

Guess Who Came to Dinner

Using Feeding Patterns and “Leavings” to Better Know Your Garden Insect Visitors



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**Sometimes it can be easy
to figure out what is
happening**



**.....particularly if the culprit
is working right in front of
you.**



A bit of cut leaf

Some small light markings on the leaf

But often the insect is long gone.





**This requires
some detective
work**



Sources for Clues

- **How does an insect feed on a plant?**
 - Changes in plant appearance after feeding
- **Do insects leave anything behind after dining?**
 - “Cast skins” following molting
 - Distinctive secreted products (e.g., waxes, silk)
 - Visible and distinctive excreted waste

How do insects feed – *solid or liquid* diet?

Some
insects
chew
leaves



Some
insects
suck
fluids
from
leaves





Grasshoppers, crickets



Earwigs

“Bugs” that Chew Leaves

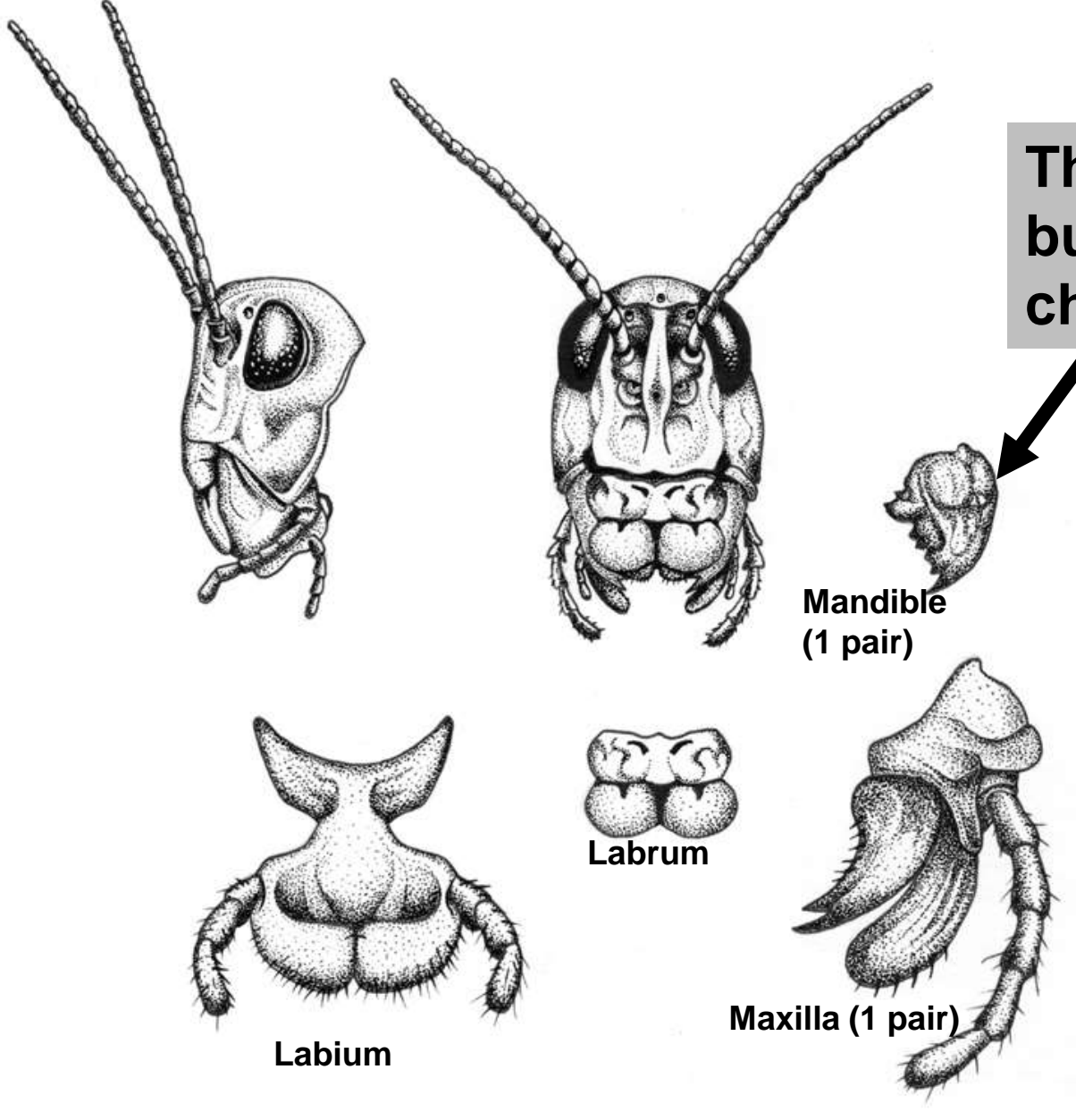


Leaf beetles



Root weevil adults

The mandibles are the business part of the chewing mouthparts



The Basic Chewing Mouthparts of an Insect



Grasshoppers, crickets



Earwigs



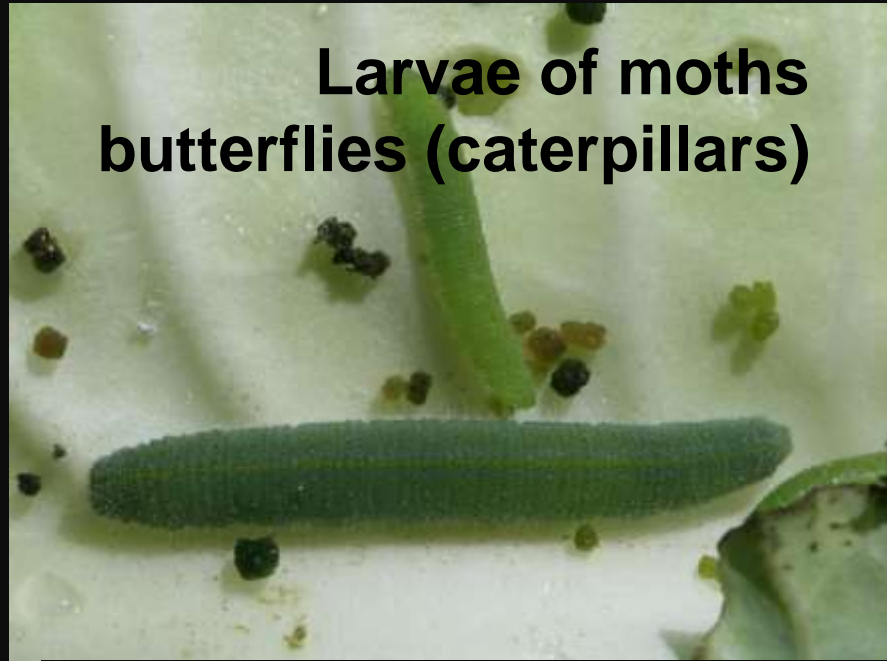
Leaf beetles



Root weevil adults

**“Bugs”
that
Chew
Leaves**

**Larvae of moths
butterflies (caterpillars)**



Beetle larvae



“Bugs” that Chew Leaves

Sawfly larvae



Slugs



**Insects can be
picky eaters**



Source: NCAdvertiser

**Insects can be
messy eaters**



Source: ParentDish



**Generalized
feeding habit**

**No consistent
pattern of feeding**



Grasshopper leaf feeding produces a generalized defoliation pattern



**Generalized feeding injury
pattern of European earwig**



Leaf Chewing Injuries Produced by Caterpillars

Generalized Defoliation





Newly emergent growth is consumed first

There can be overall chewing injury patterns on a tree

Douglas-fir tussock moth example



Injury concentrated first at the top of the tree

Generalized leaf chewing
with a unique twist



American dagger moth on maples



Leaf Chewing Injuries Produced by Sawflies

Generalized Defoliation





There can be overall
chewing injury
patterns on a tree

Pine sawfly example

Most defoliate plants
prior to bud break



New growth emerges after defoliation
event, producing tufting appearance

Leaf Chewing Injuries Produced by Beetles

Generalized Defoliation

Apple flea beetle



Colorado potato beetle



Source: NCAvertiser



“Picky” leaf chewing patterns



Leaf chewing patterns that are distinctive



Feeding concentrated at leaf edges

Some Leaf Chewing Patterns



Shotholes and injuries to the interior of the leaf

Skeletonizing injuries



**Many insects may chew
along the leaf edge –
*some of the time***

- **Many caterpillars**
- **Most sawfly larvae**
- **Some leaf beetles**
- **Earwigs**
- **Grasshoppers**



