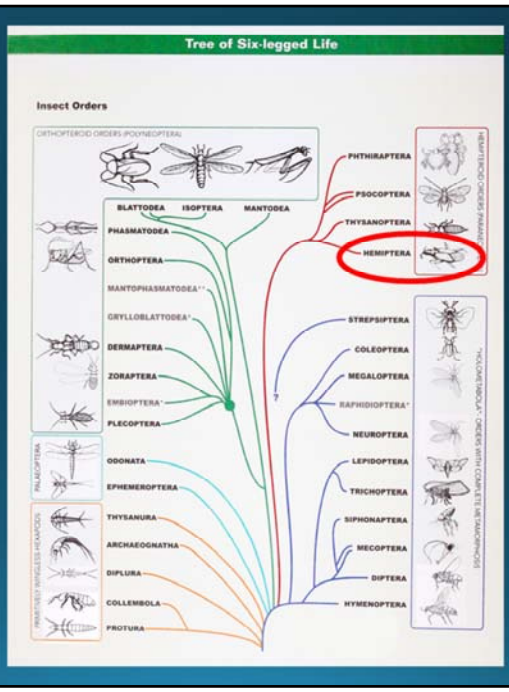
1. Introduction to scales
    1. The Hemiptera (True bugs)
    2. How “bugs” got their name
    3. Difference between Heteroptera and Homoptera
    4. Major scale families
    5. Parts of a scale
    6. Scale life cycles
2. Biology of scales
    1. How scales feed
    2. Honeydew
    3. Scale symbiotic relationships with ants
    4. Parasites and predators of Scales
        1. Parasitoids
        2. Predators
3. Controlling scales
    1. Scale protections from insecticides
    2. Different kinds of insecticides used on scales
        1. Horticultural and dormant oils
            1. Properties of oils
            2. When to apply

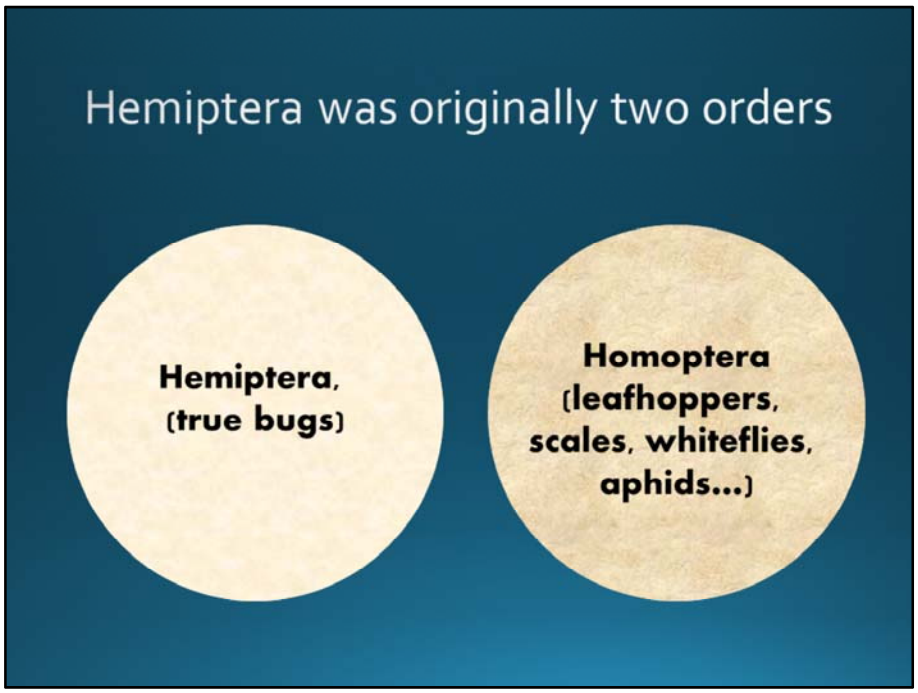
        3. Sensitivity issues
    1. Residual insecticides
        1. Timing
        2. Advantages and disadvantages
    2. Systemic insecticides
        1. Orthene
        2. Neonicotinoids
    3. Insect growth regulators and others
1. Important Texas Scale insects
    1. Eriococcidae
        1. Crape myrtle bark scale
    2. Diaspididae
        1. Euonymous scale
        2. Obscure scale
        3. San Jose scale
    3. Coccoideae
        1. Wax scales
        2. Lecanium scales

Insect classification

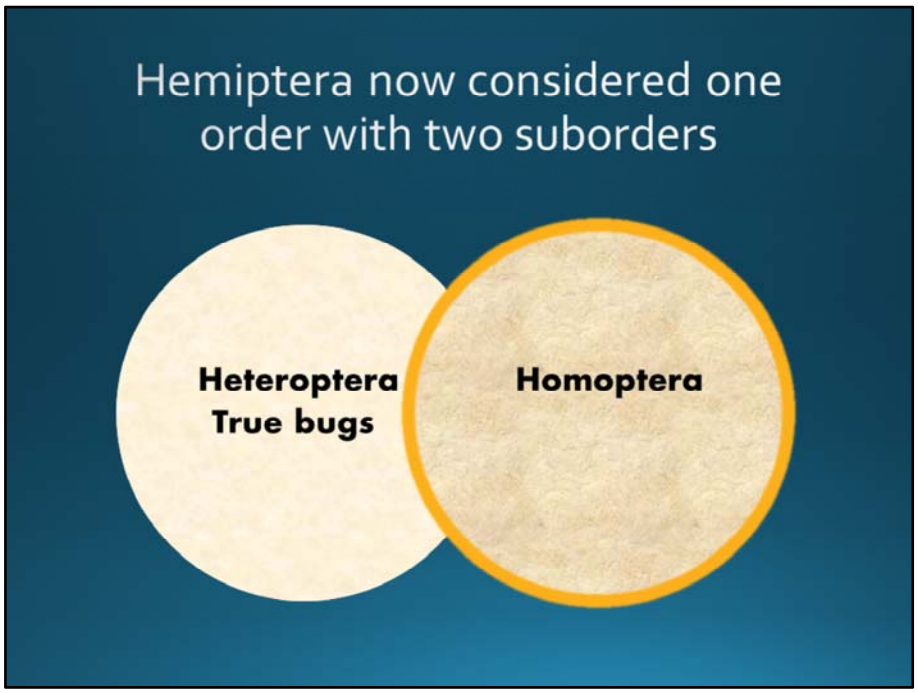
- Insects divided into major groups called Orders
  - Orders
  - Suborders
  - Superfamilies
  - Families



Scales belong to the insect Order Hemiptera

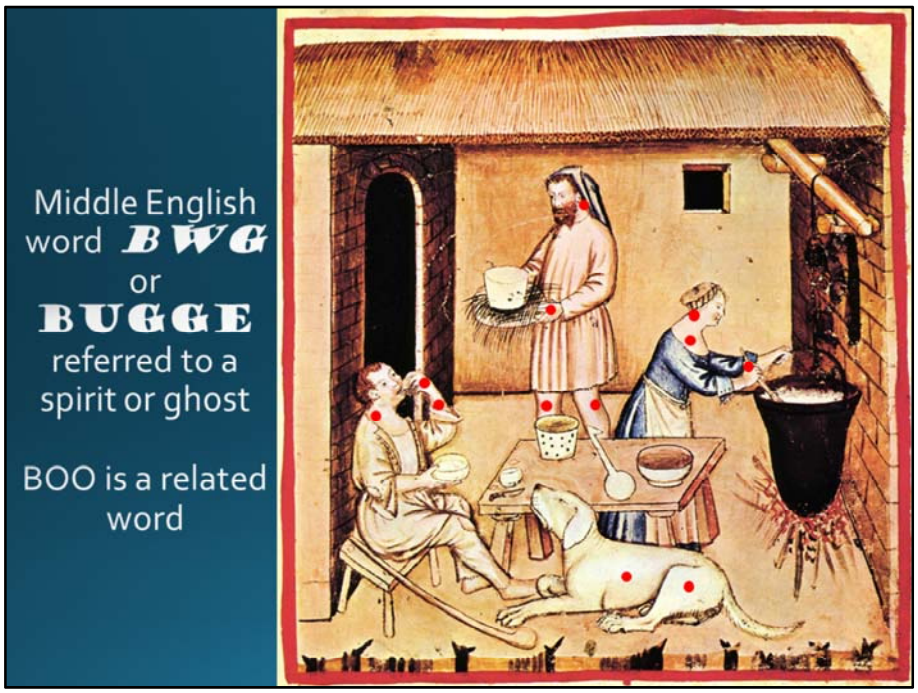


Heteroptera (originally Hemiptera)



Heteroptera (originally Hemiptera)

Origin of term "bug"



[As an aside, the term bug is an old Middle English word that meant ghost or spirit. When people woke up in the morning with red, itchy welts, people use to attribute these marks to bugges or mischievous spirits. Of course the red marks were not ghosts at all, but the bites of small insects that we today call bed bugs. The term bug evolved to refer to not just bed bugs but any relative of the bed bug, within the suborder Heteroptera. There are some other bugs that bite, BTW. Kissing bugs are another blood sucking parasite in this group.]

