



# What's Left Behind ... The Diagnostic Clues



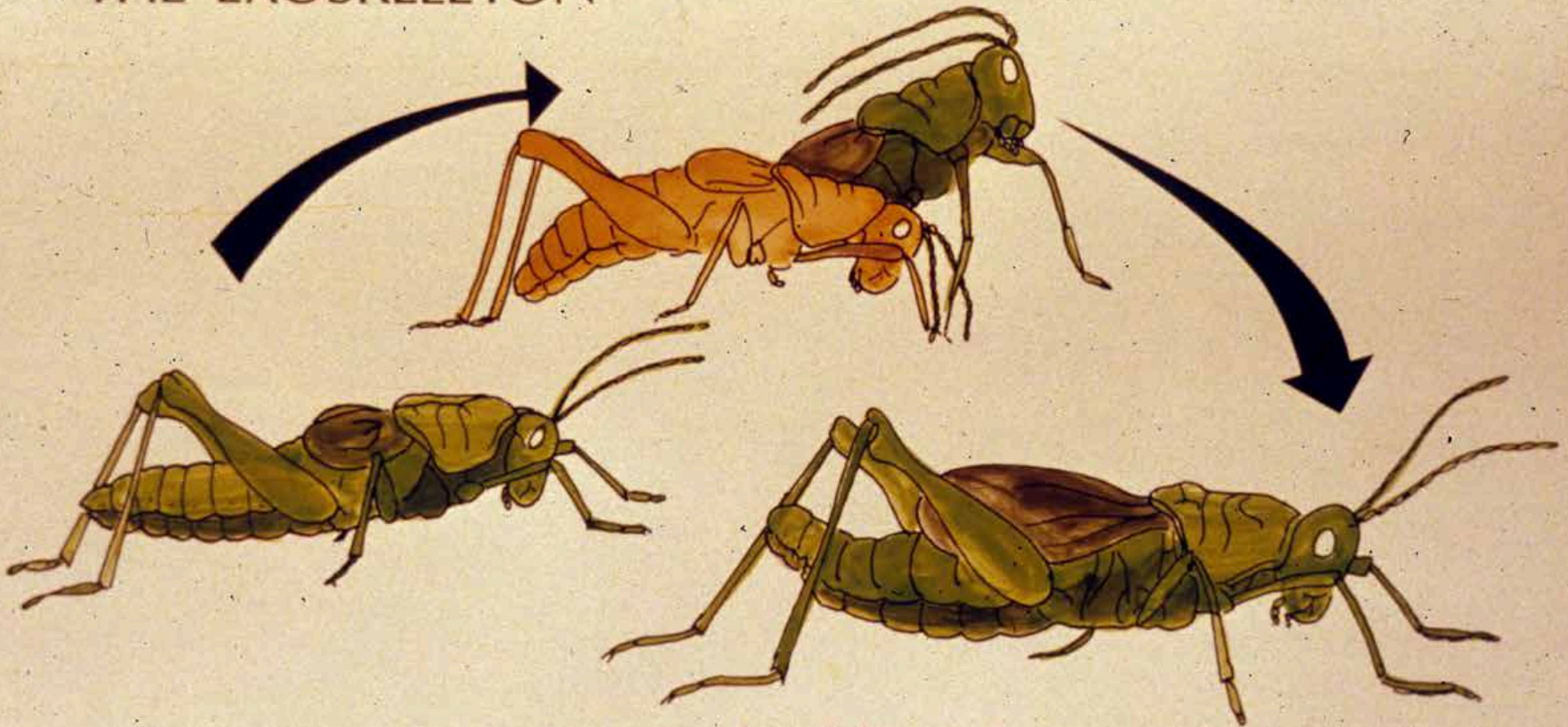
**Whitney Cranshaw**  
Colorado State University

# **Insects leave behind....**

- **Body parts**
- **Secreted materials (silk, wax)**
- **Excreted matter (frass, honeydew, etc.)**

# Insects grow in stages, punctuated by a molting of the previous exoskeleton

THE EXOSKELETON



shedding the exoskeleton  
to permit growth





**EGG**

**NYMPH**

**ADULT**





**Molting example**

**Cicada**

**Immature stages (nymphs)  
live in soil and feed on plant  
roots**

**Adults live in crowns of trees  
and shrubs. The males  
produce songs.**





**When full-grown the nymph  
digs to the soil surface,  
climbs some vertical  
surface, then molts to the  
adult stage.**





**After it extracts itself from the remnants of the nymphal exoskeleton, the adult expands its body and wings. It is pale colored as the exocuticle has not yet sclerotized.**







**After the new exoskeleton has sufficiently hardened, the adult insect can fly away.**

**The remnant of the last nymphal exoskeleton remains behind**





The discarded remnants of the previous exoskeleton remain after the adult emerges. This may be known as the exuviae, or, more popularly, a “cast skin”.





**Madagascar hissing coackroaches – two are in various stages of a molting event**







**Chewing insects typically consume the old cast skin to recover nutrients**

# **Plant-feeding Arthropods that feed with sucking mouthparts**

- **Hemiptera (true bugs, aphids, leafhoppers, whiteflies, mealybugs, scales, etc.)**
- **Thysanoptera (thrips)**
- **Acari (mites)**



**Molting of a  
squash bug  
nymph**





**Aphid shedding  
previous exoskeleton  
(cast skin)**



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



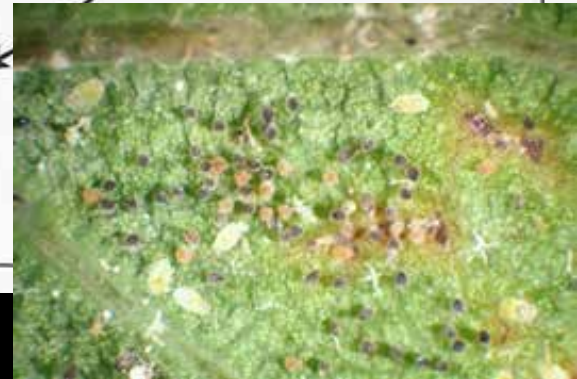
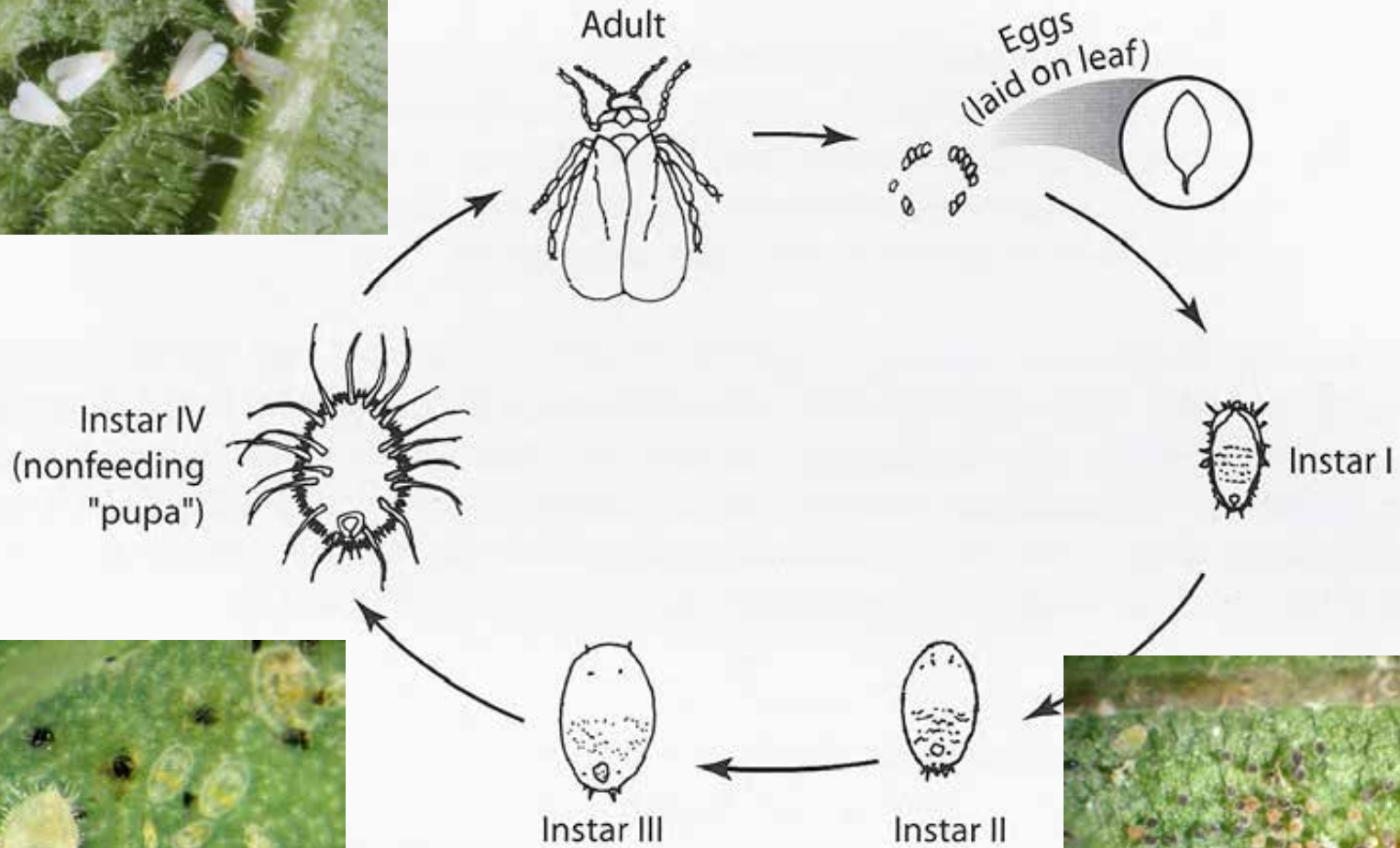