Leaf Notching Wounds



Leaf cuts originating from the leaf edge, angular in form

Many adult weevils chew only along the edge of the leaf



This results in leaf notching



**Weevil feeding usually occurs at night.
During the day they hide at the base of
the plant**





Leaf notching injuries

Cause: Night feeding weevils

**A leaf chewing oddity: Semicircular cuts to leaves of green ash
(or rose, lilac, Virginia creeper.....)**





Leaf cut oddity:
leafcutter bees



Leafcutter bees use leaf fragments for nest construction



Step 1. Find a suitable nest site



Soft, rotting wood is often excavated for nest sites





Leafcutter bee excavation in rotten garden timber



Interior of wood used for leafcutter bee nesting

Nesting sites can be provided to support many kinds of cavity nesting bees (e.g., leafcutter bees, mason bees)





Step 2. Collect leaf fragments for nest cell building

Photographs courtesy of David Shetlar

Leafcutter bee carrying leaf fragment





**Leafcutter bee
returning with
leaf fragment**



Step 3. Build nest cells out of the leaf fragments



For nest construction:



3-4 rectangular pieces,
crimped for the base

Oval pieces along the sides of
the cell



Step 4. Collect pollen/nectar to supply a nest cell



Pollen/nectar stores of two leafcutter
bee nest cells

For nest construction:



3-4 rectangular pieces, crimped for the base

Oval pieces along the sides of the cell

Nearly perfect circles used to cap the cell







Leaf notching injuries

Cause: Night feeding weevils



**Leaf cuts by
leafcutter bees**



**Leaf notches by
root weevil adults**



Shotholes



Leaf chewing produces small holes in the leaf interior

Shothole wound producing insects



Flea Beetles and Other Small Beetles



Crucifer flea beetles

Specialist leaf beetles that feed on
cabbage family plants, primarily





Potato flea beetles - Specialist flea beetles confined to Nightshade family plants (potato, tomato, etc.)



**Shotholes in elm produced by
European elm flea weevil adults**





**Large holes in
elm leaves
produced by
elm leaf beetle
adults**

Skeletonizing



Leaf chewing avoids the larger veins

Skeletonizers



Some leaf beetle larvae



Slug sawflies



Some caterpillars (particularly young stages)

Common skeletonizers



Cottonwood leaf beetle

Leaf beetle larvae

Willow leaf beetle



Elm leaf beetle

Common skeletonizers

Slug sawfly larvae

Pearslug



Roseslug



Adult pearslug



Common leaf skeletonizers



Japanese beetle adults



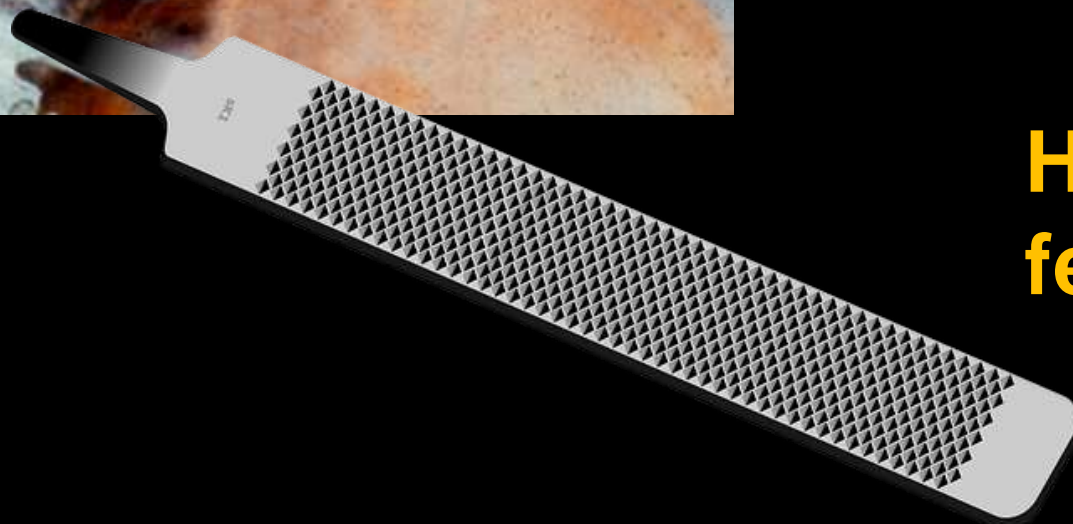


Slugs and Snails
Class: Gastropoda

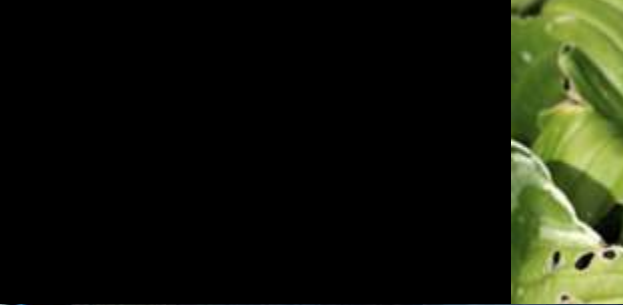




Source: Living World of Mollusks website, Robert Nordsieck



How do slugs feed on plants?



Slug injuries



Slugs become most active after dark

Diagnostic slug “leaving”



Slime trails of mucus



Slugs and snails are out and about



There is a lot of action in the garden at night – don't miss it!

Root weevils are doing their leaf notching



Earwigs come out of hiding to feed on leaves, flowers...and insects





Insects that chew on leaves....

....produce waste that is solid or semisolid



Cabbageworm



Frass – the solid waste excreted by insects that feed with chewing mouthparts



Elm leaf beetle larva



Grasshopper

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





Hornworm "frass"





Cabbage looper "frass" on hoophouse grown tomatoes



Grasshopper Frass



Leaf beetle larvae



Frass is in the form of elongated pellets, often semi-solid





Colorado potato beetle larvae with associated leaf damage and frass

Secreted products produced by insects

Silk



Wax



Caterpillars can produce silk.

They may use silk to create sheltering tents or to bind together leaves.



How do insects feed – *solid or liquid* diet?



Some
insects
chew
leaves

Some
insects
suck
fluids
from
leaves



“Bugs” That Feed on Plant Fluids

- **Hemiptera**
 - True Bugs (e.g., squash bug, plant bugs)
 - Leafhoppers, spittlebugs
 - Aphids, whiteflies, scale insects, mealybug
- **Thysanoptera**
 - Thrips
- **Acari**
 - Spider mites
 - Rust mites





....produce **liquid waste**

Insects and mites suck fluids from leaves....