So bed bugs were the original bug. We don't usually call Homoptera "bugs" but they are cousins of the true bugs – the Heteroptera.

Hemiptera

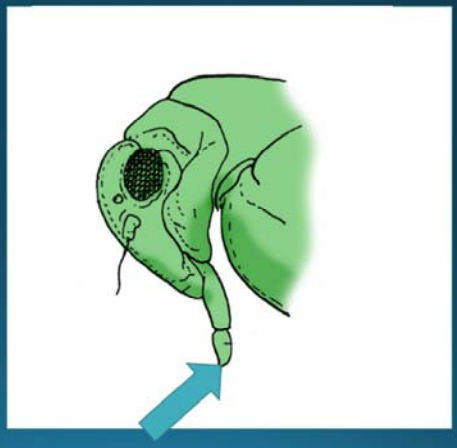
- Heteroptera (true bugs)
- Other homopteran suborders
  - Auchenorrhycha
  - Sternorryhncha

Characteristics of homopteran groups

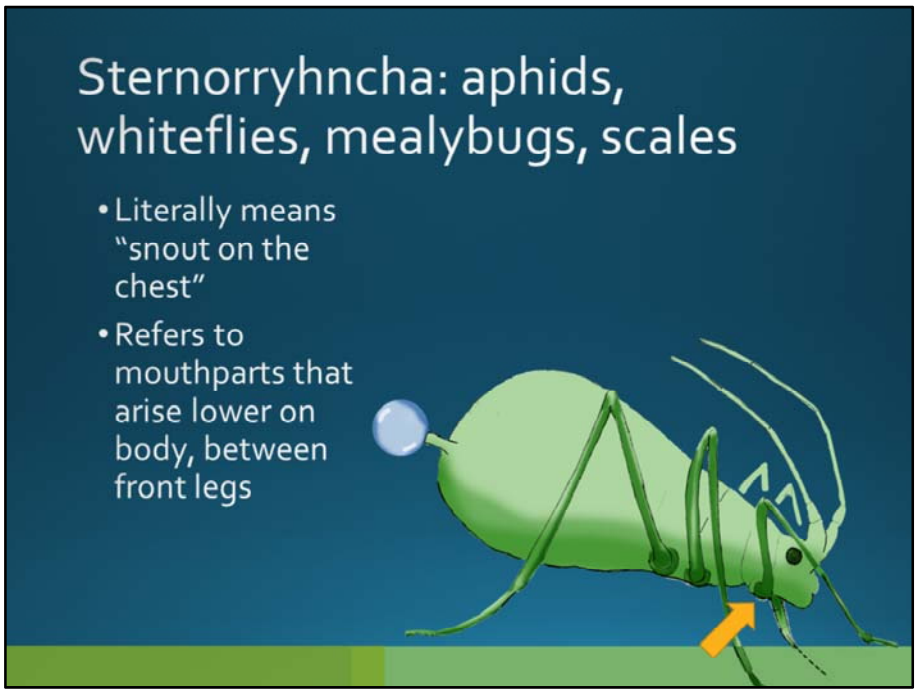
- Gradual metamorphosis
- Piercing/sucking mouthparts arise from back of head or between legs
- Antennae short, bristle-like, or filiform
- Plant feeders

Auchenorrhyncha: cicadas, leafhoppers and spittlebugs

- Name means "snout behind the head"
- Refers to mouthparts that arise "behind" the head



Suborder Auchenorrhyncha

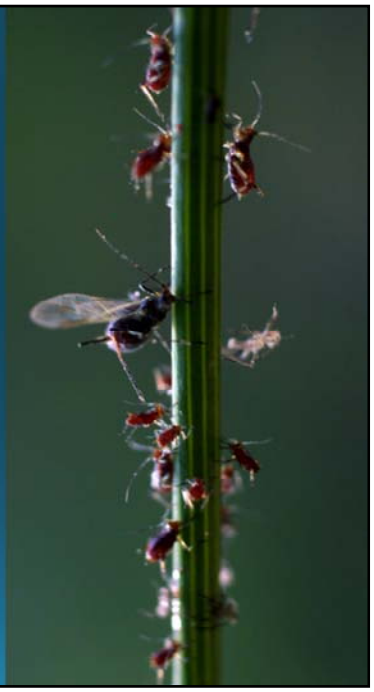


Suborder Sternorrhyncha is the group we are going to focus on today, specifically the scales.

There are four major kinds of insects that feed on phloem sap.

Aphids

- One of most common sap-feeding insects
- Hundreds of species, often specialized in one or a few types of hosts
- Rapid reproducers



Two more important sap feeders to be able to recognize.

Because they feed on leaf undersides, whiteflies make an ideal target for systemics. It's especially difficult to kill these insects with standard contact and residual sprays because of their feeding location.

Scale insects superfamily Coccoidea

- Related to aphids
- Over 850 species in America north of Mexico
- 17 families

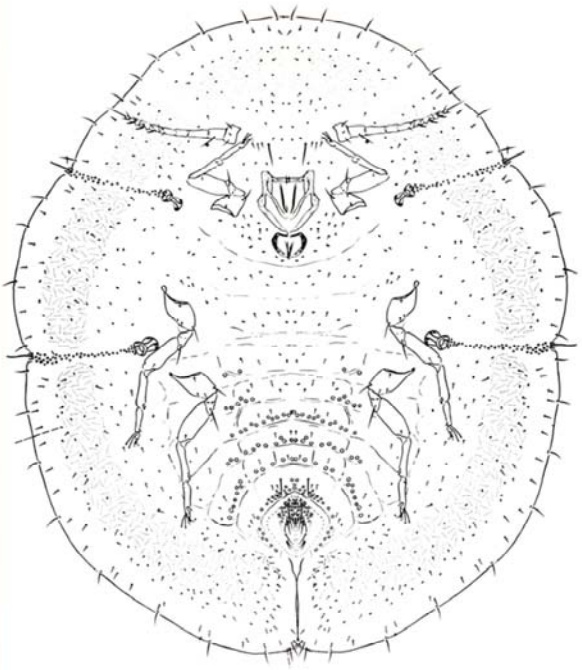
Important Coccoidea families

- **Pseudococcidae** – mealybugs
- **Eriococcidae** – felt/bark scales
- **Cryptococcidae** – bark crevice scales
- **Kermesidae** – gall-like scales
- **Asterolecaniidae** – pit scales
- **Cerococcidae** – ornate pit scales
- **Lecanodiaspididae** – false pit scales
- **Acleridiidae** – flat grass scales
- **Dactylopiidae** – cochineal scales
- **Coccidae** – soft scales
- **Diaspididae** – armored scales