# Plant bug nymphs





# Generalized Life History of a Whitefly





**Adults, last stage nymphs and old nymphal skins of whiteflies**





**Diagnostic:** Since Hemiptera have piercing-sucking mouthparts they do not consume the cast skin after molting



# Life Stages of the Twospotted Spider Mite



egg



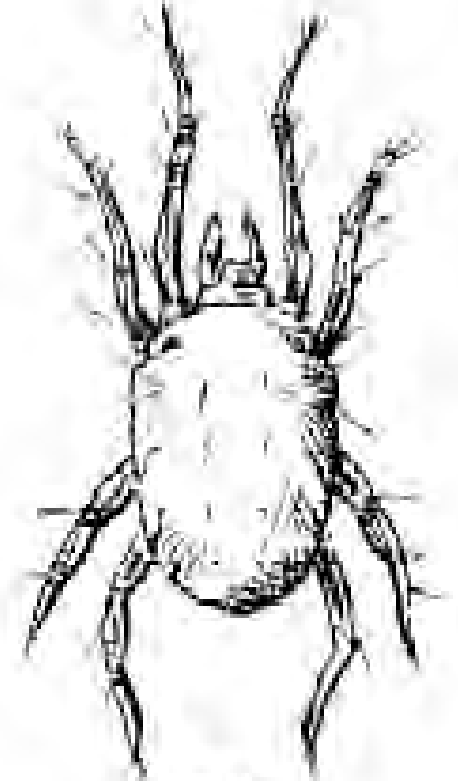
larva



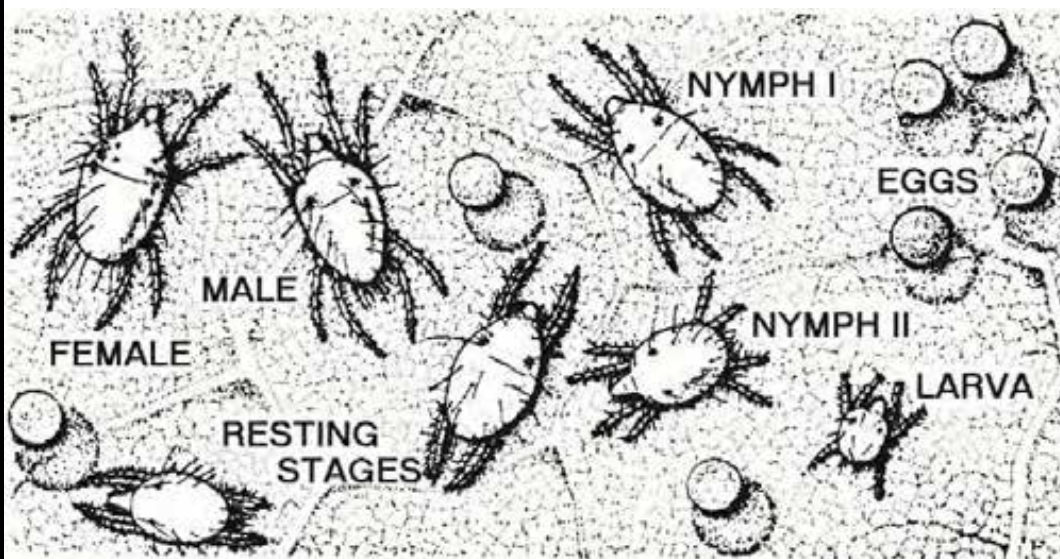
protonymph



deutonymph



adult







**Female spider mite with eggs**

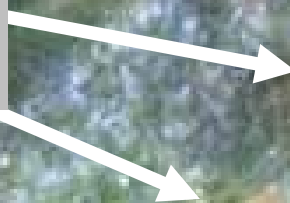


**Male spider mite**

**Photographs courtesy of  
David Shetlar**



**Eggs**



**Adult female**







**Spider mites also leave behind their old  
“cast skins”**

Spider mite exuvia  
(cast skins)

Spider mites

Spider mite eggs





# Secreted Products



Wax



Silk

# Silk Producers

- **Many insects**
  - Pupal coverings (cocoon)
  - Shelters
- **Spiders**
- **Spider mites**



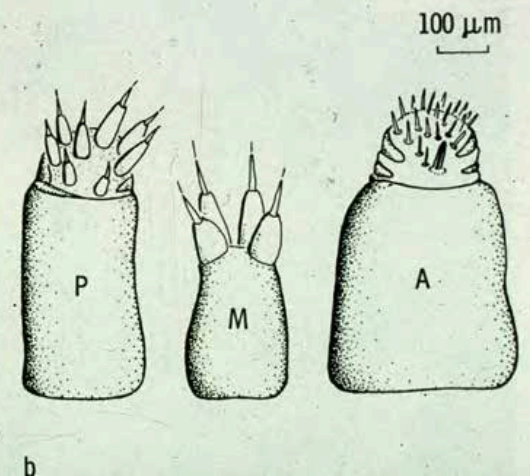
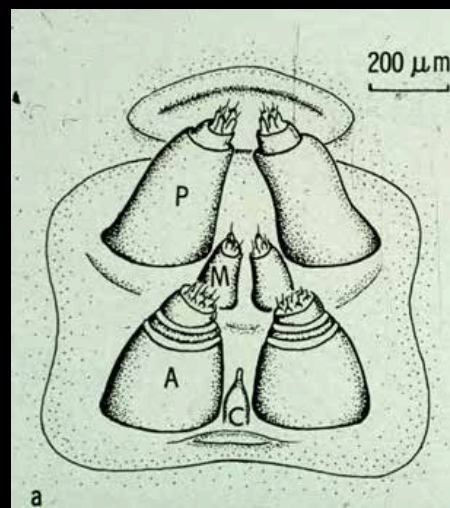