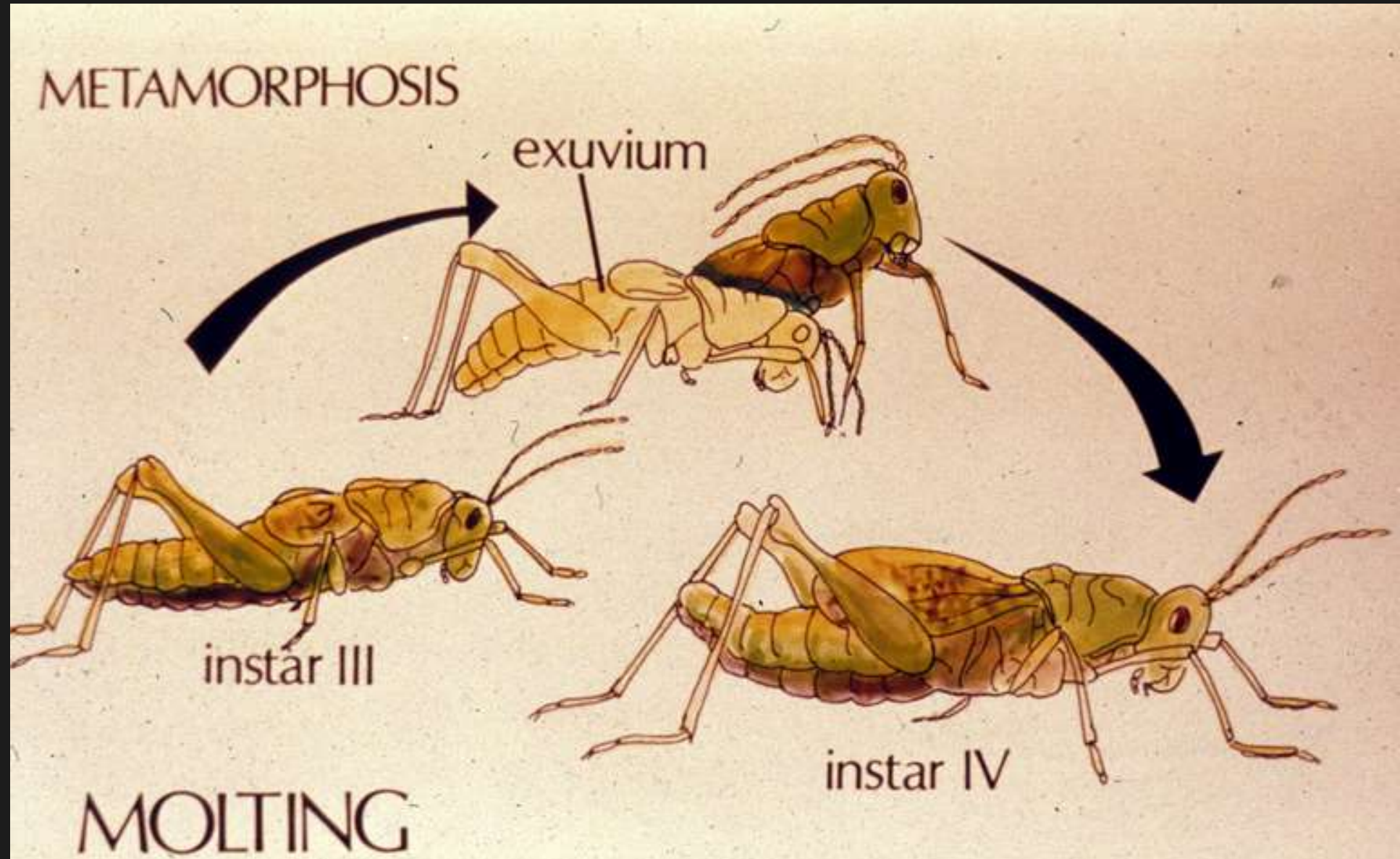




**“Cast skins” can
be very useful
for diagnostics**



Disadvantage of an exoskeleton:



Molting grasshopper



OLD INTEGUMENT
(SKIN) →

RECENTLY MOLTED
NYMPH ↓



**Cicada adult emerging from
exoskeleton remains of the
previous stage (nymph)**



**Damselfly adult emerging
from exoskeleton remains of
the previous stage (nymph)**





Aphid that has almost completely extracted itself from the exoskeleton



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



“Cast skins” can be very useful for diagnostics



Leafhoppers



Scale Insects



“Bugs” that Suck Plant Fluids - Hemiptera

Aphids



Squash bugs





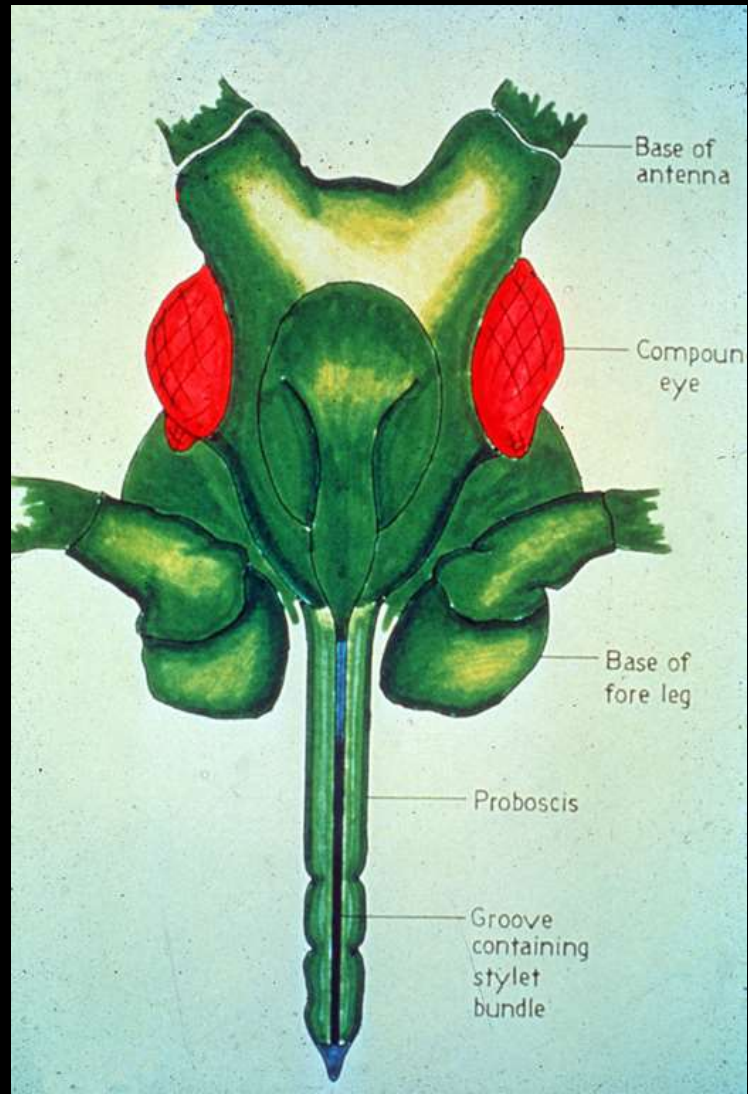
Thrips

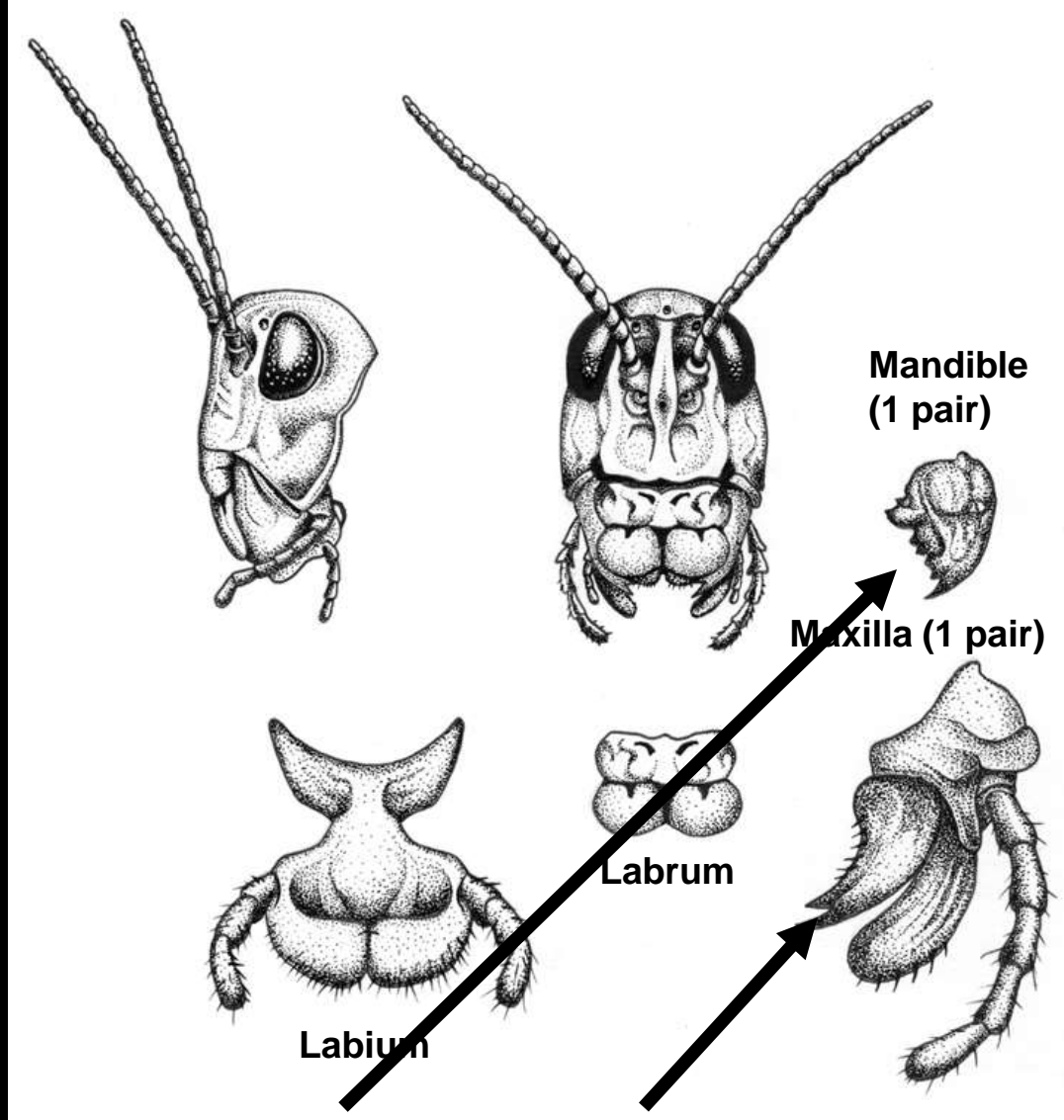
Other “Bugs” that Suck Plant Fluids



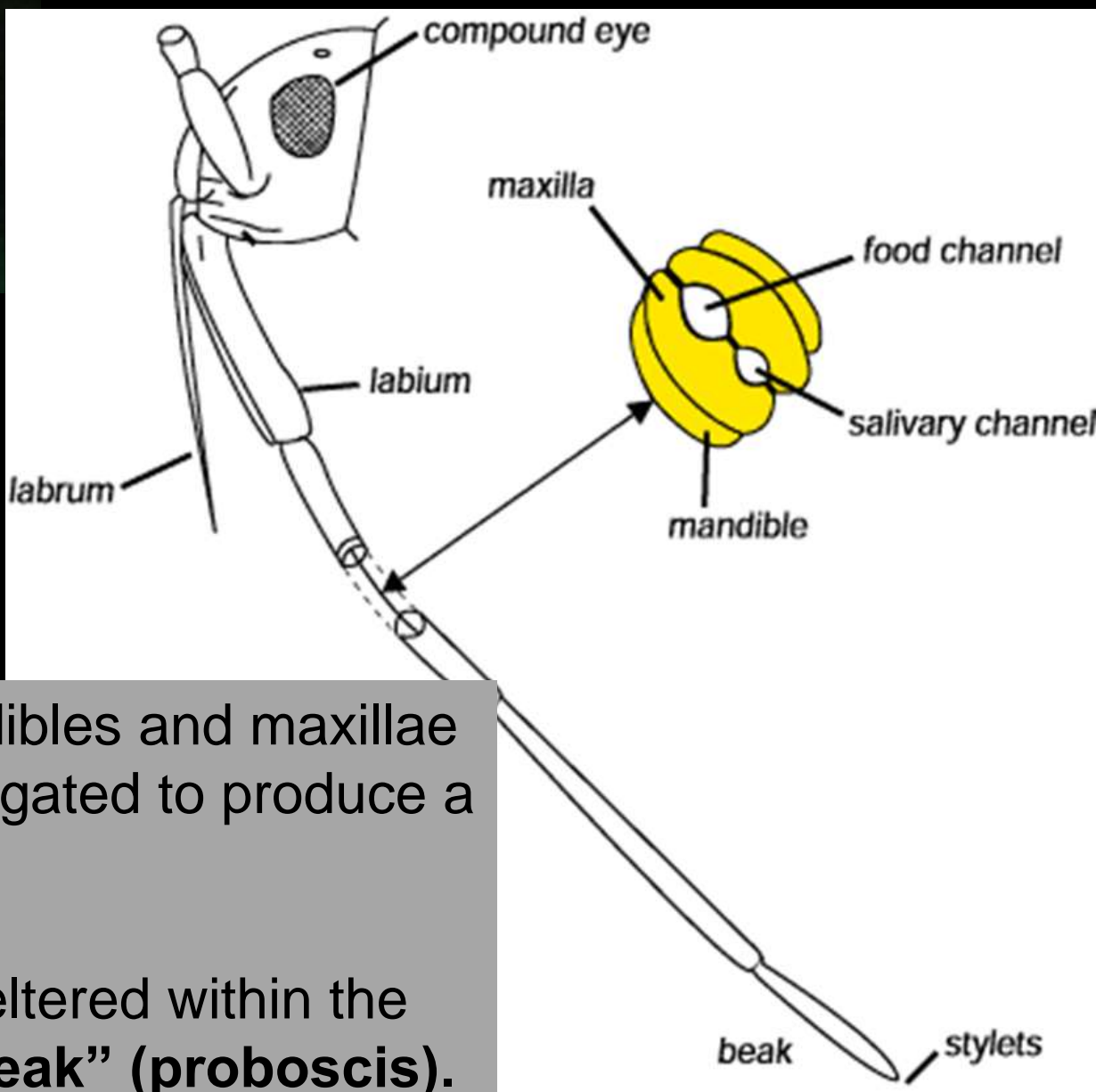
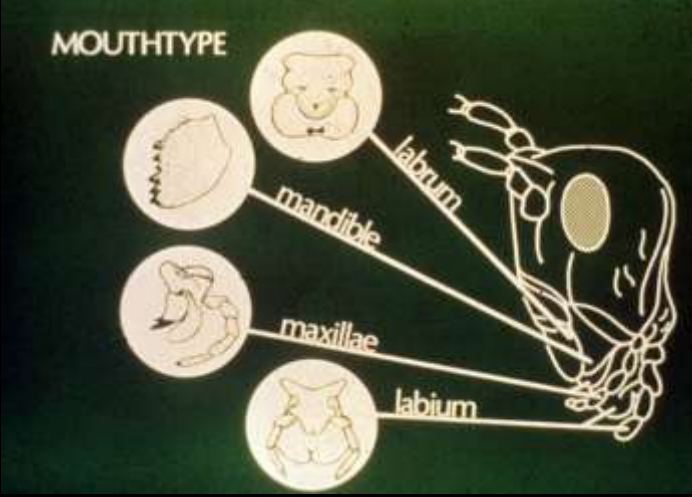
Spider Mites

Piercing-sucking mouthparts of Hemiptera





The mandibles and the maxillae become a “stylet bundle” for piercing plants and sucking plant fluids.



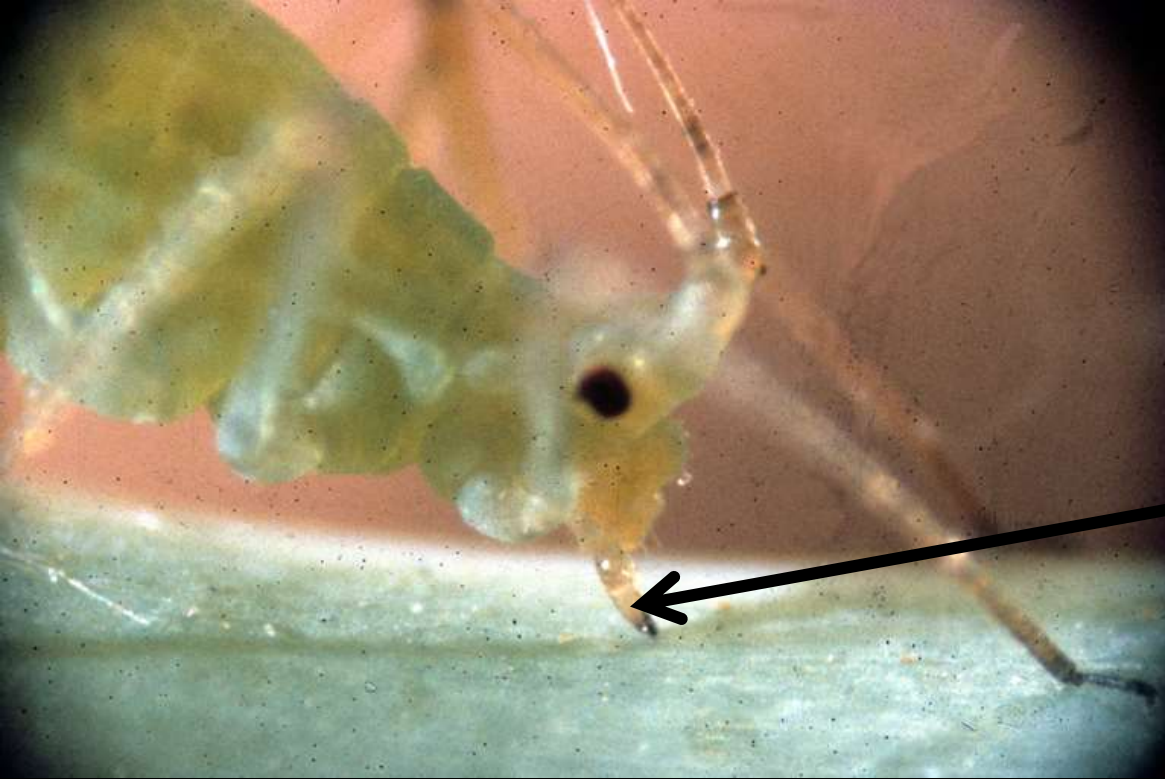
In Hemiptera, the mandibles and maxillae become extremely elongated to produce a **stylet bundle**.