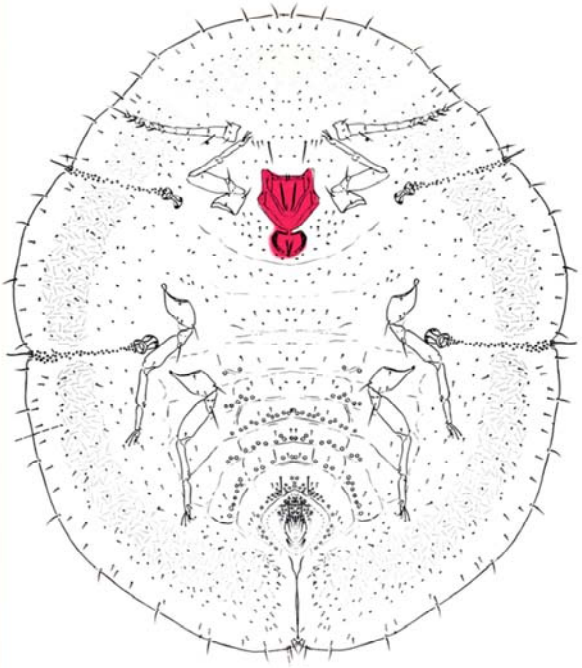

Parts of a scale

Parts of a scale

Viewed as if mounted on a microscope slide

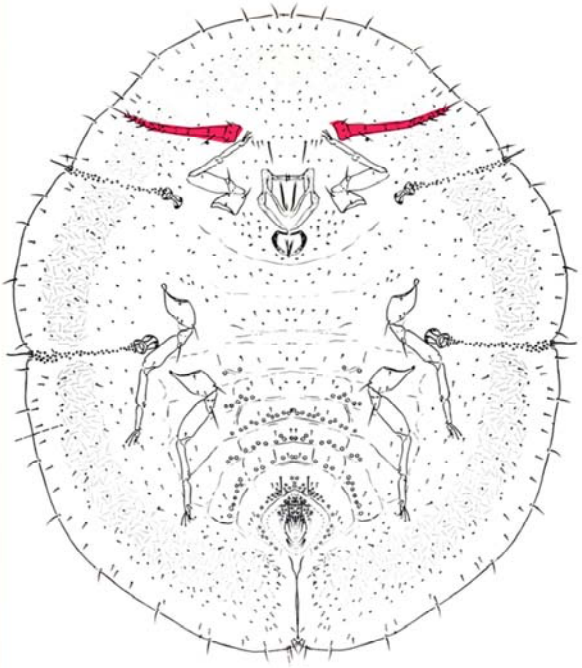


Parts of a scale



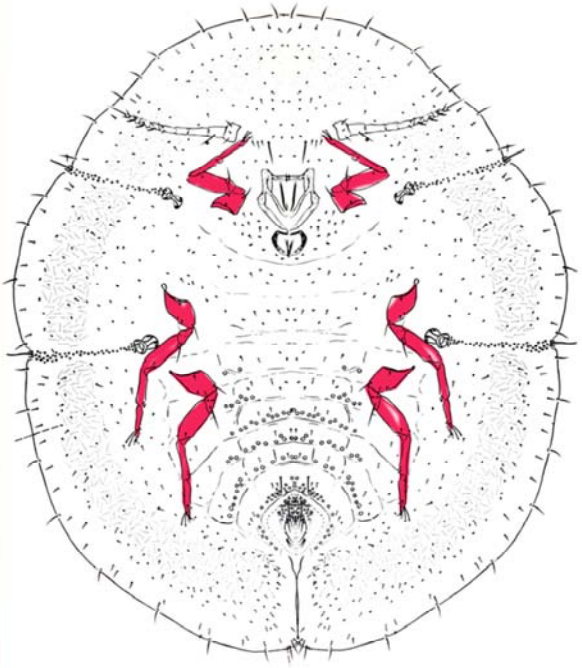
mouth

Parts of a scale

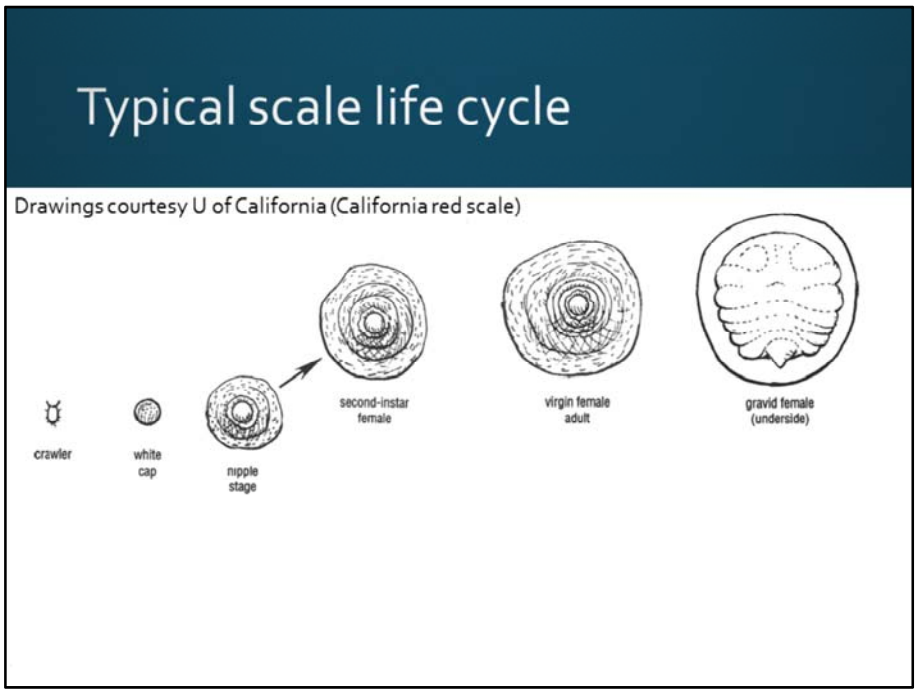


antennae

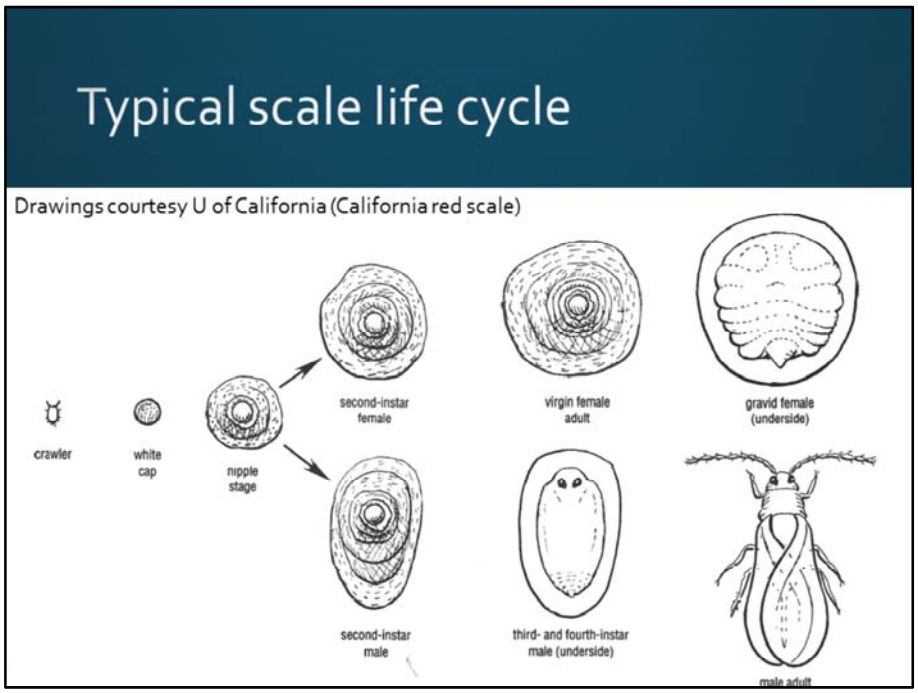
Parts of a scale



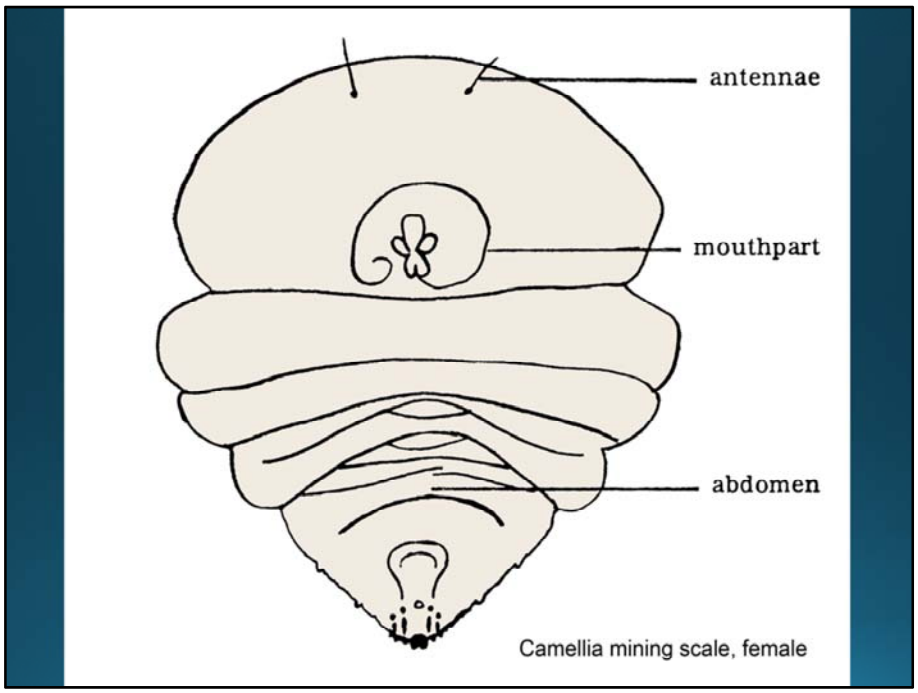
legs

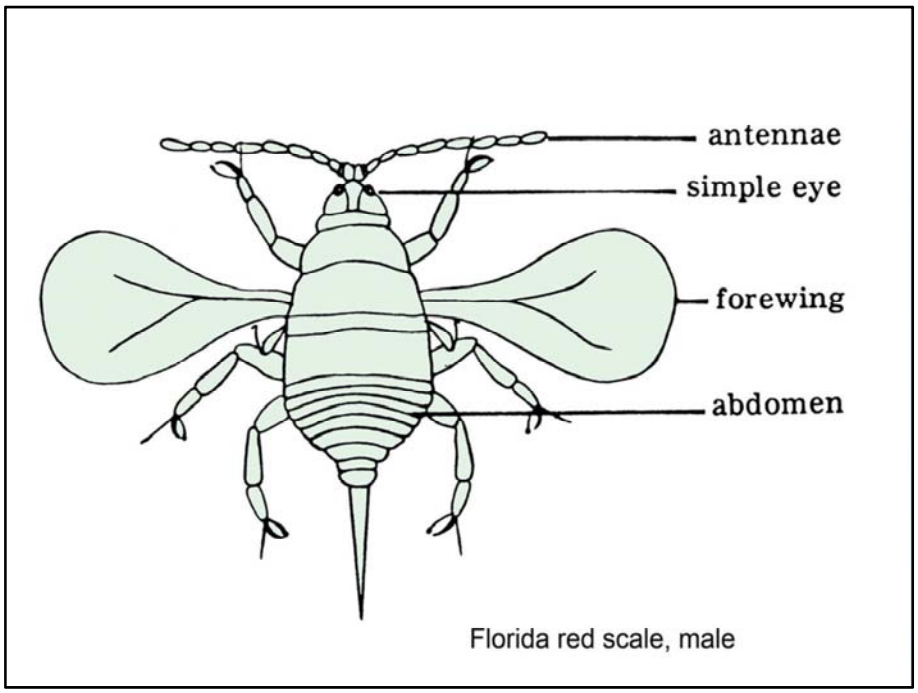


Scales are one of the oddest appearing insects, and have some unique life stages.
Drawings courtesy U of California (California red scale)



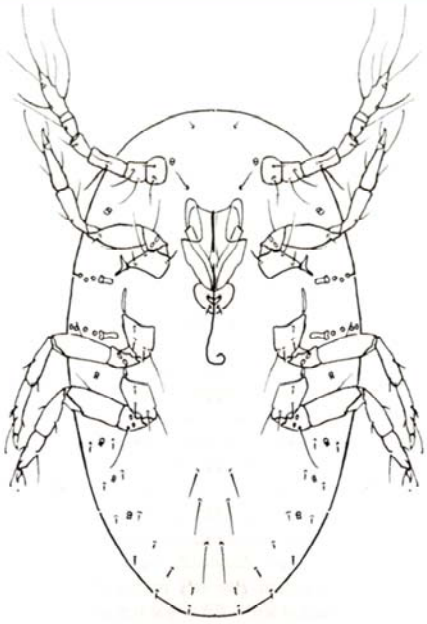
The adult male, unlike the female, is winged. If you bag a branch with scale insects at the right time, chances are good that you will see little flying insects in the bag after several days. These are the males. Males seek sexually mature females by their pheromone scents, and mate. Then the females become gravid and fill with eggs, eventually dying under the scale cover she has spent her entire life under.