**Caterpillars can produce silk. They may use silk to create sheltering tents or to bind together leaves.**



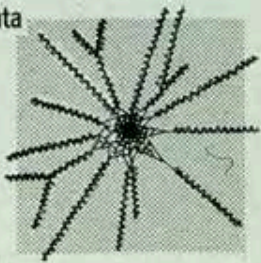


# Spider Silk

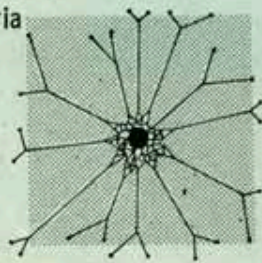




Filistata

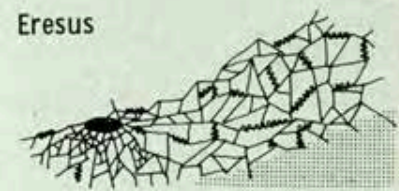


Segestria

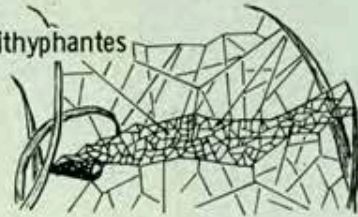


I

Eresus

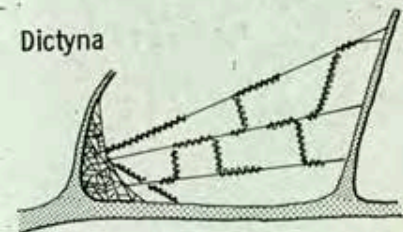


Lithyphantes

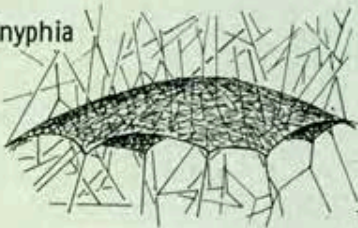


II

Dictyna

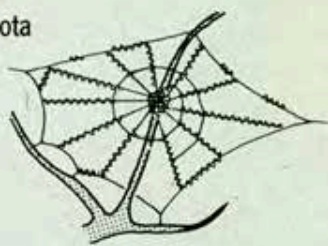


Linyphia

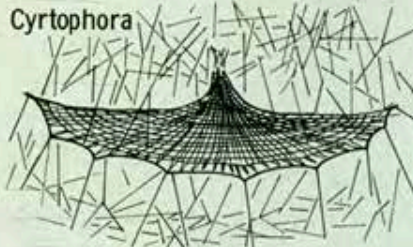


III

Sybota

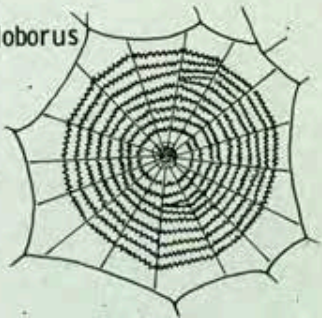


Cyrtophora

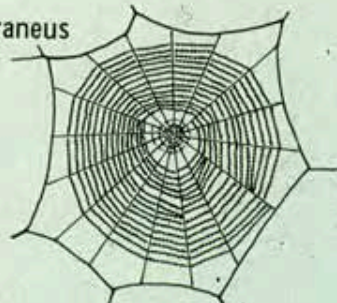


IV

Uloborus



Araneus



V

**Silk for Prey Capture**

**Silk for Binding Prey**







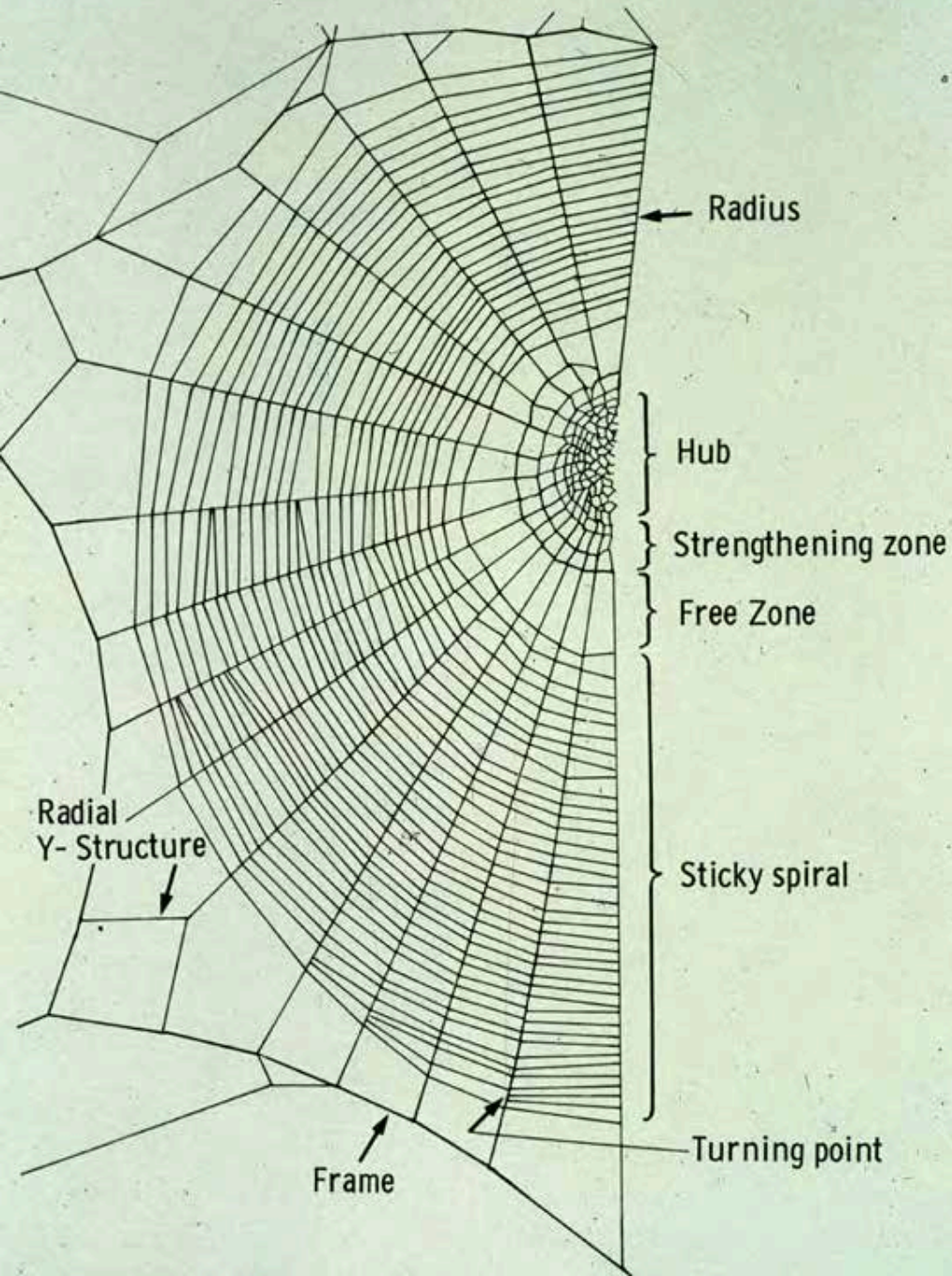
## Funnel weaver webs







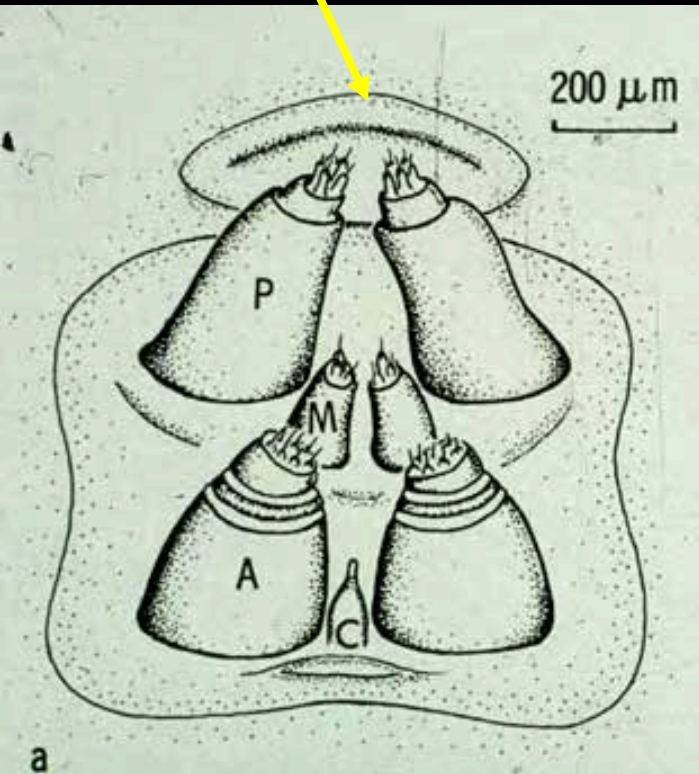
**Cobweb style of spider web (e.g.,  
combfooted spiders, cellar spiders)**



# The Orb Web



# Cribellum



**Silk for binding prey**

# Egg Sacs







**Protection of eggs**





**Webbing may be produced by spider mites and becomes visible when they are in high populations**



Photographs courtesy of David Shetlar, Ohio State University



# Spider mites travelling along webbing



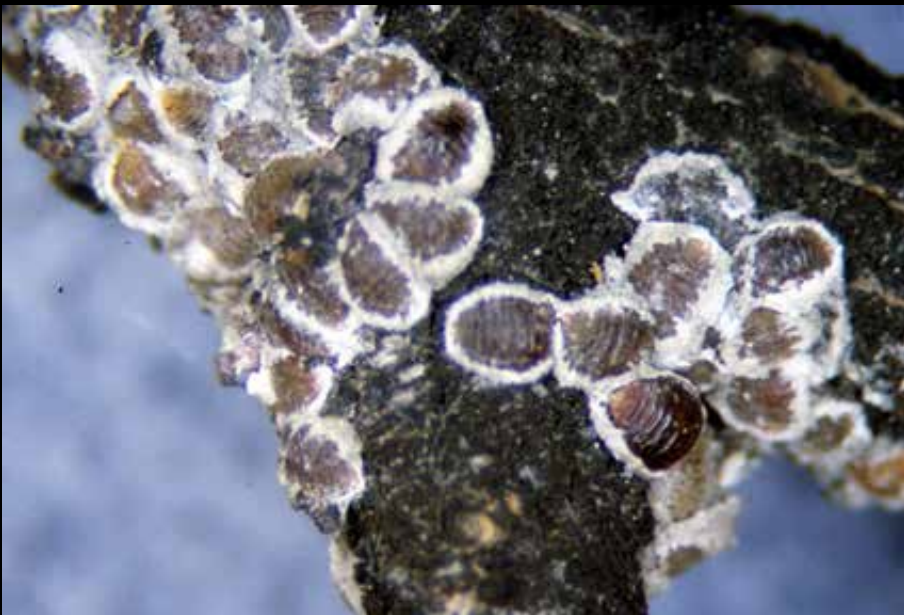
# Wax as body covering





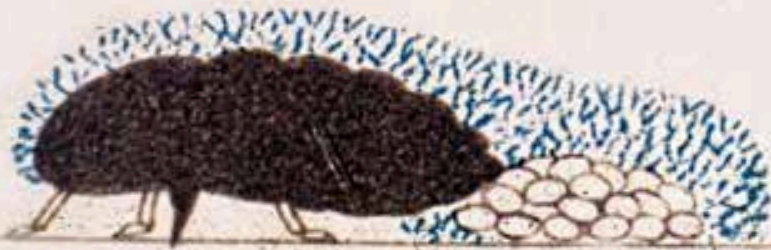
# Scale Insects

**Hemiptera: Many families**



## 'Soft' Scales

## Armored Scales





Pine needle scale



Oystershell scale



## Armored Scales

## Family Diaspididae

San Jose scale



Scurfy scale







**Soft Scales Families Coccidae, Eriococcidae and others**







## Mealybugs

Wax covers the body and is used to create an egg sac







**Hawthorn mealybug  
and associated wax**





**Most aphids *do not* produce noticeable wax**





## Cabbage aphids – Covered with a waxy bloom





**Waxy threads being secreted  
by leafcurl ash aphids**



# Woolly Aphids





**Adelgids –the  
“woolly aphids” of  
conifers**



Hemiptera: Adelgidae

**Woolly apple aphid**  
– a “true aphid”  
that is well covered  
with wax



Hemiptera: Aphididae





**Aphids in moist sites are often associated with wax**





**Root-infesting  
aphids are  
associated with  
wax**





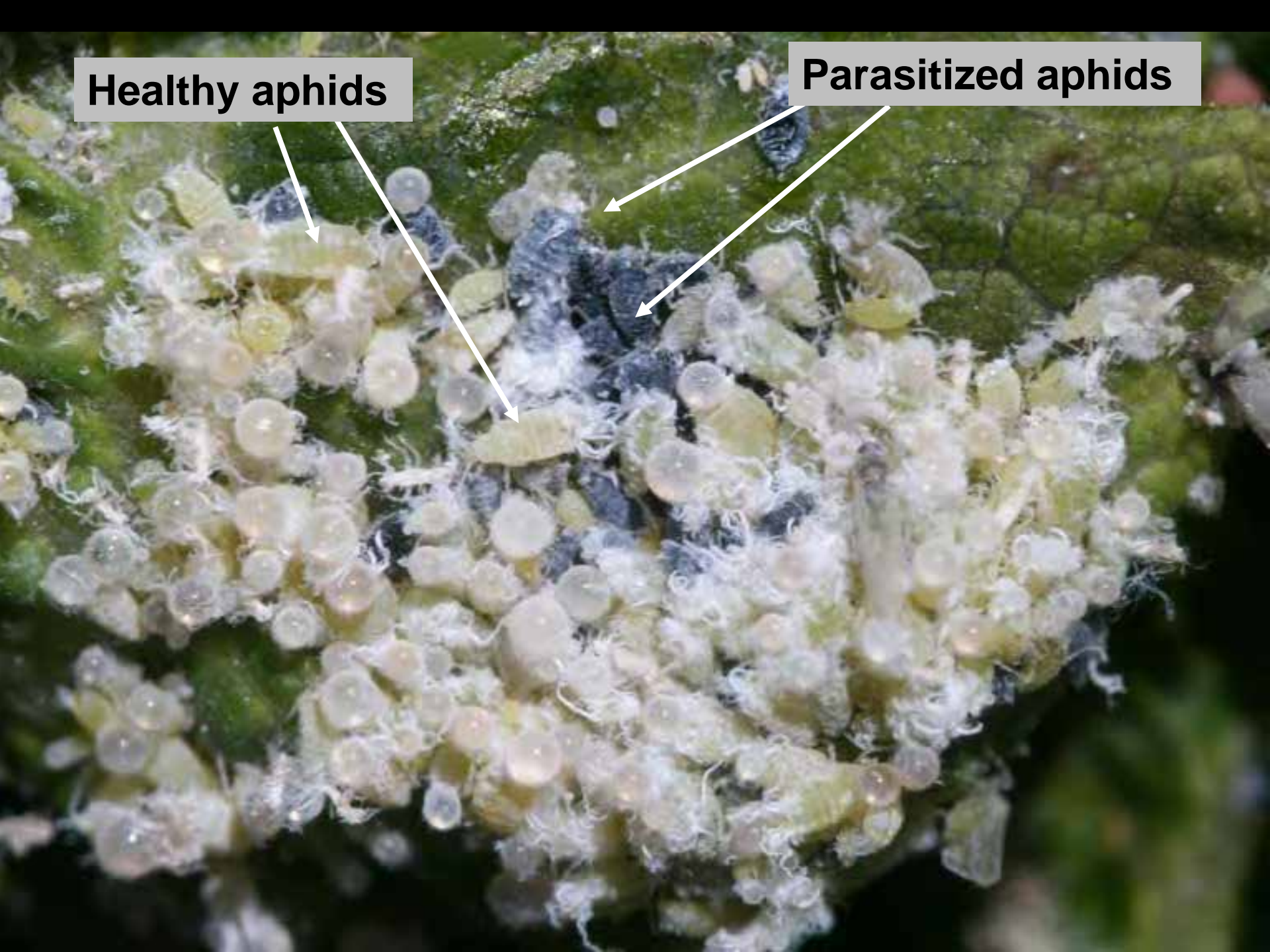
**Aphids that produce leafcurls often produce wax that covers the body**





**Healthy aphids**

**Parasitized aphids**





**Wax coated balls of excreted honeydew**





# **Insect Scatology**

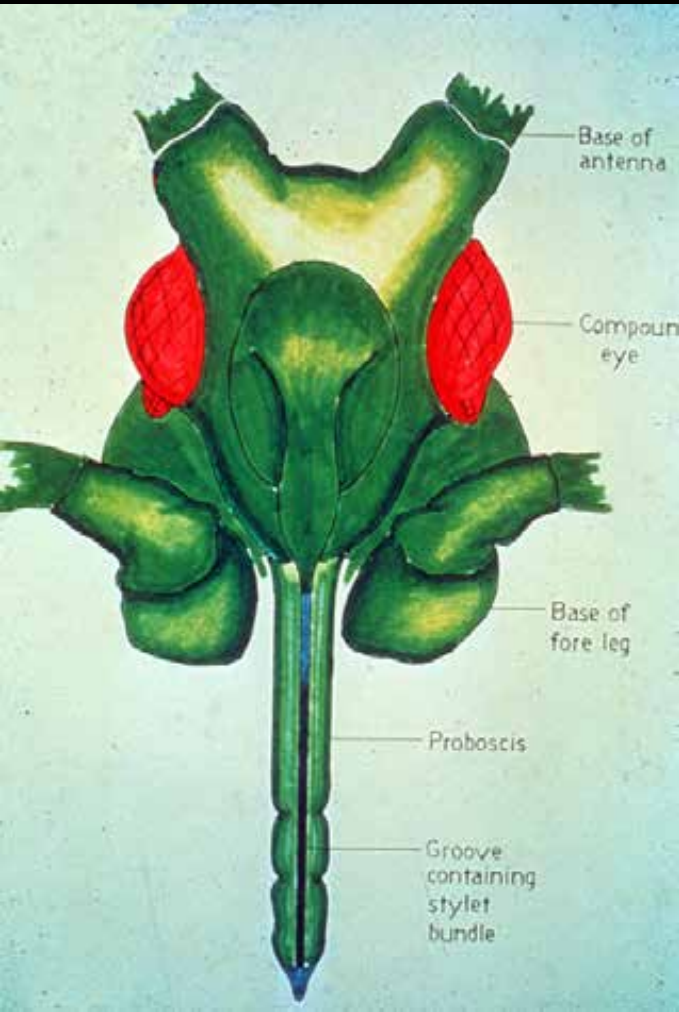
**Diagnosing the activity of  
insects based on their  
“leavings”**