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

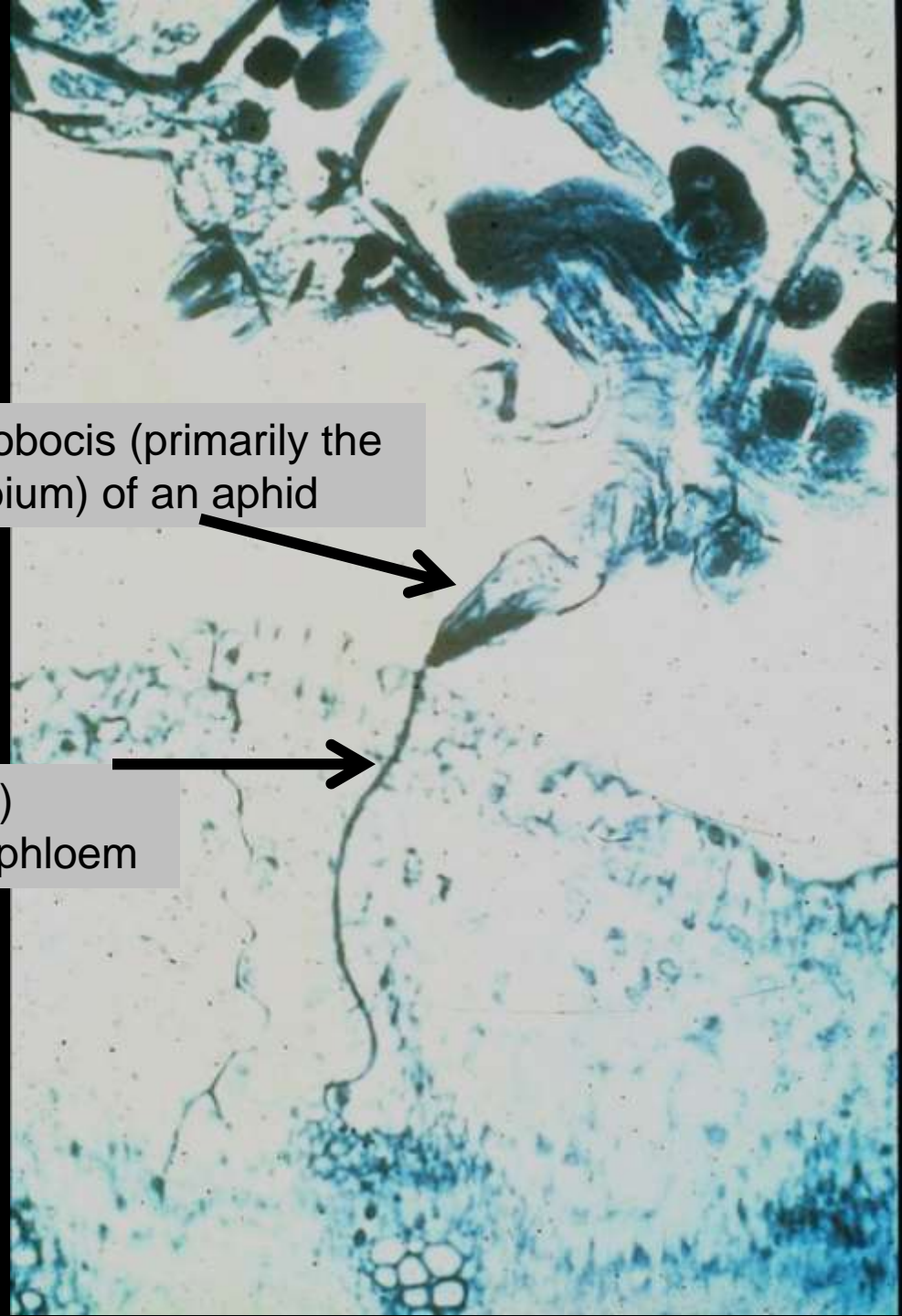


Some sort of "beak" is present on the underside of the head



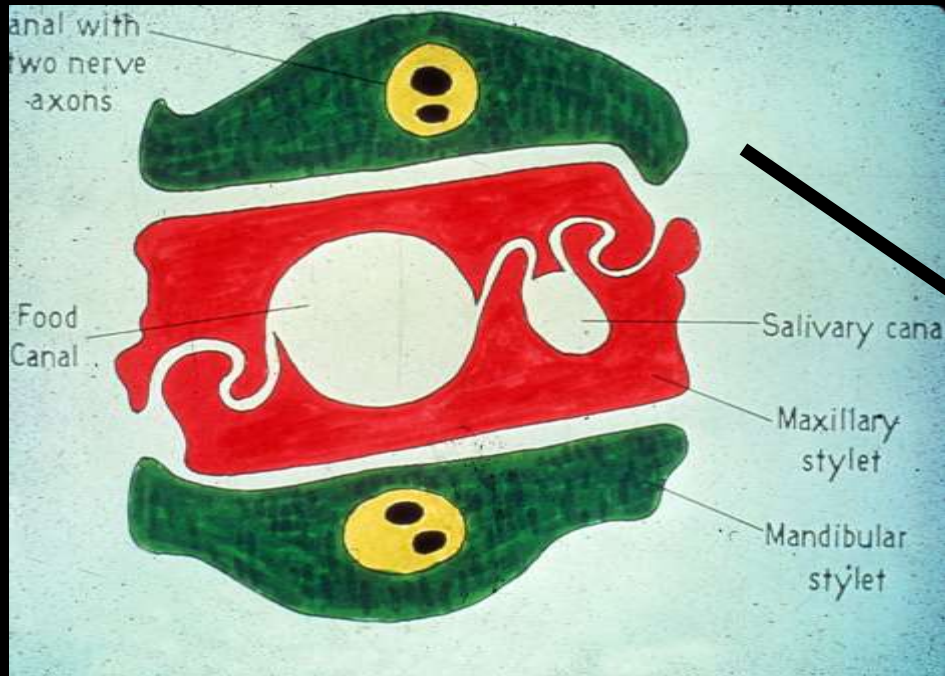


Proboscis (primarily the labium) of an aphid

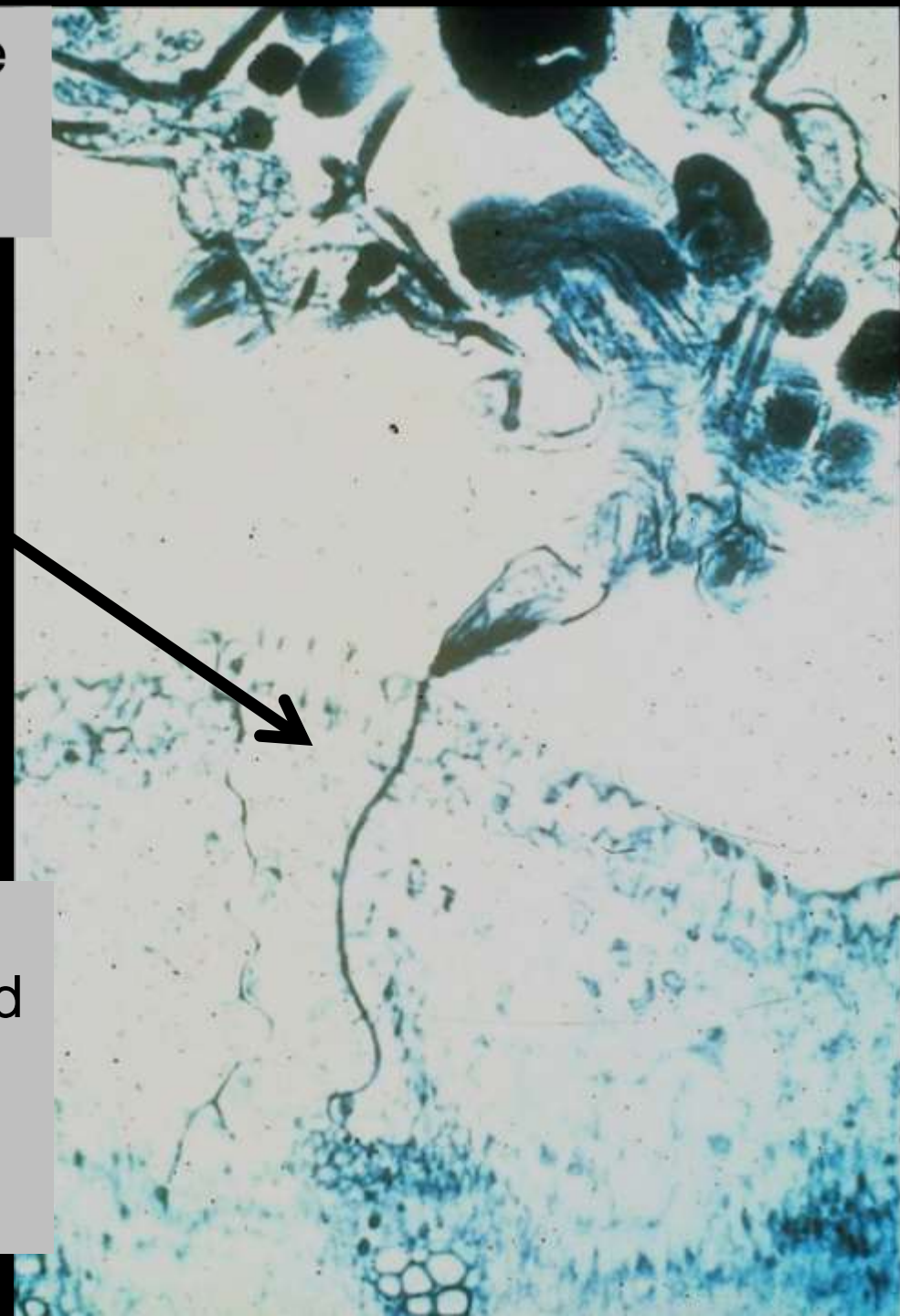


Stylet bundle (mandibles and maxillae) meandering through plant en route to phloem