antennae
mouthpart
abdomen
Camellia mining scale, female

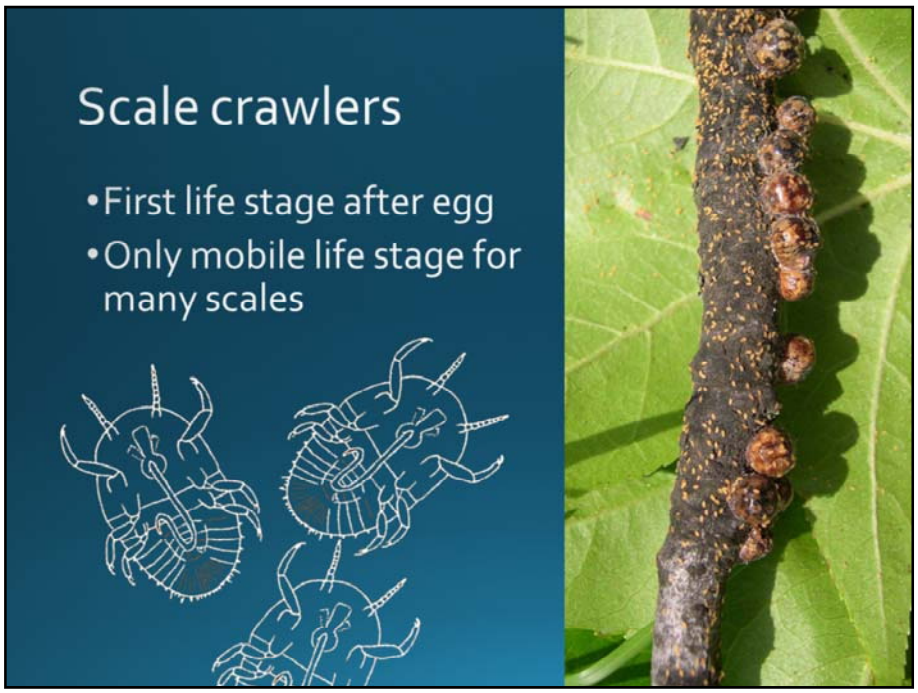


Florida red scale, male

crawler



Coccid scale crawler, 1st instar

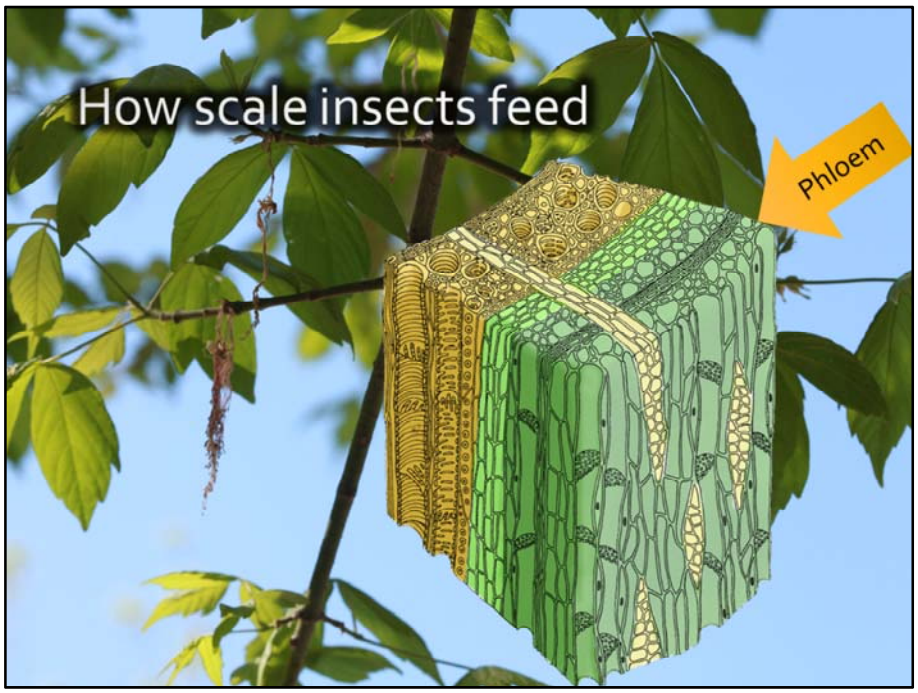


Unfortunately every scale species is a little different, so it is difficult to predict when scale emergence will occur without observations. The small, yellow insects on the stem in this picture are crawlers.

If the female is wingless, how do scale infestations spread?

- Wind (crawlers)
- Rain
- Ants
- Human transport
- Birds, mammals?

Other scale, notably the armored scales feed on non-vascular plant cells, the parechyma. This type of damage is often seen as discoloration at the site of feeding on the leaves.



Many scale insects feed exclusively on phloem

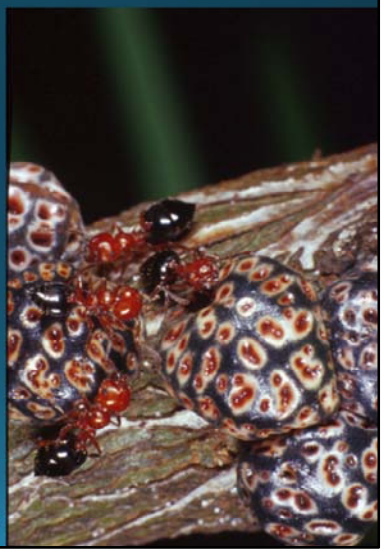
Honeydew consists of sticky organic sugars and excess water taken up by the scales in their efforts to extract sugars and nitrogen from the plant. Because nitrogen is essential to protein building for the scale, but present in relatively minute amounts in the phloem, soft scales take in and excrete large amounts of sap to grow and reproduce.


Honeydew supports other insect communities
Wasps
Bees
Ants

Bees
Ants

Symbiotic benefits

- Scales receive
  - Reduction of sooty mold accumulation
  - Protection from natural enemies
  - Protection from weather
- Ants receive
  - Reliable food supply



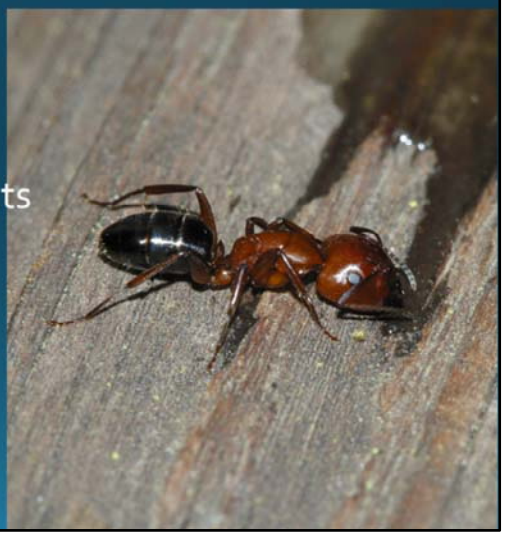
Acrobat ants tend calico scales

How can scale insects contribute to indoor ant infestations?

- A home landscape is an ecosystem with many living parts
- Scale infestations on plants may sustain ant populations that infest indoor areas
- Controlling scale insects will contribute to integrated control of indoor ants

Ants that will feed on honeydew

- Carpenter ants
- Acrobat ants
- Rover ants
- Odorous house ants
- Argentine ants
- Fire ants
- Crazy ants



Scale predators and parasitoids

- Many natural enemies
  - Parasitoids
    - Encyrtid and Aphelinid wasps
  - Predators
    - Lady beetles
    - Mites
    - Lacewings

Encyrtid wasp parasitizing scale

Twice stabbed ladybeetle

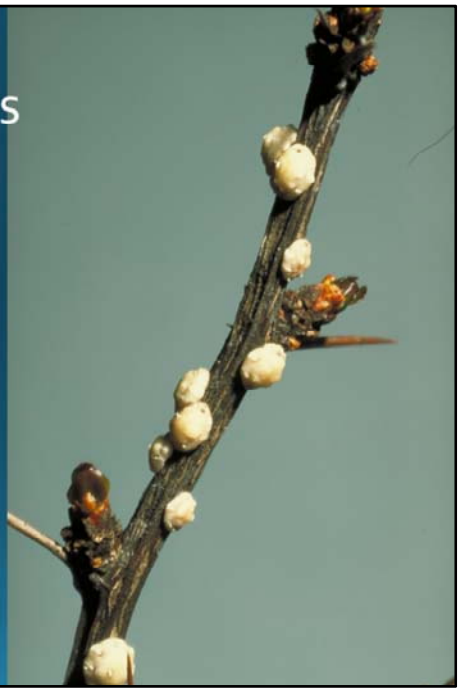
Important scale insects on Texas trees and shrubs

- Coccidae – soft scales
  - Seed-like in shape
  - Scale cover attached to body
  - One generation a year
- Diaspididae – armored scales
  - Flattened
  - Unattached cover of wax and cast skins (armor)
  - Multiple generations per yr
- Eriococcidae – felt or bark scales
  - Felt-like egg sac
  - Multiple generations per year

Crape myrtle bark scale

Coccid soft scales

- Feed on phloem and produce copious honeydew
- Some produce egg sacs
- Do not lose their legs, so may move
- Some produce heavy wax



Ceroplastes wax scale


Calico scale

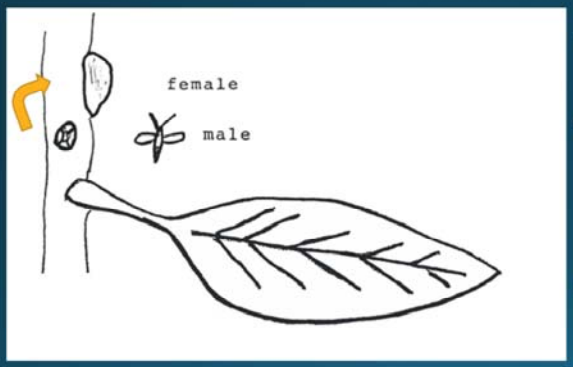

Hemispherical scale on sago palm

One of the most prominent features of this scale is its large ovisac, an egg mass produced by the female at the end of her life. Identification of these scales is best done just before egg lay.

Tropical scale seen mostly on indoor plants

One of the most destructive scales on oak in the area. May require treatment with pyrethroid insecticide during crawler emergence.