# **Insect excrement will be based on:**

- **Feeding habit**
  - Chewing
  - Sucking
- **Type of food**
- **Where it feeds**

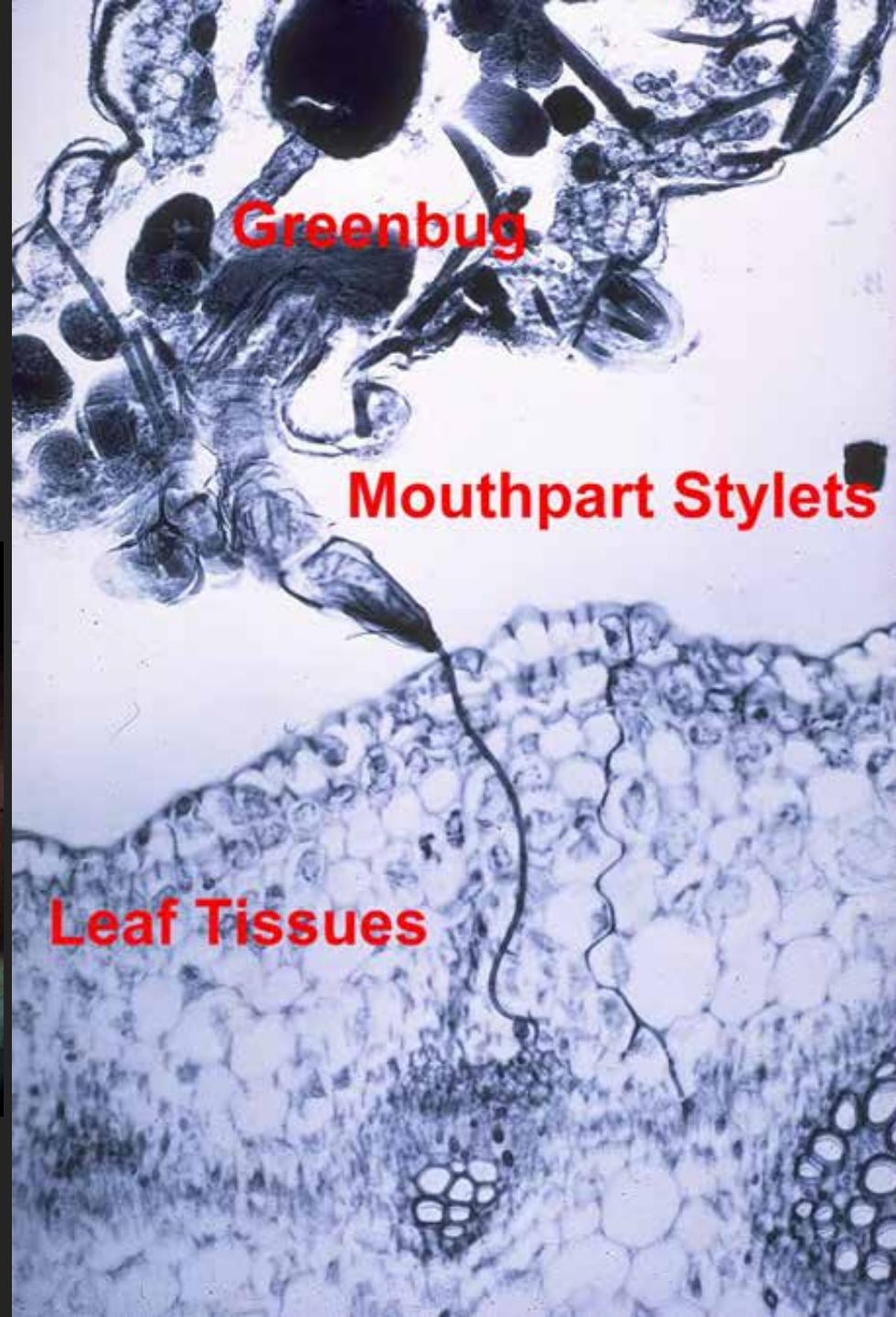
**Several insects feed with piercing-sucking mouthparts**





Ph use their mouthparts to tap into the phloem. Most cause very little, if any, cell injury.