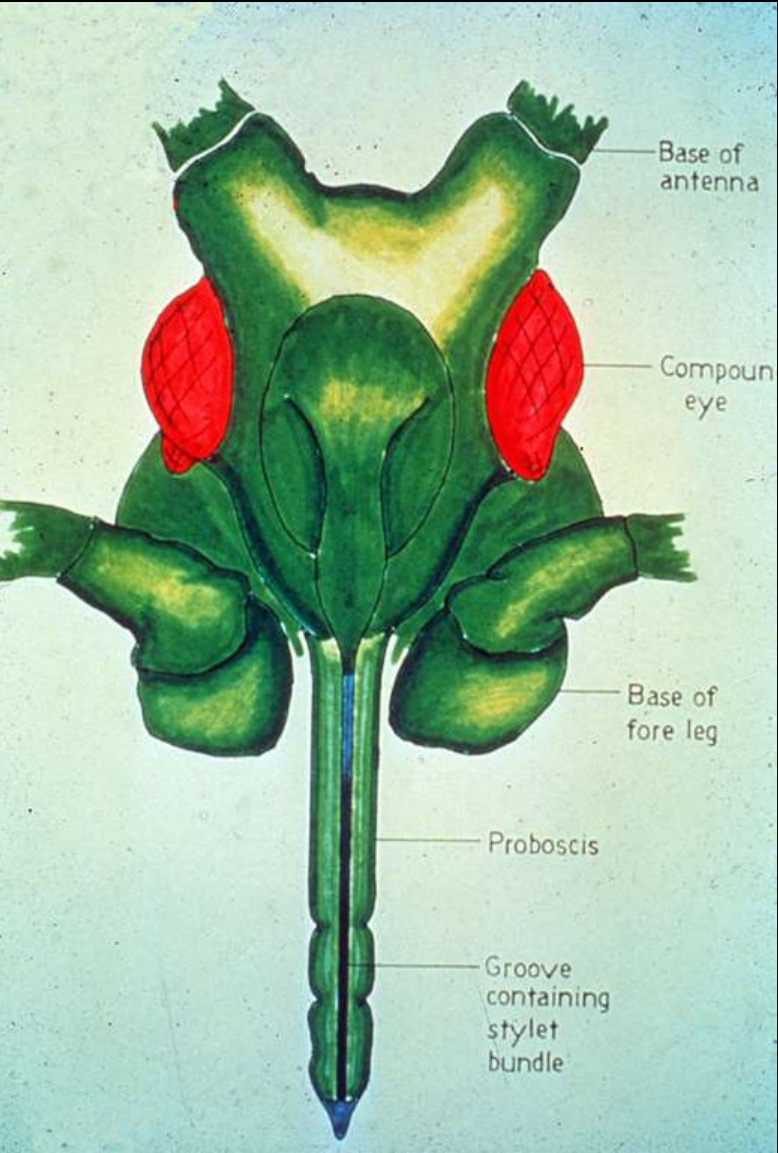
The mandibles are on the outside of the stylet bundle. They are used to penetrate the plant.



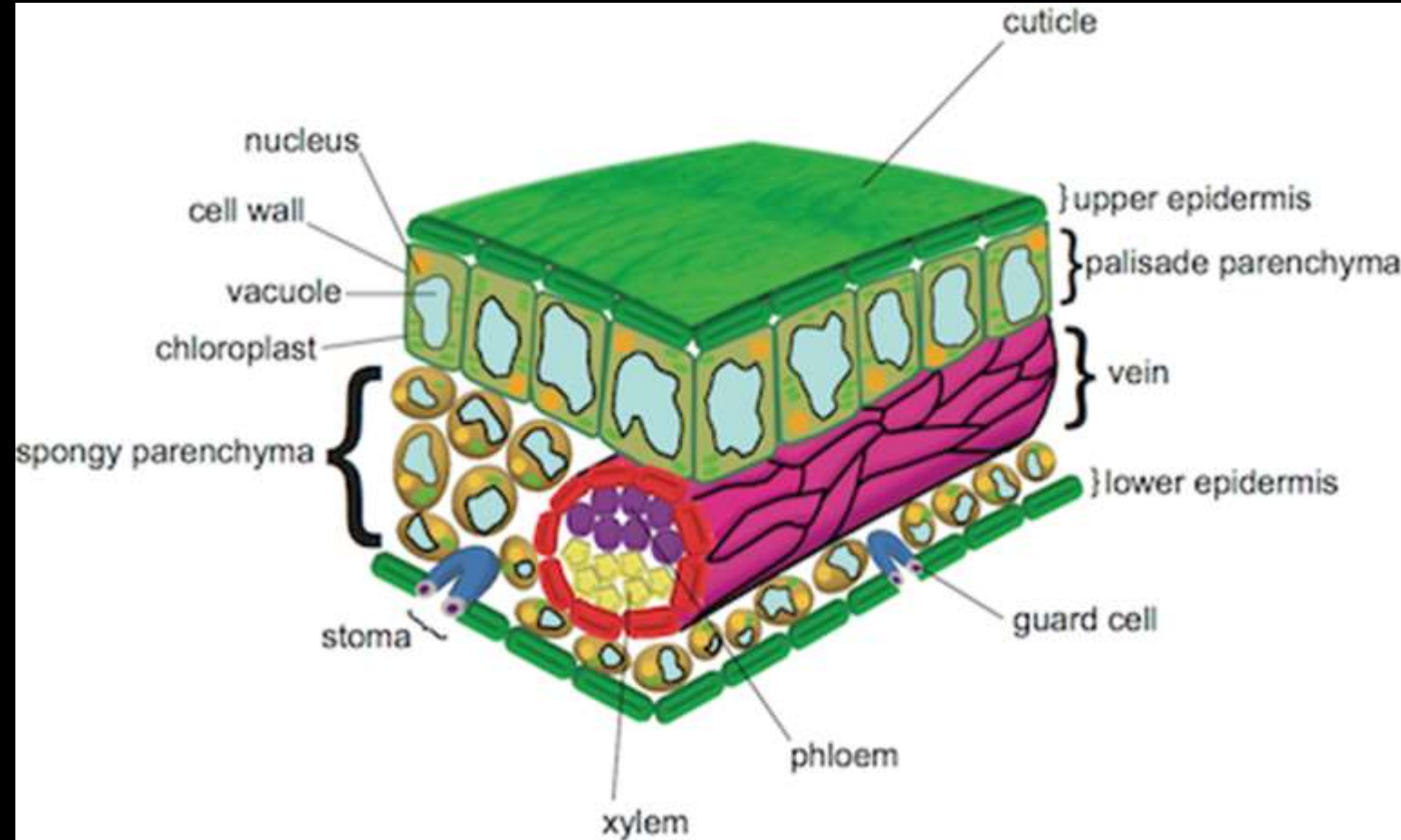
The maxillae are on the inside of the stylet bundle. They are paired and interlock. A food canal and parallel salivary canal are formed by the paired maxillae.



Plant symptoms associated with piercing-sucking mouthparts of Hemiptera



Plant response to feeding depends on how the insects use their mouthparts **and** where they feed in the plant



Plant Symptoms are Associated with *Feeding Site and Feeding Habit*

- **Fluids are extracted from phloem**
 - Aphids, soft scales, whiteflies, mealybugs, etc.
- **Fluids are extracted from the xylem**
 - Sharpshooter leafhoppers, spittlebugs, etc.
- **Cell contents of mesophyll/parenchyma and/or epidermis are consumed**
 - Some leafhoppers, armored scales, lace bugs, some stink bugs, etc.
- **“Lacerate and flush” feeding**
 - Plant bugs, leafhoppers, some stink bugs

Squash Bug

Anasa tristis





Feeding is done in a “lacerate and flush” manner that kills cells at the feeding site



