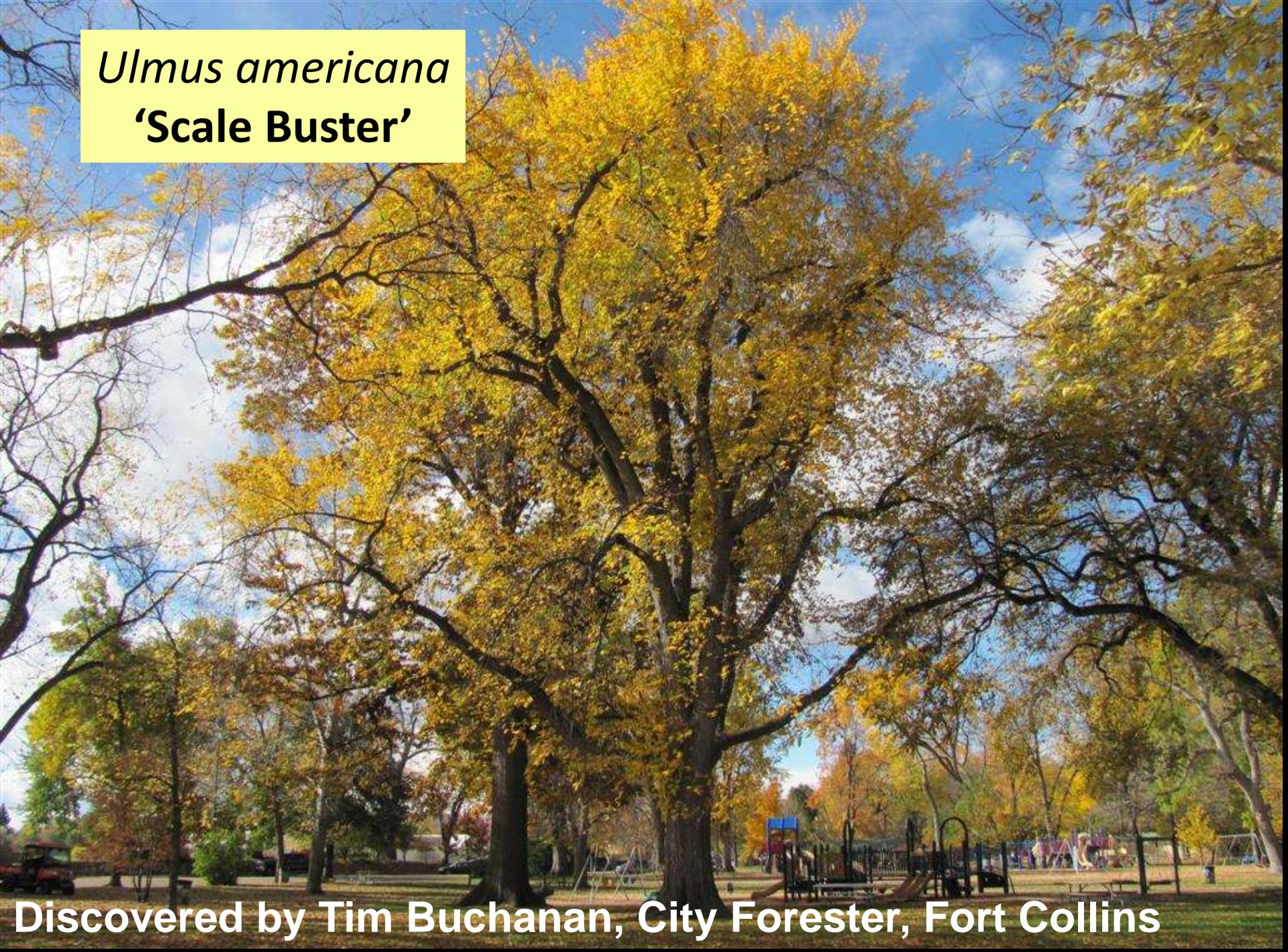
- **Soil/Trunk Injections**
  - Acephate (Lepitect, AceJet)
  - Azadirachtin
- **Foliar Applications**
  - Pyriproxifen (Distance, Fulcrum)



American elms resistant  
to the scale insect?



*Ulmus americana*  
**'Scale Buster'**



**Discovered by Tim Buchanan, City Forester, Fort Collins**

Cuttings from Scalebuster were first taken for propagation in 1996.

Five years later these were planted out around 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***