loem feeding species



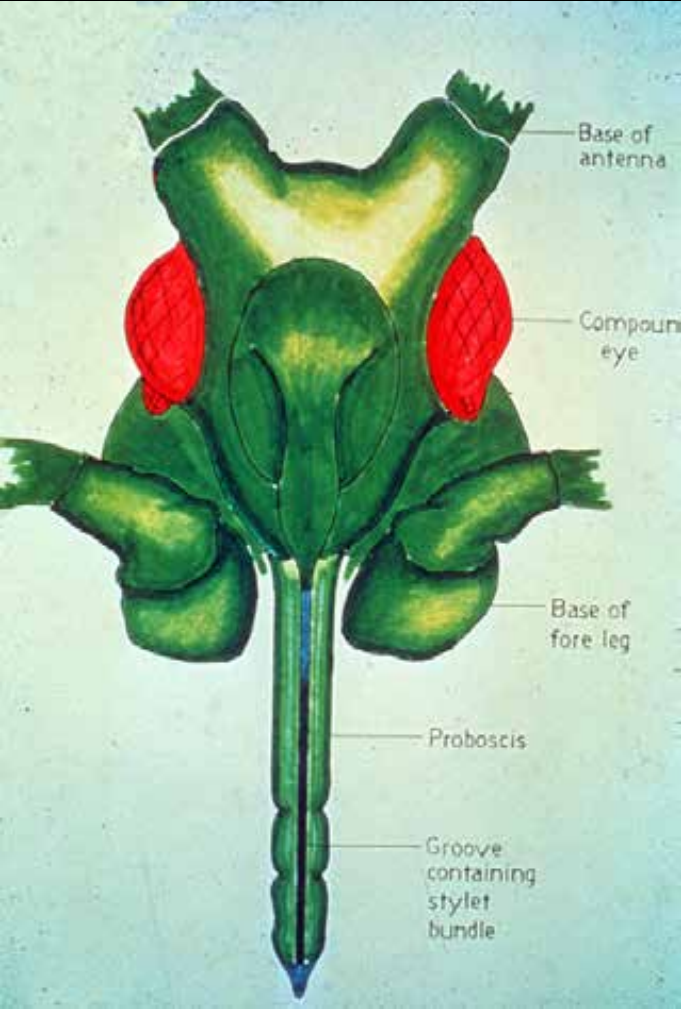
Greenbug

Mouthpart Stylets

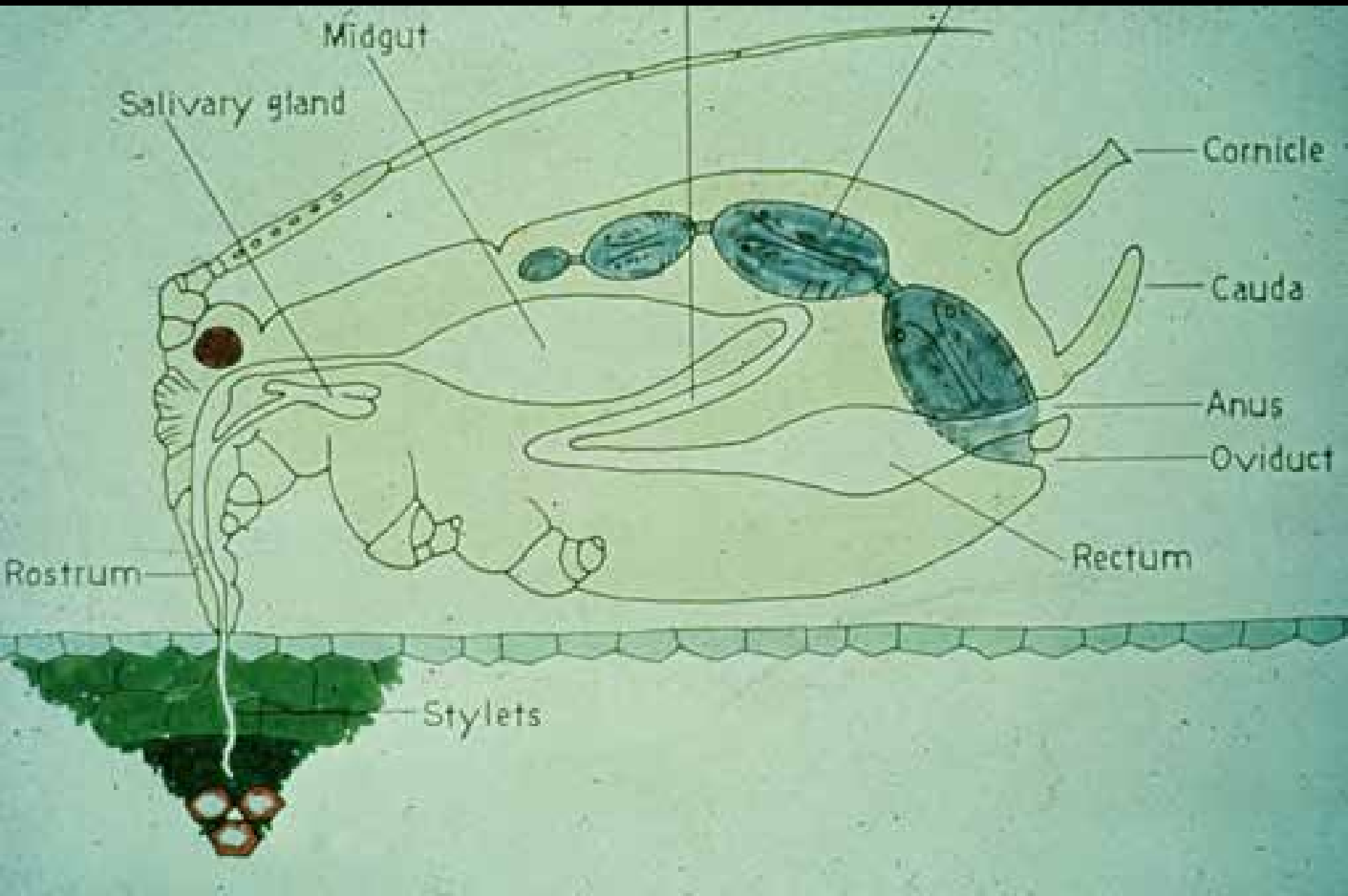
Leaf Tissues



# Plant symptoms associated with piercing-sucking mouthparts

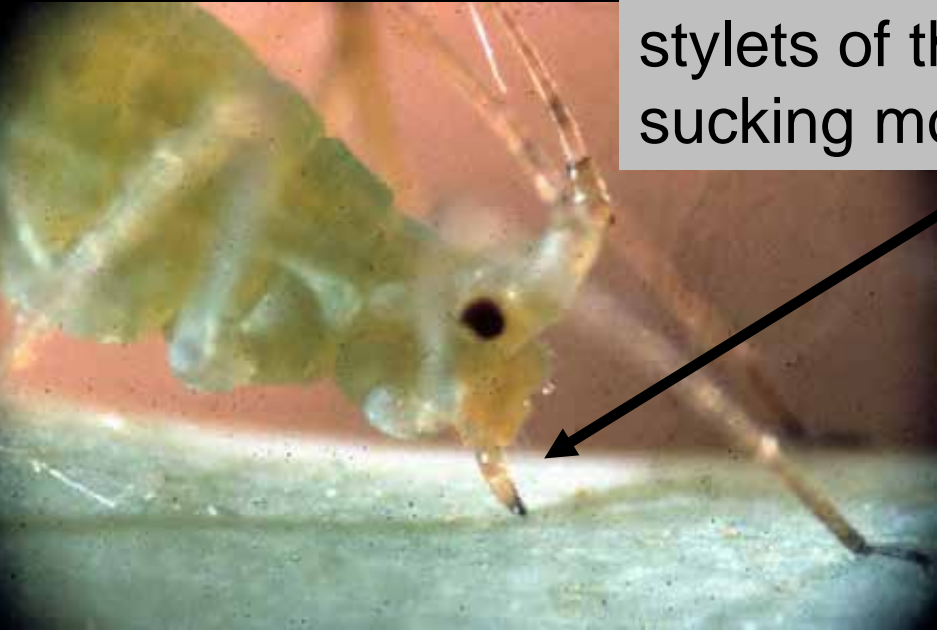




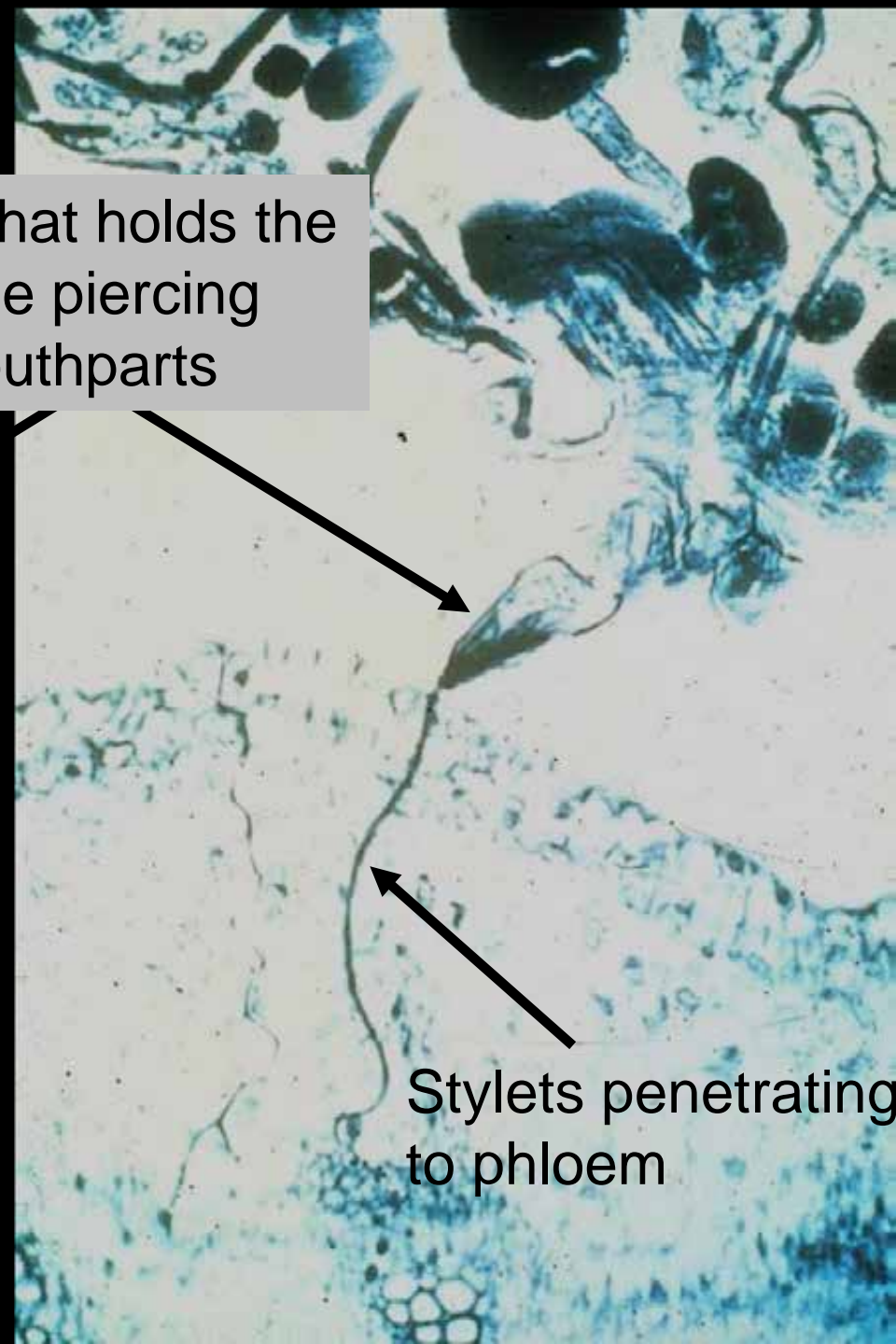






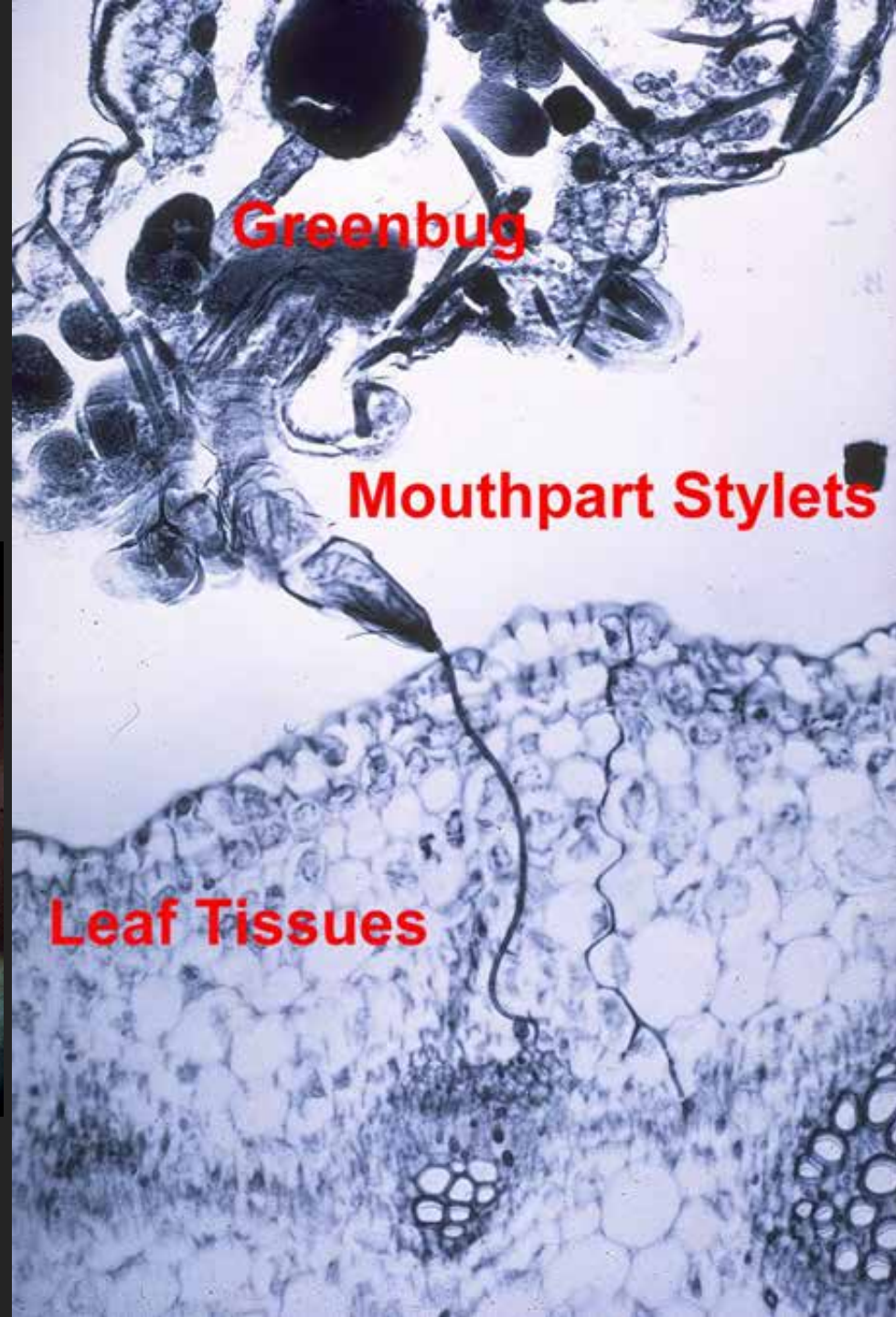


Proboscis that holds the stylets of the piercing sucking mouthparts



Stylets penetrating to phloem

**Phloem feeding species use their mouthparts to tap into the phloem. Most cause very little, if any, cell injury.**



**Greenbug**

**Mouthpart Stylets**

**Leaf Tissues**



# Honeydew production





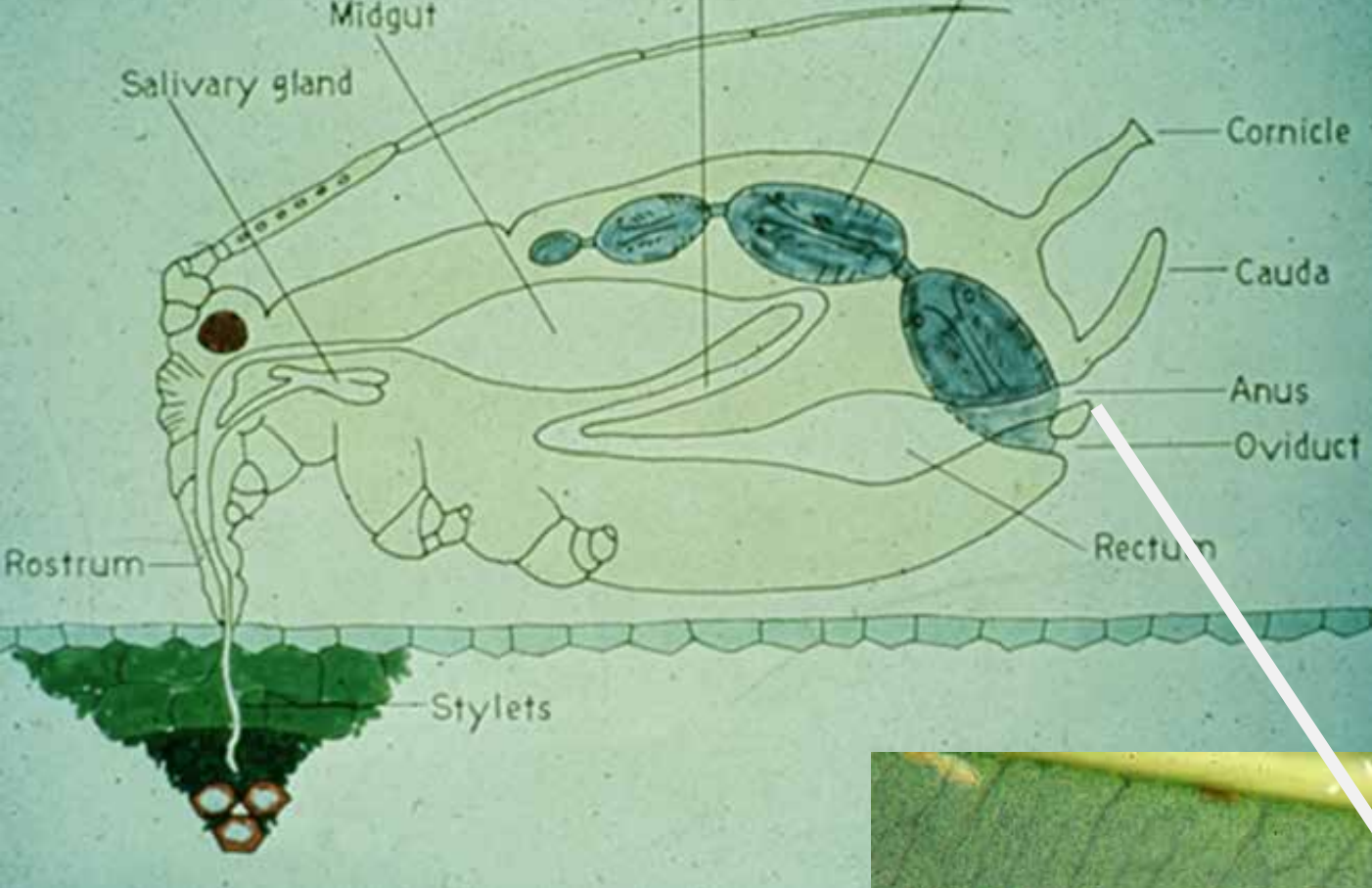
**Hawthorn leaves shiny with honeydew excreted  
by a mealybug**