Plant Bugs
Hemiptera: Miridae

Fourlined plant bug injury



Symptoms on cucumber leaf



Plant reaction to feeding wounds on a shrub host



Honeylocust Plant Bug



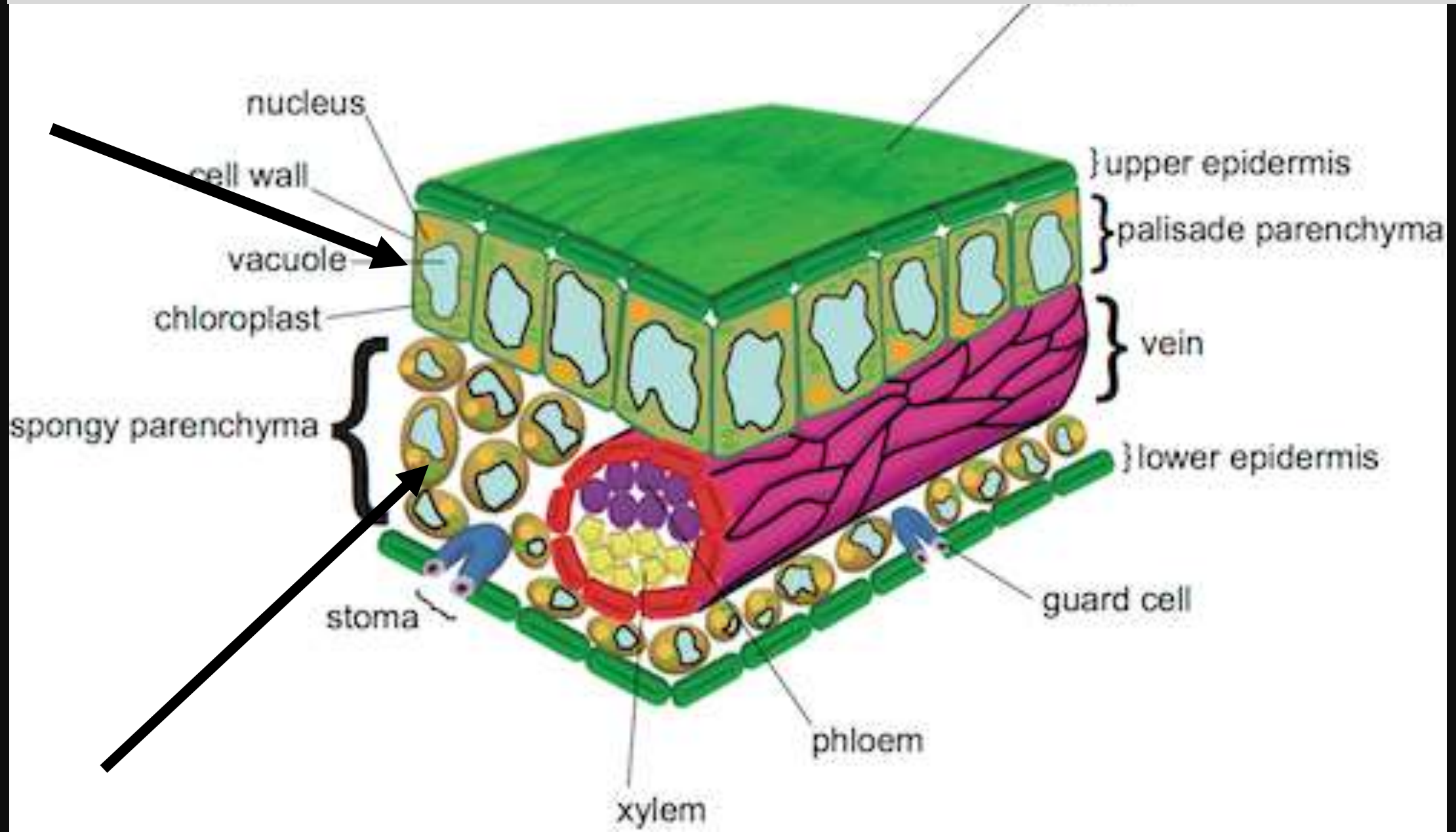


Stippling

Stippling injuries are produced by sucking insects that feed on the contents of leaf cells



Feeding Sites – insects that feed on cells of the parenchyma cells of the mesophyll and/or epidermis





Leafhoppers

Hemiptera: Cicadellidae



**White apple leafhopper
stippling injury**





Rose leafhopper

Small black fecal drops are excreted by many of the mesophyll-feeding leafhoppers





Tar Spots

Dark spots of excrement produced by mesophyll-feeding insects and mites



Lace Bugs

Hemiptera: Tingidae



**Stippling (flecking)
wounds are symptomatic
on the upper leaf surface**



**Lace bugs excrete
spots of dark fluid**





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



Thrips

Other “Bugs” that Suck Plant Fluids



Spider Mites



**A different way to
feed on plant fluids**

Order Thysanoptera
Thrips





The mouthparts of thrips appear as a short cone on the underside of the head

Thrips Mouthparts

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



Most feeding damage is produced by the immature stages of thrips



Thrips injuries – Silvery scars
with small dark fecal spots





**Thrips injury symptoms
often appear as a type of
stippling damage**



Gladiolus thrips on gladiolus



Bean thrips on *Baptisia*



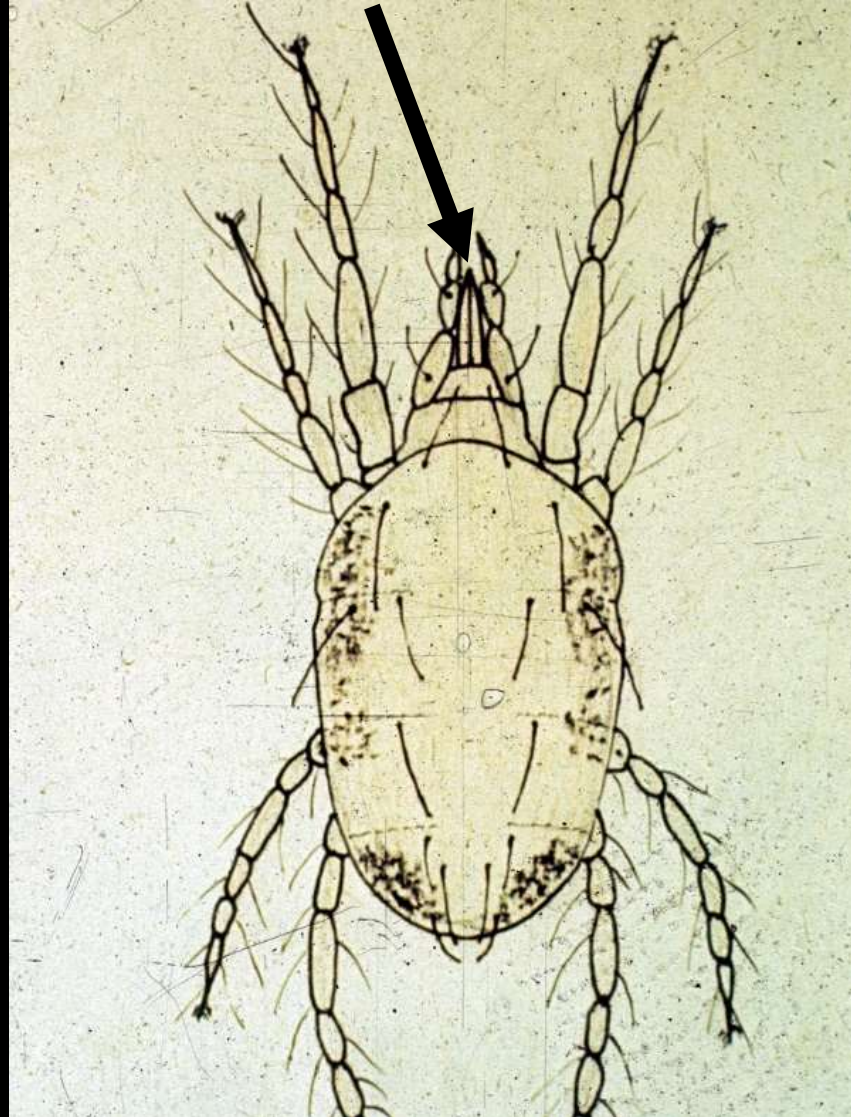
Onion thrips on cabbage



Western flower thrips on bean

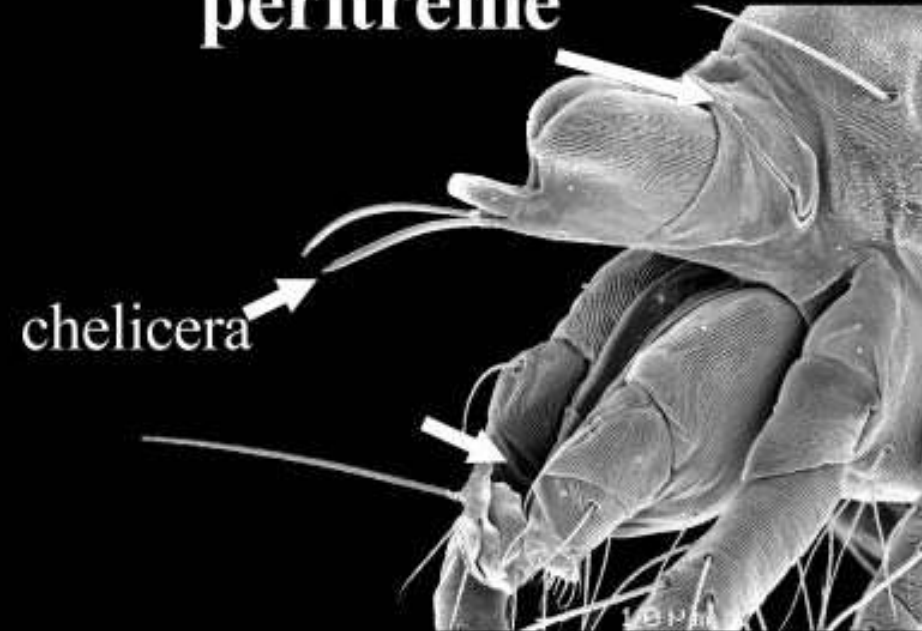


Spider mites pierce cells with their whip-like chelicerae



Spider Mite

**Prodorsum
peritreme**



Typically they will destroy 1 to 2 dozen cells at each feeding site – then move on

“Rototill and Suck”





Each feeding site produces a small area of dead cells – a type of **stippling injury**





With high mite populations, the stippling injuries may cover much of the leaf area.