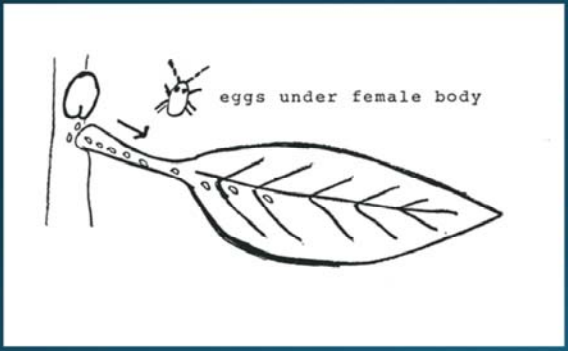
Typical soft scale life cycle



- Early Spring (Mar-Apr)
- Overwintering immature scales on bark molt into adult forms
- Mating occurs now

Drawing: Barbara Rudd

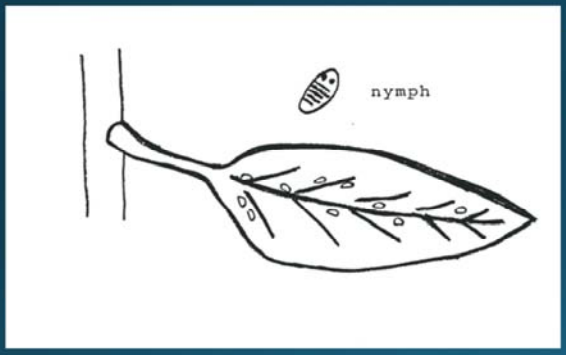
Typical soft scale life cycle



Drawing: Barbara Rudd

- Early summer (Apr-Jun)
- Females enlarge assume typical color pattern
- Heavy honeydew
- Eggs laid and hatch
- Crawlers emerge – good time to treat with insecticide

Typical soft scale life cycle



- Mid summer (Jul-Sep)
- Settled crawlers or nymphs continue to feed

Drawing: Barbara Rudd

Typical soft scale life cycle

Drawing: Barbara Rudd

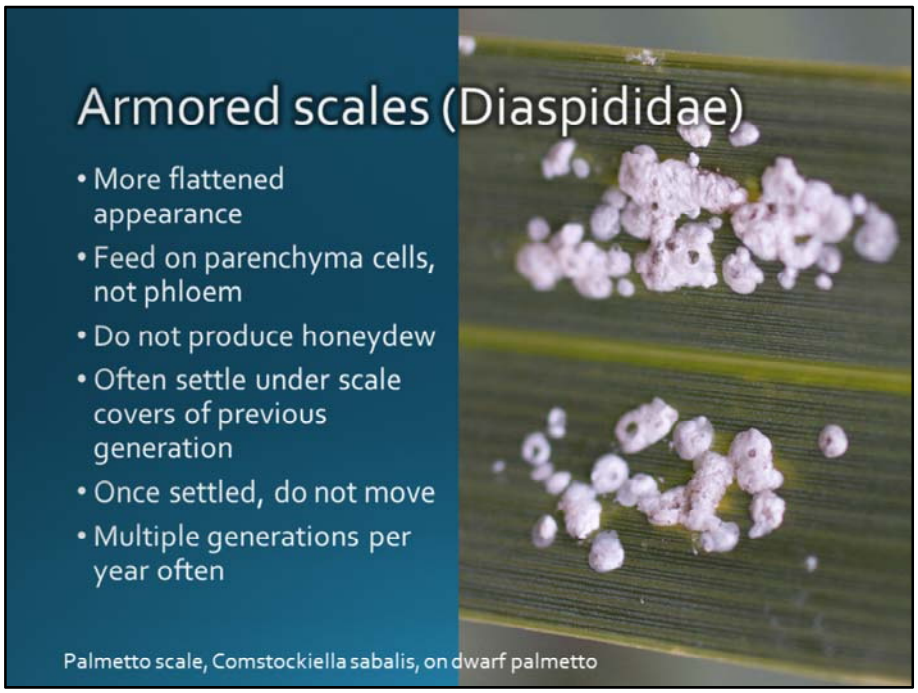
- Fall (Oct-Nov)
- Surviving immatures move back to bark to overwinter
- Second chance to treat with insecticide

Typical soft scale life cycle

- Winter (Dec-Feb)
- Immatures overwinter on bark
- Dormant oil sprays may be profitable for some species

Drawing: Barbara Rudd

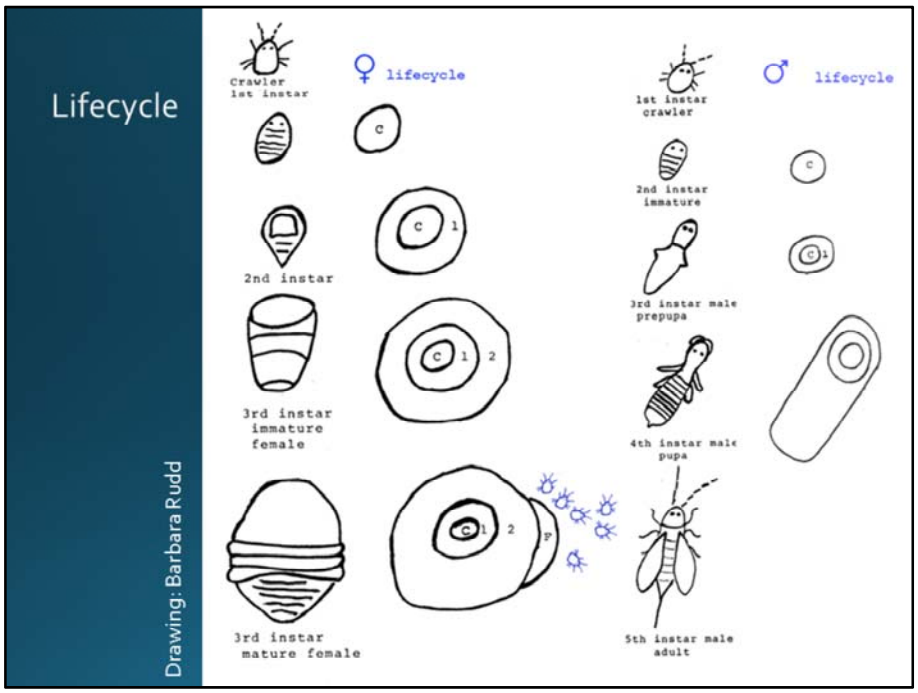

Detecting scale crawler movement
• Use 2X tape wrapped tightly around branches
• Check and replace weekly
• When crawlers are moving, good time to treat



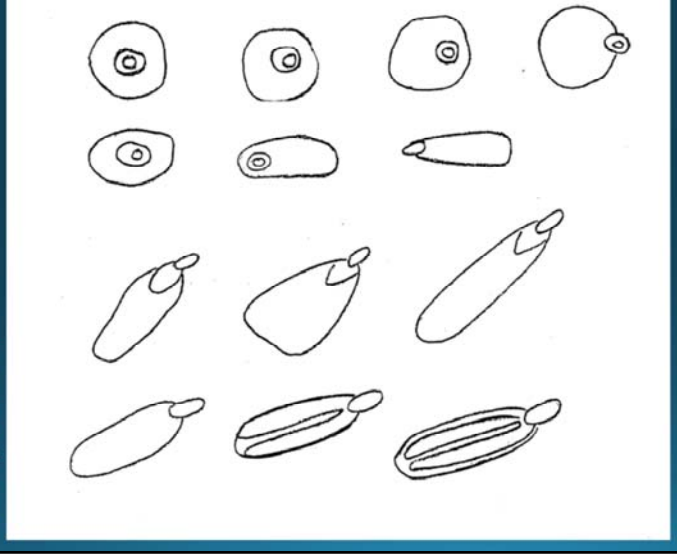
Palmetto scale, Comstockiella sabalis, on dwarf palmetto. An endemic on sabals. Usually held in check by parasitoids.