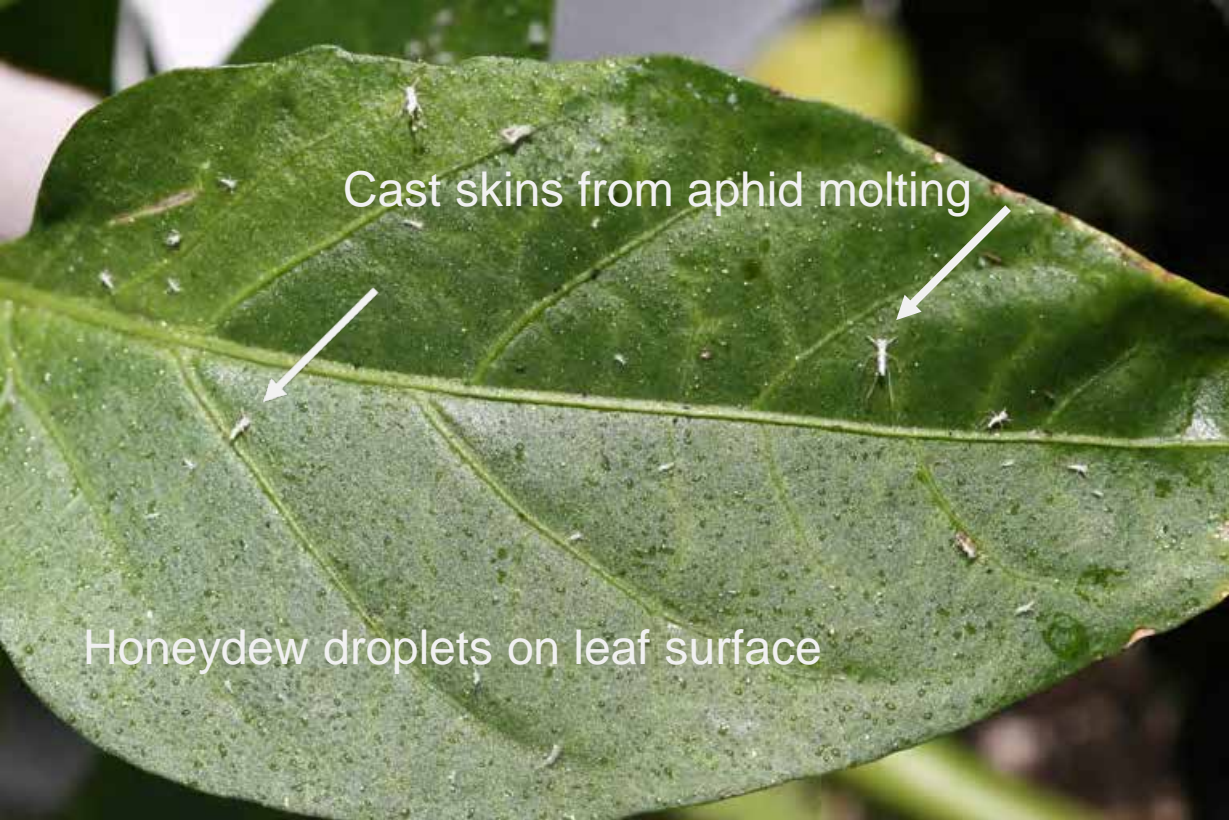












Honeydew droplets on leaf surface

**Look above to find the  
honeydew producer**





# Sooty Molds

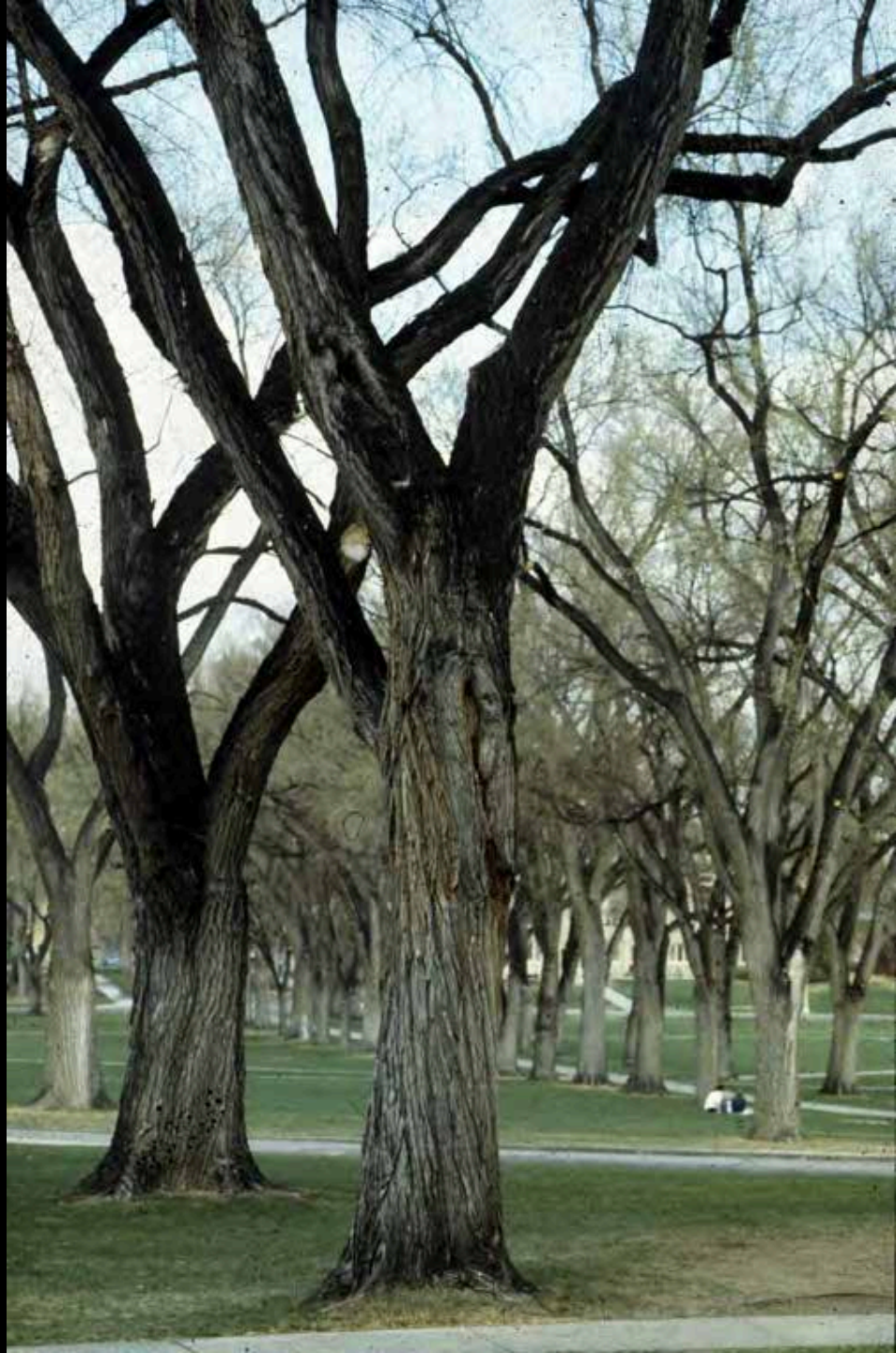
Fungi that grow on honeydew-contaminated surfaces

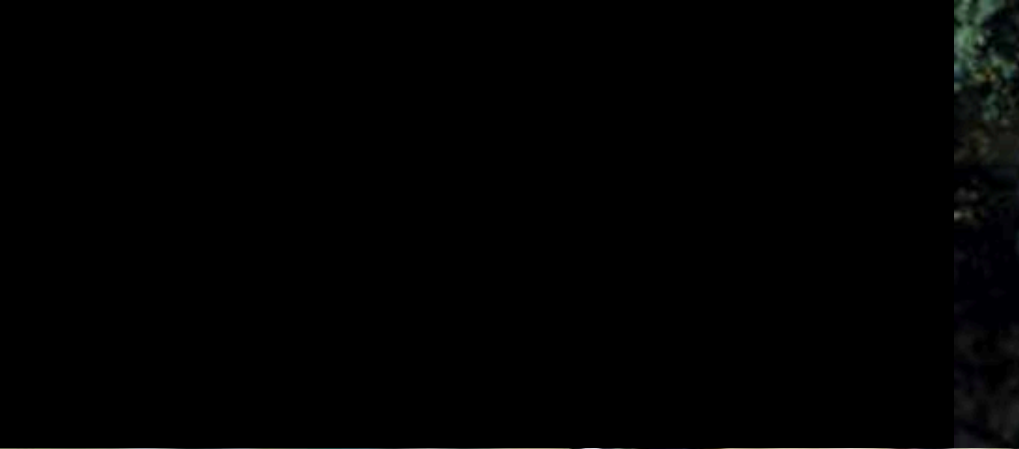




**Sooty mold  
growing on  
linden aphid  
honeydew**













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



# Ants and Aphids – A Mutualistic Relationship

- Aphids provide food – *honeydew*
- Ants provide protection







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- Aphids provide food – *honeydew*
- Ants provide protection