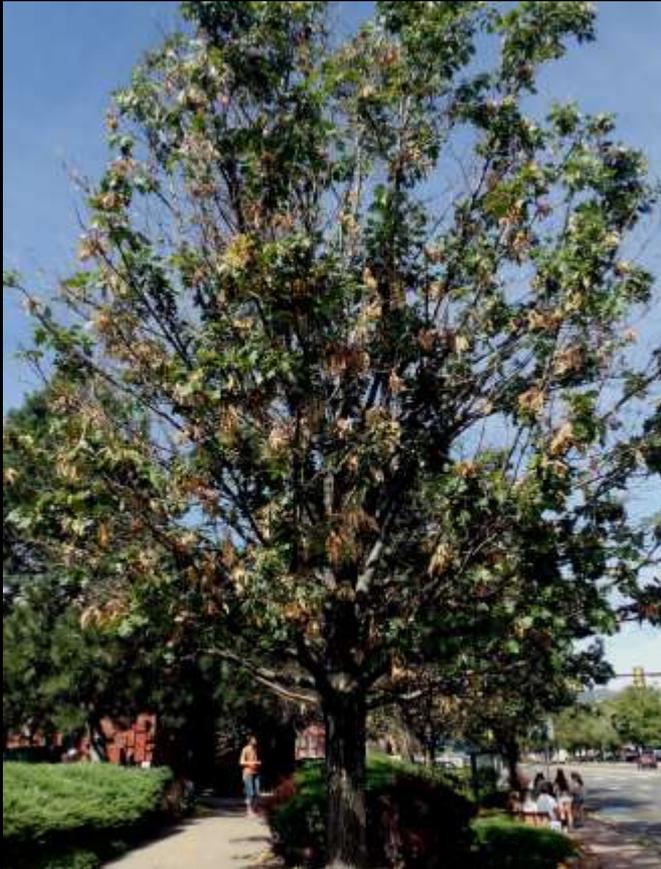


**This presentation will be posted at the Insect  
Information Web Site**

- **Housed at Department of  
Bioagricultural Sciences and Pest  
Management**
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bottom of page**

# 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**



Result?



Twig dieback, flagging



Abscission of twigs

Which leads to:



Reduction in healthy foliage

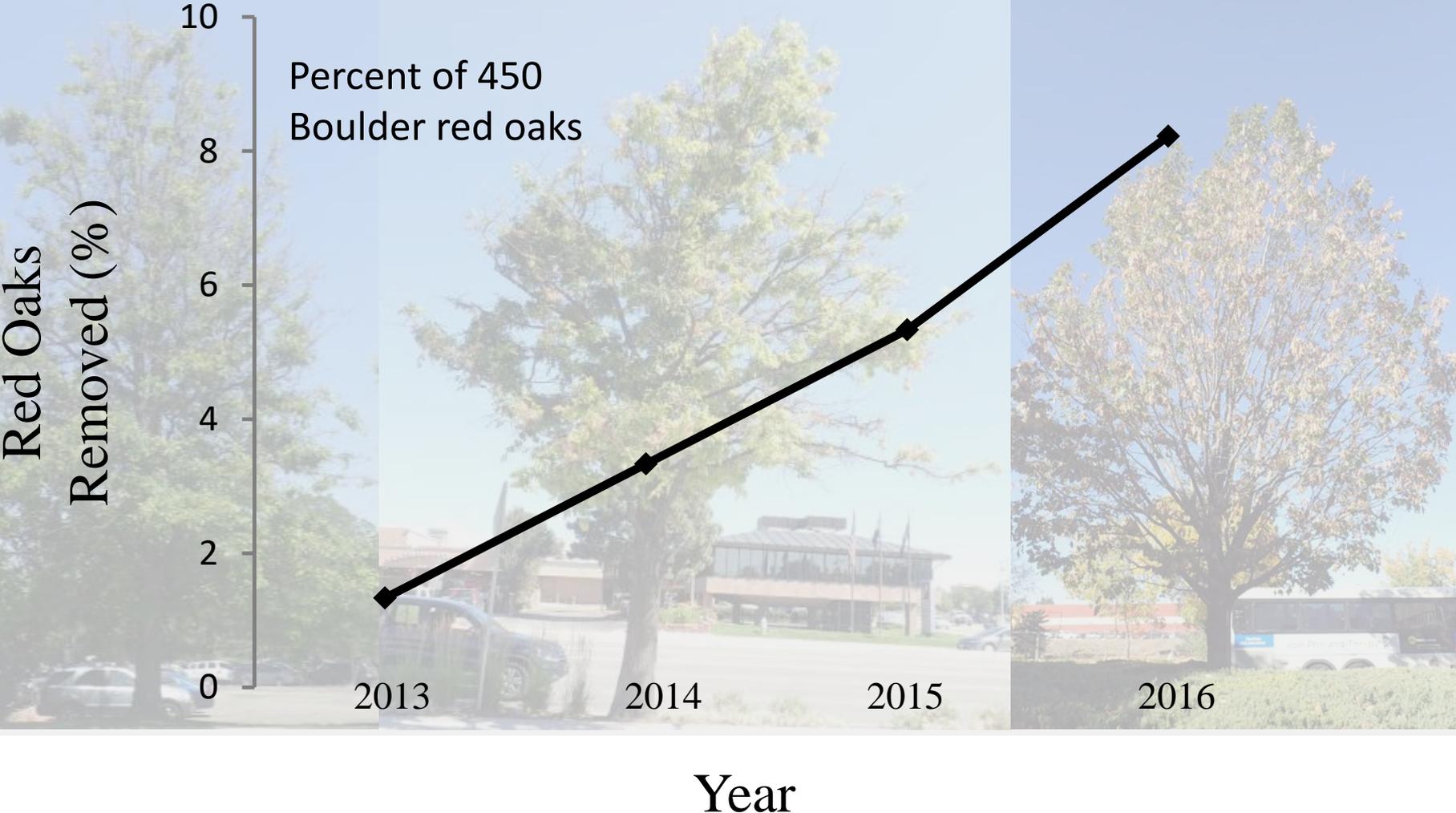


Progressive dieback of canopy



Invasion by flatheaded  
appletree borer

# Trees that have sustained injury decline and become candidates for removal





Drippy blight has be  
worked up by Rachael  
Sitz – now a USFS  
plant pathologist at  
Moscow



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