Lifecycle

Drawing: Barbara Rudd

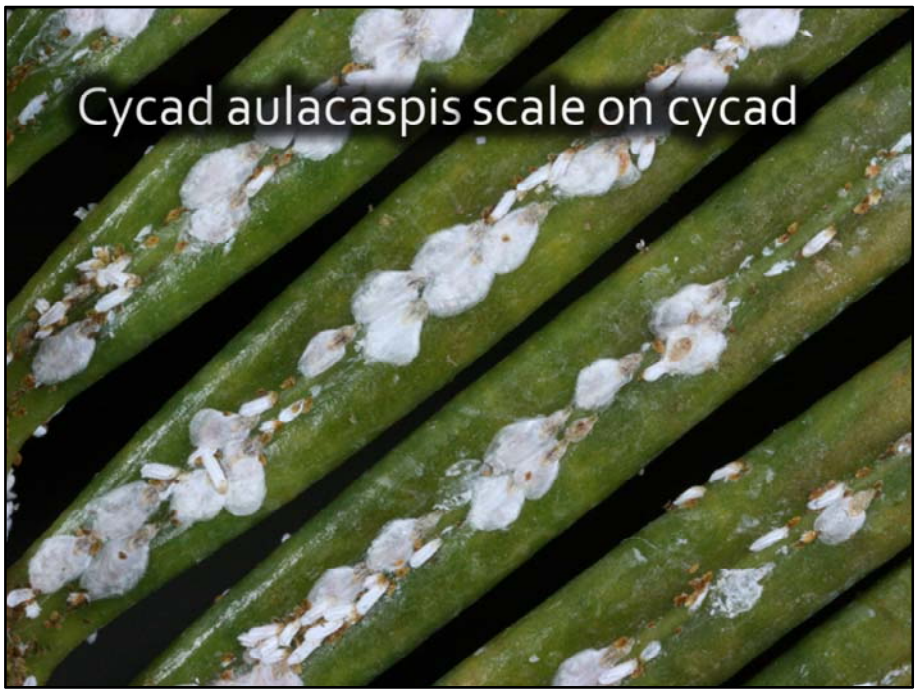

Lifecycle
Drawing: Barbara Rudd
Crawler
1st instar
♀ lifecycle
2nd instar
3rd instar
immature
female
3rd instar
mature female
1st instar
crawler
♂ lifecycle
2nd instar
immature
3rd instar male
prepupa
4th instar male
pupa
5th instar male
adult

Shape variations in armored scales



Drawing: Barbara Rudd

Tropical scale seen mostly on indoor plants



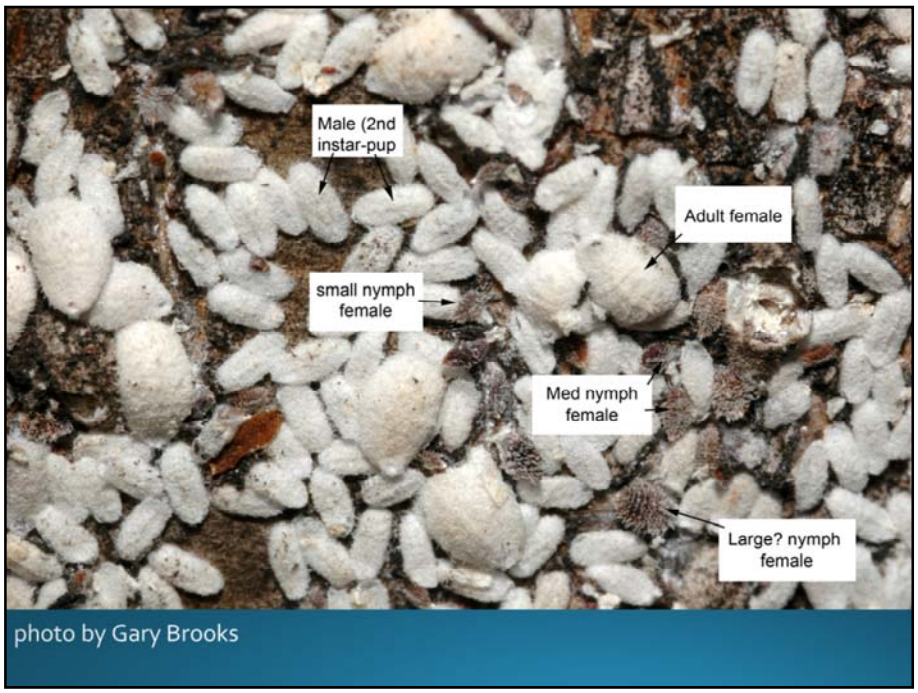
Tropical scale seen mostly on indoor plants

Tropical scale seen mostly on indoor plants

Bark scales (Eriococcidae)

- Adult females (largest scales) enclosed by a white, felt-like egg sac
- Occurs on trunk, branches, roots of host
- Heavy honeydew

Crape myrtle bark scale on crape myrtle



Females have two instars, then the adult. Males have four immature stages. The elongated scales in this image are the males. The large ovisacs are females.


Crape myrtle bark scale
Photo by Erfan Vafaie

The tree on the left was treated with dinotefuran, the one on the right untreated


Chilocorus cacti, twice stabbed lady beetle
Adult

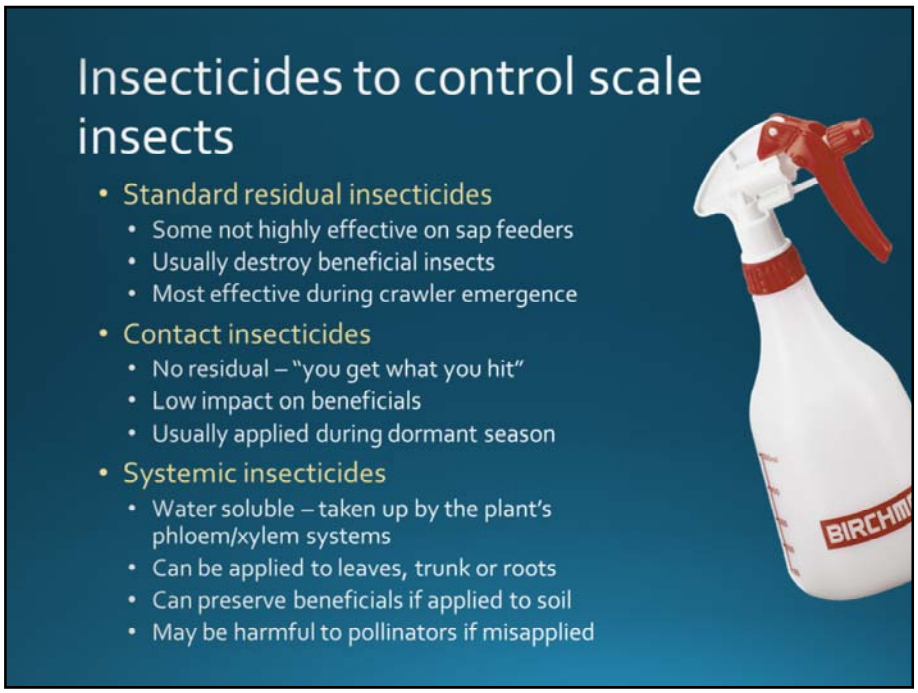
Goals of IPM for scale insects

- Protect and preserve beneficial insects
- Achieve effective and affordable control
- Minimize aesthetic damage due to excess honeydew production

Protecting beneficials

- Protect beneficial pollinators and predators/parasitoids
- Use short-lived contact insecticides
- Avoid applications during or just prior to blooming
  - Especially important on favored nectar trees
- Systemic insecticides applied as a soil drench

Horticultural oil



But before we talk about some of these insects, let's familiarize ourselves with some of the new and old products that control sap-feeders.

Residual insecticide sprays

- Best used in combination with monitoring tape
- Time sprays when crawlers or immatures are moving on the tree
- Longer residual products like
  - Cyfluthrin
  - Bifenthrin
  - Esfenvalerate
  - Other pyrethroids
- Insect growth regulators

Avoid application when temperatures will dip below 32 deg, or above 95 deg. Winter is the best time to use oils because leaves are off most trees and you can use 2X rate without harming the plant. This method is only useful, though, on pests that overwinter on the bark of the tree, and is best on trees that actually lose their leaves in winter.

Systemic insecticides

- Water-soluble, can be absorbed into phloem system of the tree
- Popular products
  - Acephate (Orthene)
  - Imidacloprid
  - Thiamethoxam
  - Clothinidin
  - Acetamiprid
  - Dinotefuran

Which insects would you expect to be well controlled by phloem-transported insecticides?