# Ants on the peonies?





**If ants are excluded from the buds, a honeydew-like material that exudes from the buds becomes noticeable.**





**Western  
yellowjacket  
visiting aphid  
honeydew**



**Rough bulletgalls of oak – a gall that exudes honeydew**



# Honeydew Producing Insects\*

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



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





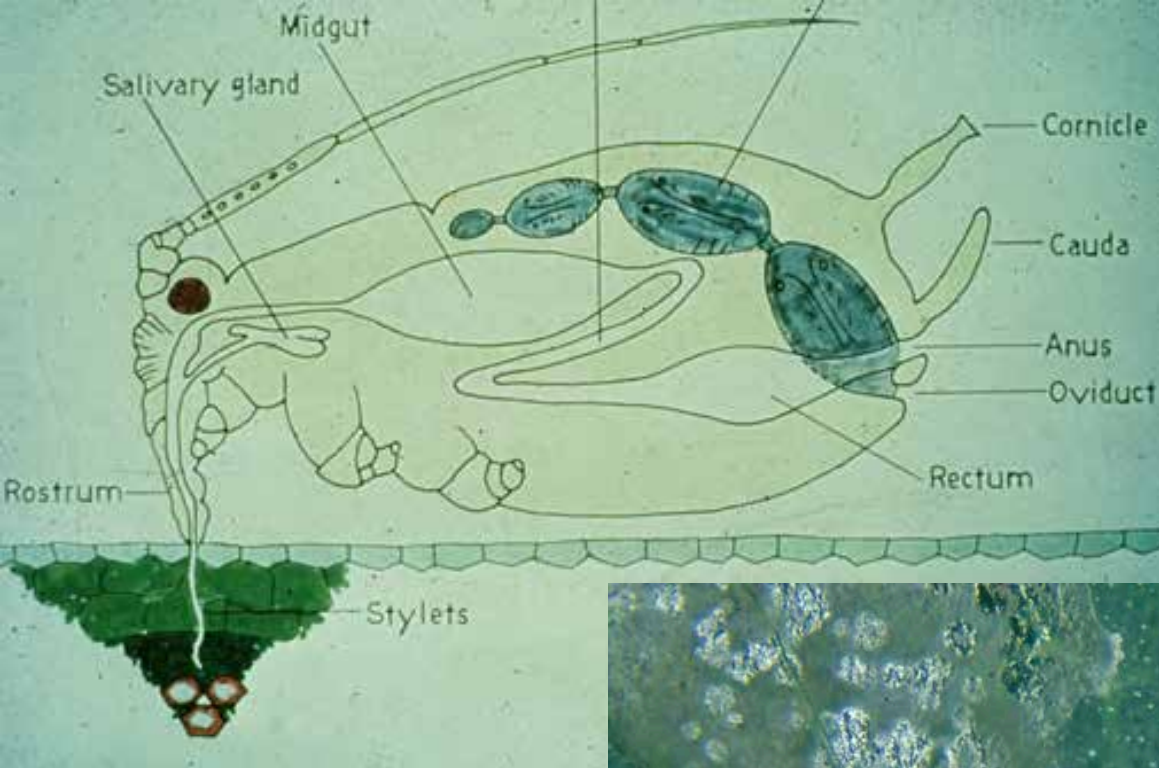
**Mealybugs**  
**Soft Scales**



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







**Like aphids, soft scales suck sap from the phloem and excrete honeydew.**







**Pear psylla**



**Honeylocust  
leafhopper**

# Honeydew Producing Insects\*

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

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



# Leafcurling aphid – Leafcurl ash aphid







**Excrement is covered with wax. This keeps the insects from being covered with honeydew.**





UGA1325032









UGA1325026

**Within the confines of the gall honeydew is covered with wax and forms balls**



UGA1325034

**Transition to lerps?**

# Lerps

**Wax-coated pellets**



# Potato/tomato Psyllid



Excretes wax  
coated sugary  
droppings





A close-up photograph of a green leaf heavily infested with a white, powdery substance known as 'Psyllid sugar'. The sugar is scattered across the leaf surface, with some areas showing a higher concentration. Several small, orange and yellow insects, likely psyllids, are visible on the leaf, some appearing to be feeding or moving. The background is a blurred green, suggesting the rest of the plant.

**“Psyllid sugar” associated  
with potato/tomato psyllid**













Wax threads excreted by boxwood psyllid





Wax threads excreted by currant psyllid



# “Tar Spots”



Some of the mesophyll feeding insects excrete small dark “tar spots” that can assist in diagnosis



# Lace Bugs

**Hemiptera: Tingidae**







**Lace bug adult**



**Lace bug nymph**







**Flecking wounds are symptomatic on the upper leaf surface**







**“Tar spots” and  
old cast skins are  
symptomatic on  
the lower leaf  
surface**







# Stippling injuries



Stippling produced by mesophyll-feeding species of leafhoppers

Stippling produced by lace bugs







# Leafhoppers

**Hemiptera: Cicadellidae**

# Injuries Produced by Leafhoppers

- Removal of sap (phloem feeders)
- Stippling leaf injuries (mesophyll feeders)
- Hopperburns (*Empoasca* spp.)
- Transmission of phytoplasmas (phloem and xylem feeders)





**Stippling injuries  
produced by  
leafhoppers that  
feed on the  
mesophyll**





**Leafhopper injuries to Virginia creeper and grapes are caused by several species**



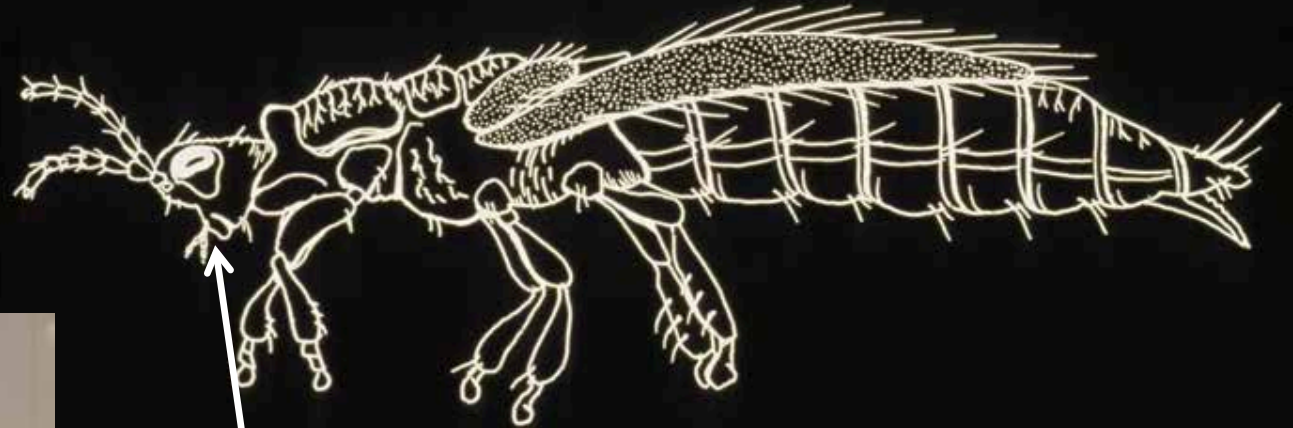


# Thrips

Thysanoptera: Thripidae







**Thrips mouthparts – a unique type of piercing-sucking mouthpart**

# Thrips Mouthparts

- **Single *mandible***
  - 2<sup>nd</sup> mandible vestigial
  - penetrates leaf surface
- **Paired *maxillae***
  - punctures cells below surface
- **Labium forms a supporting cone**
- **Functions to “puncture – poke – suck”**





Thrips feeding injuries





Scarring by  
thrips larvae  
and associated  
fecal spotting





**Thrips injuries – Silvery  
scars with small dark  
fecal spots**









# **Xylem-feeders**

**Spittlebugs and  
sharpshooter leafhoppers**



**Spittlebugs  
(Cercopidae)**











**Adult spittlebugs  
(froghoppers)**







**Sharpshooter  
leafhoppers feed on the  
xylem.**

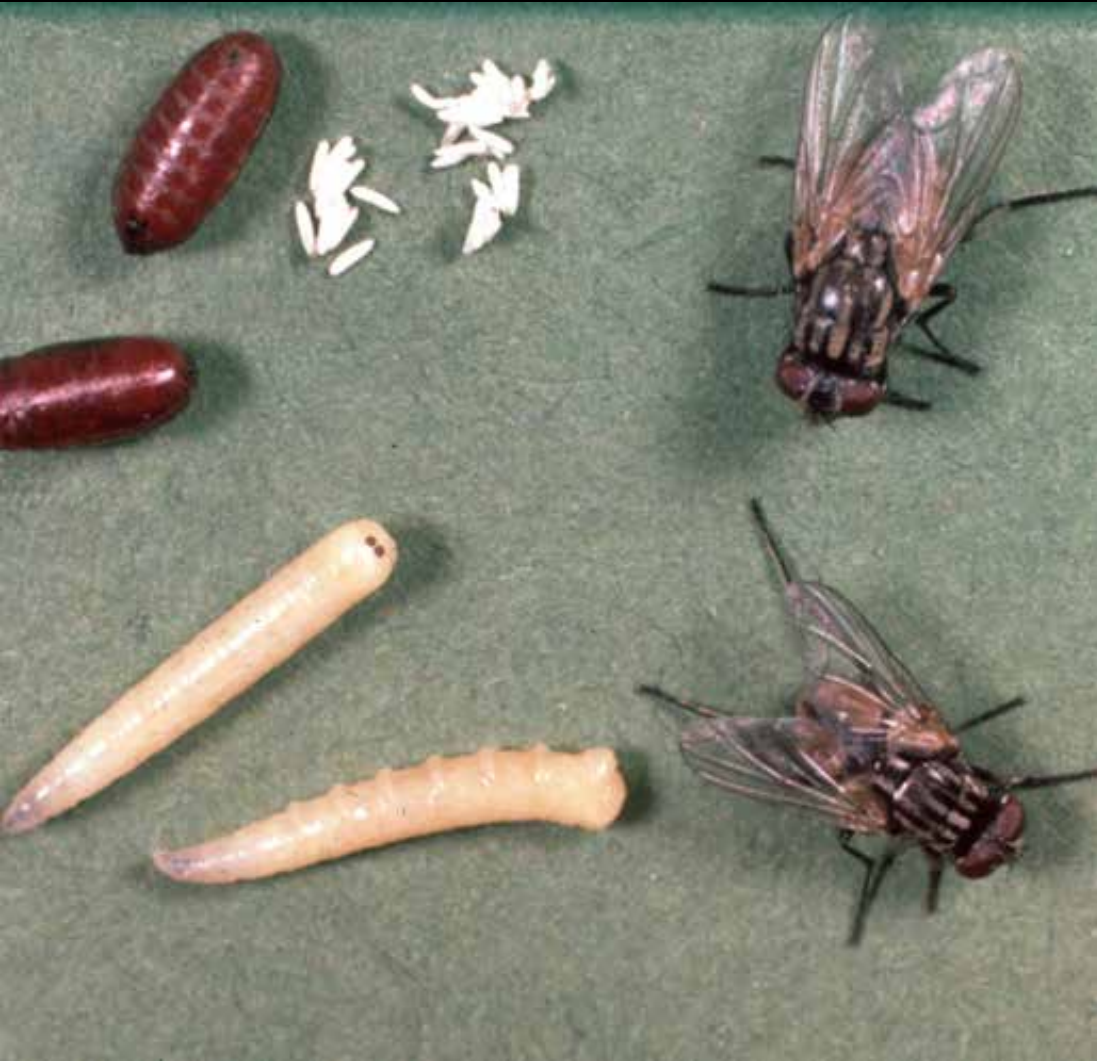
**They will flick watery  
droplets as they feed.**





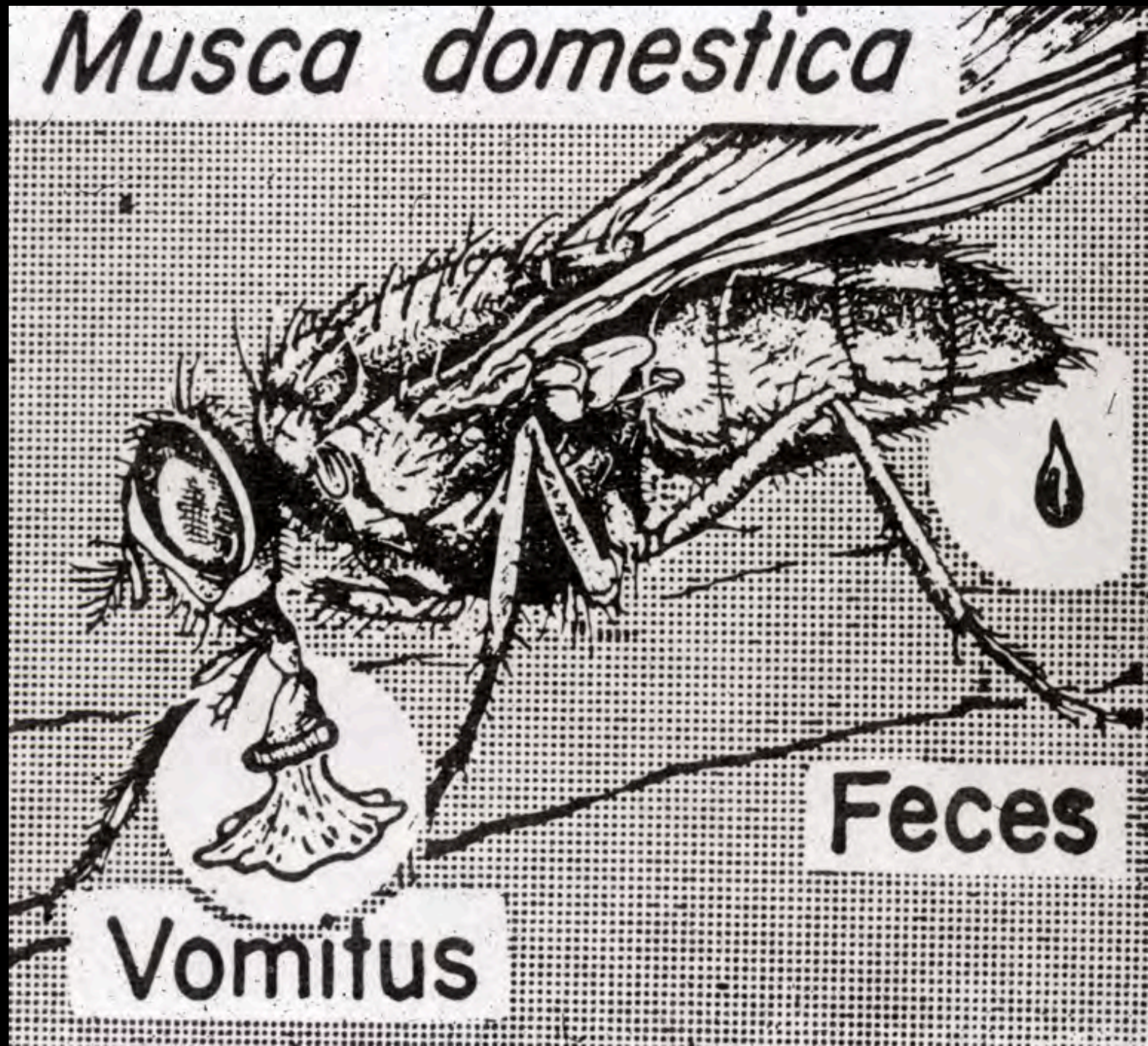


# Fly Specks





# *Musca domestica*



Vomit

Feces



# Fly specks







INSTANT **HAND**  
**SANITIZER**

A close-up photograph of the nozzle of a hand sanitizer dispenser. The nozzle is white and has a white label with blue text. The label reads "INSTANT HAND SANITIZER". The nozzle is heavily splattered with brown, dried residue, likely from a beverage. The background is dark.



**SANITIZER**

Kills 99.99% of most common germs

• Rub onto hands until dry.

A close-up photograph of the body of a hand sanitizer dispenser. The dispenser is white and has a white label with blue and purple text. The label reads "SANITIZER" in large blue letters, followed by "Kills 99.99% of most common germs" in purple, and "• Rub onto hands until dry." in blue. The dispenser is heavily splattered with brown, dried residue, likely from a beverage. The background is dark.

# Shore Flies





# Shore Fly (left) versus Fungus Gnat (right)



**'Fly specks'**  
associated with  
shore flies





**Algae is the food of larval stages of shore flies**







## Flower (Syrphid) Flies





# Syrphid egg in aphid colony







**Syrphid fly larvae are common predators of aphids**







**Syrphid fly larvae  
excrete tarry smears  
amongst aphid  
colonies**

**“Syrphid  
smear”**





# Frass – The term used for waste produced by insects with chewing mouthparts



**Caterpillars feeding on leaves often produce very distinctly formed frass (excreted droppings)**





# Frass produced by hickory horned devil

University of Florida



Photographs of frass courtesy of David Shetlar





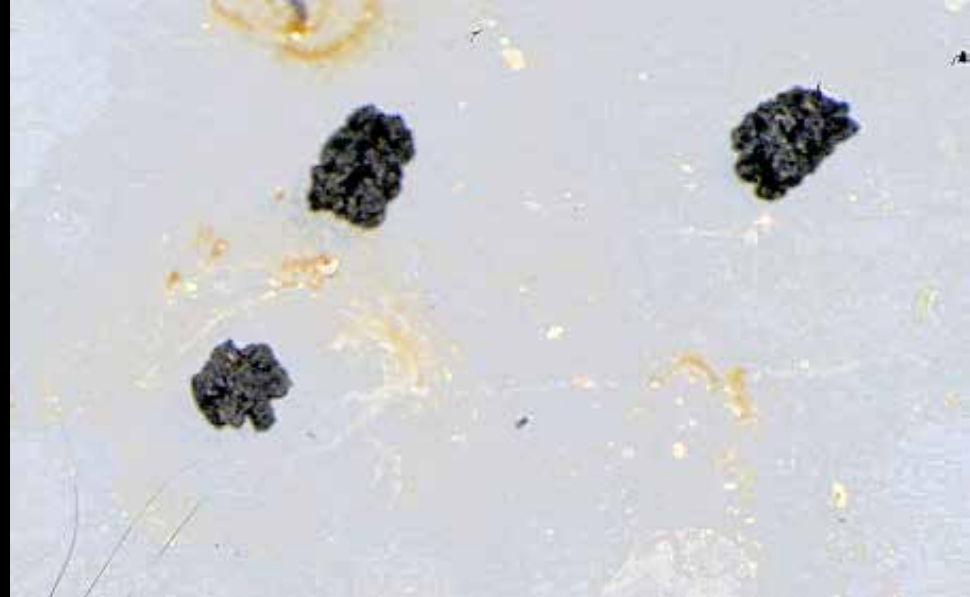






Hornworm "frass"





**Frass  
produced by  
gypsy moth**



**Caterpillar, frass pictures by Phil Nixon**



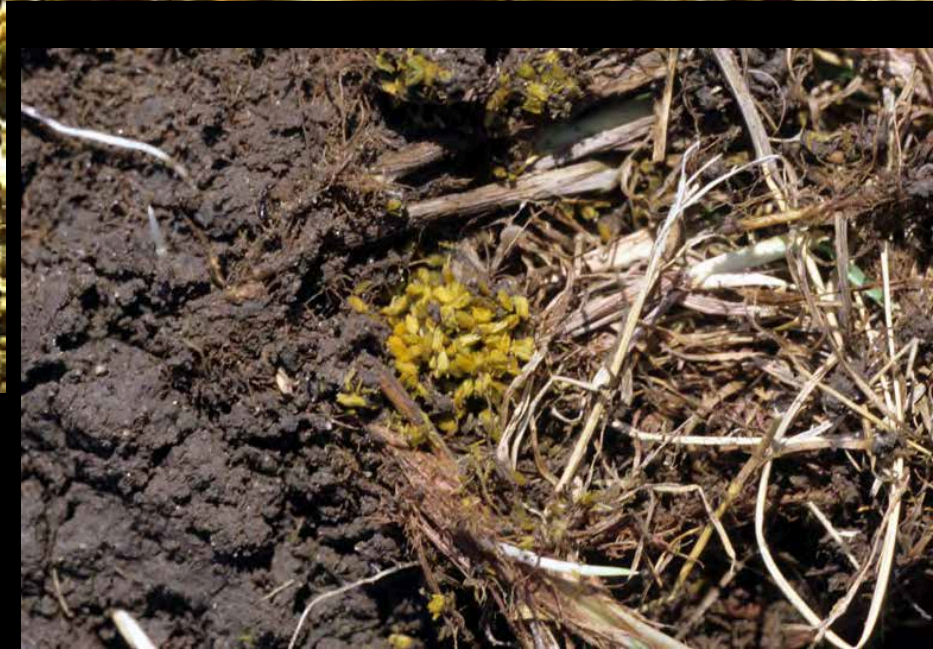
# Sod Webworms –

Caterpillars that feed on grasses, usually within a silken structure





**Piles of fecal pellets collect where sod webworms (and cutworms) rest**





**Diagnostic: Fecal pellets produced by sod webworm caterpillar**







**Fall armyworm frass – fibrous due to diet of grasses**





**Grasshopper  
feeding and frass**





**Grasshopper frass  
is typically elongate  
and fibrous, related  
to diet**



# Leaf/Needle-feeding Sawflies





Pellets are round or elongate, with no distinctive ridges



**Frass pellets within leafmine of the birch leafminer (a type of sawfly)**







**Frass produced  
by leaf beetle  
larvae**

May be elongate,  
intact pellets pellets





Often pellets break up or become pasty





**Colorado potato beetle larvae produce moist waste that smears**





**White pasty droppings  
(and skeletonizing!) are  
characteristic of Mexican  
bean beetle**



5490333



# Some beetle larvae carry their frass





# Billbugs

*Sphenophorous* spp.

*The grass feeding weevils*



**Billbug damaged turfgrass breaks easily at crown (“tug test”)**



Photograph courtesy of David Shetlar,  
Ohio State University



# Diagnostic: Sawdust frass characteristic of billbug larval feeding







**Slugs**



**....or earwigs?**



**Earwig injuries**





**Flower petals and soft plant parts are also eaten by earwigs.**

**Earwigs feed at night.**





Earwig feeding at night. Note the chewing mouthparts.





# Slug Injuries









**Sluysgs almost always feed at night. Occasionally they are active during overcast periods following rains.**





**Slugs leave slime trails**





# Slug trails on pavement



# Slugs vs. Earwigs

## Slugs

- Tend to affect plants lower to the ground
- **Leave slime trails as they feed**
- Damage may be more ragged
- Night surveys
- Trapping

## Earwigs

- Often feed near the top of the plant
- **No slime trails produced**
- Damage may slightly less ragged
- Night surveys
- Trapping



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Colorado State University