- Caterpillars
- Leaf beetles
- Soft scales
- Mealybugs
- Armored scales
- Bark scales

Which insects would you expect to be well controlled by phloem-transported insecticides?

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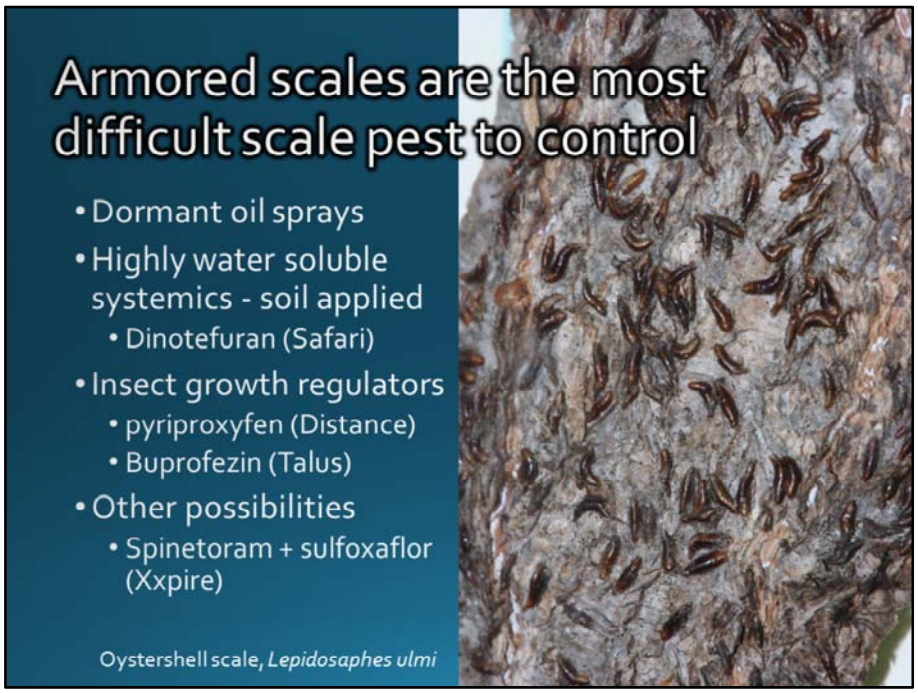
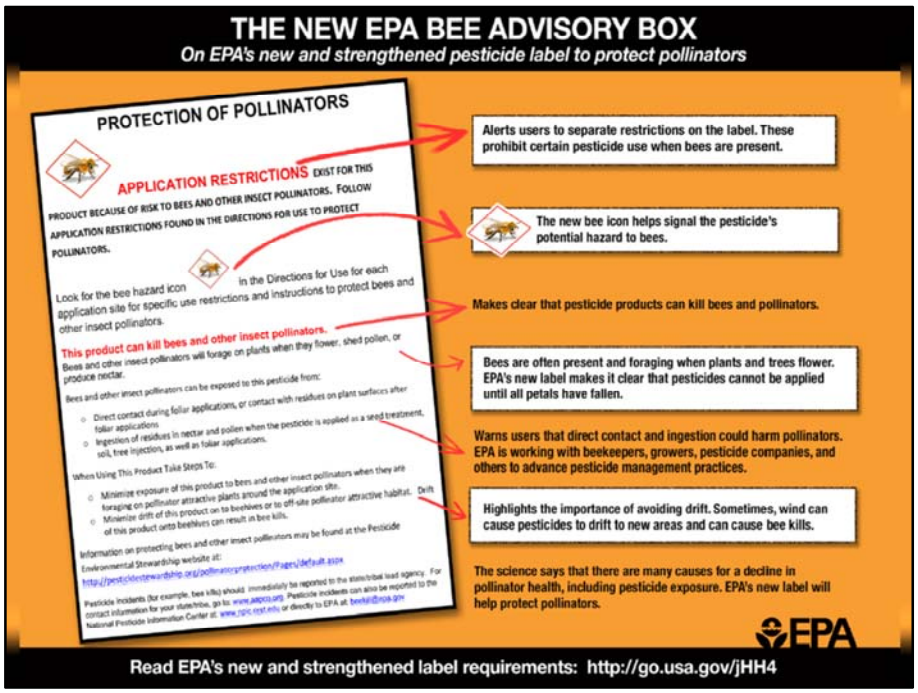
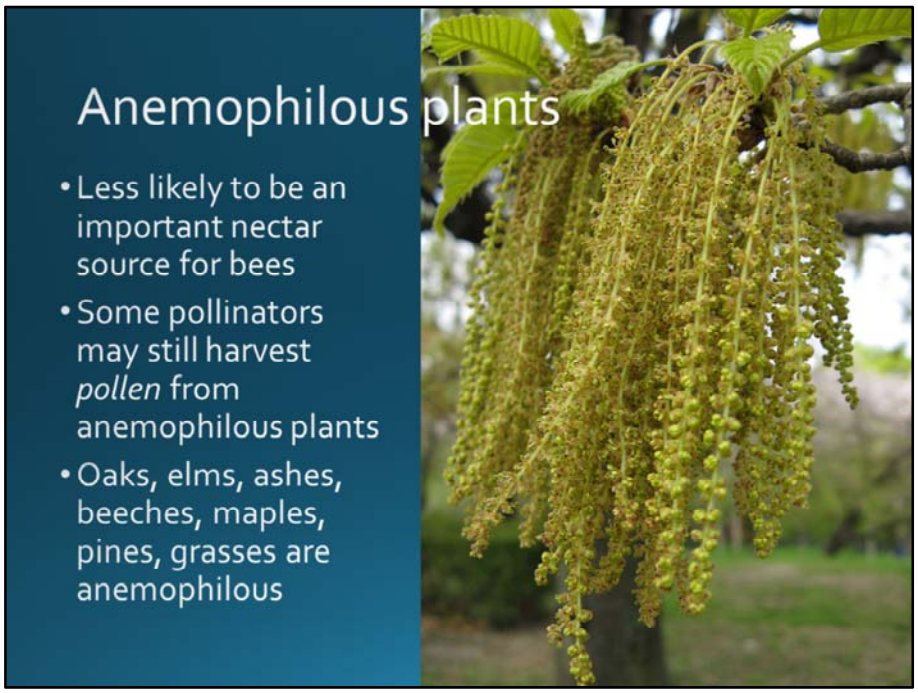


Remember armored scales do not feed in phloem tissue, so only the most highly water soluble systemics will have a chance to be effective. Dinotefuran's high solubility (80X more water soluble than imidacloprid) gives it some unique features when it comes to scale control.

Oystershell scale



Bee Labeling Info Graphic (PDF). U.S. EPA.
http://www.epa.gov/opp00001/ecosystem/pollinator/bee-label-info-graphic.pdf



Trees in urban areas fall into 2 categories from a bee's viewpoint: entomophilous (insect pollinated) and anemophilous (wind pollinated). Entomophilous trees generally include the Rosaceae and Fabaceae as well as lindens and citrus. Bees harvest both nectar and pollen from the obvious flowers on these trees. Anemophilous trees include the oaks, elms, ash, and maples. Bees only harvest pollen from these trees as they do not produce nectar. It should be noted that these wind pollinated trees produce vast amounts of pollen and some of that abundant pollen is readily collected by bees.

Bees will, if given the option, preferentially collect pollen from the entomophilous plants. The issue is that there are times, especially early in the year, when bees are extremely hungry for pollen and there just isn't enough out there for them from their favored plants. We did some pollen collections this spring and were surprised to see that at certain times in early May the bees were collecting 75 or 80% anemophelous tree pollen. I'm not sure about the grass pollen (our pollen analysis hasn't gotten that far through the year's sample yet), but people have definitely shown that bees will collect it as well if there's nothing better. Of course bees, when given no other choice, will begin to collect pollen-like substances like sawdust

and flour.

I don’t know of anyone that has looked broadly pesticide residues in these tree or grass pollens. There has been some work on ash pollen, but I can’t find it at the moment.
Comments from Reed Johnson at Ohio State University.