Life Stages of the Twospotted Spider Mite



egg



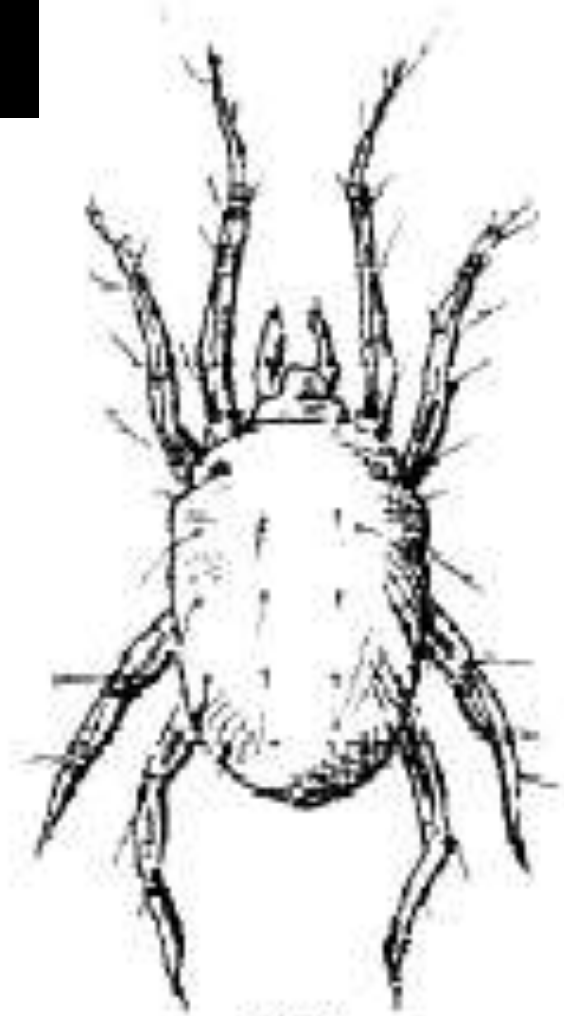
larva



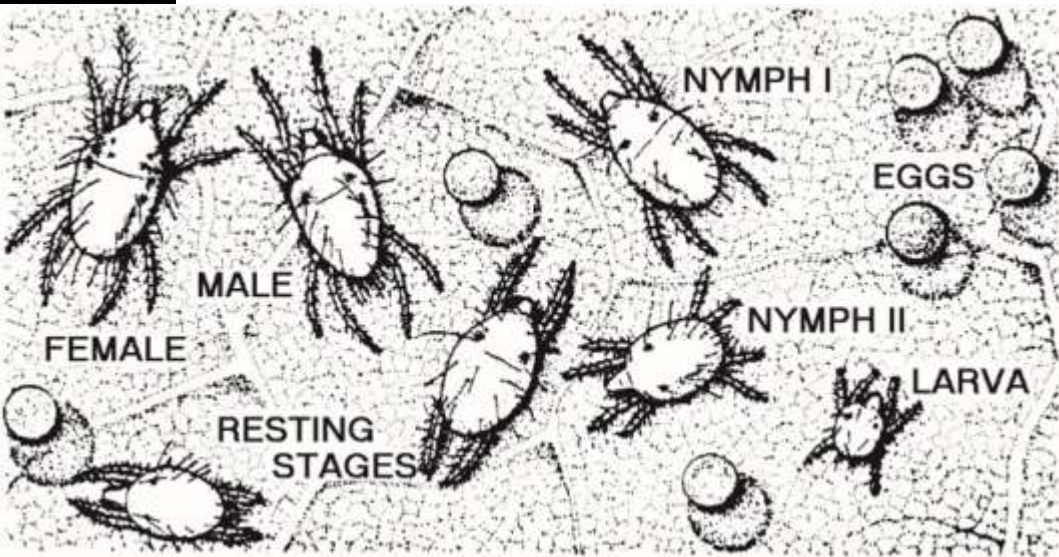
protonymph

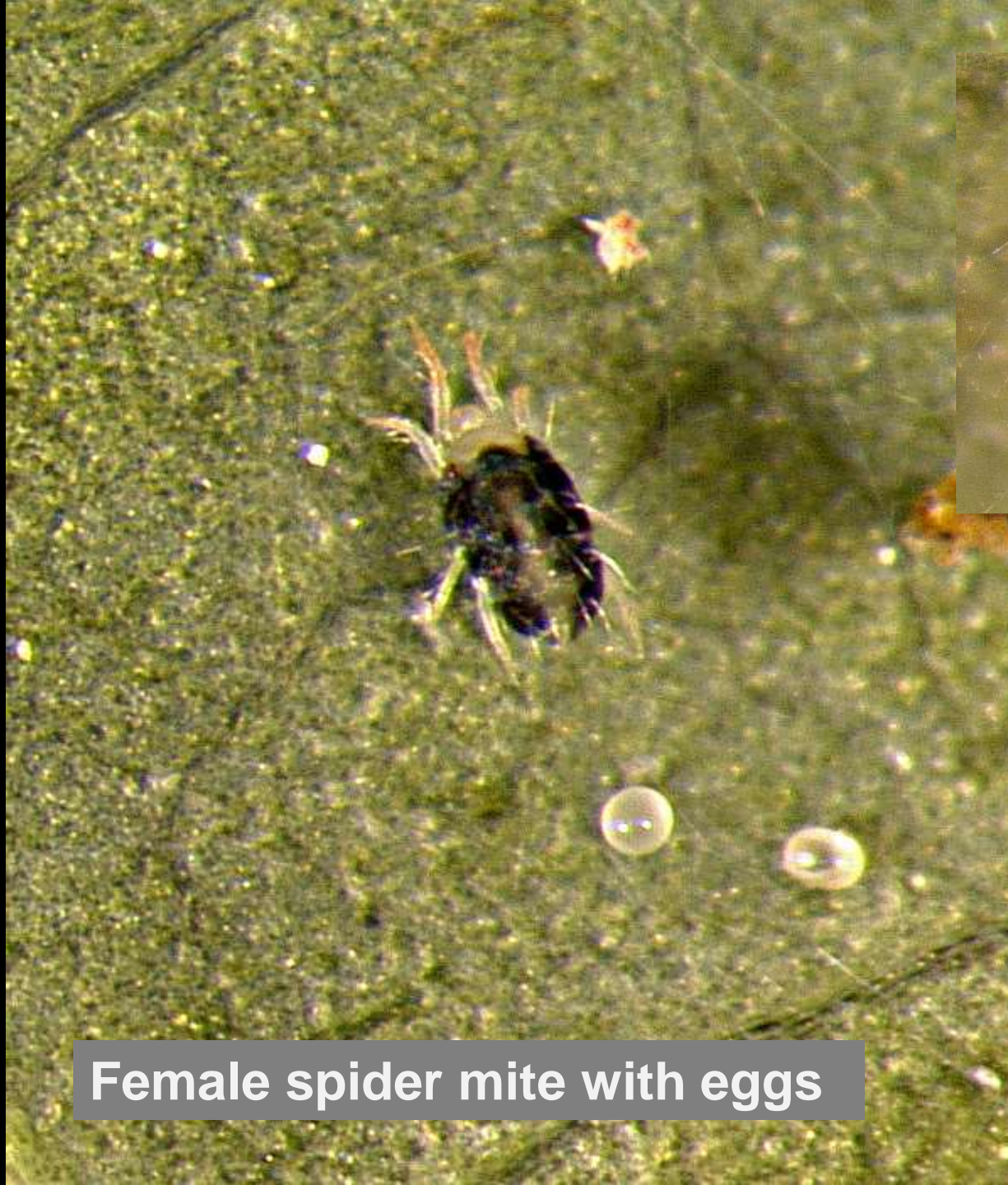


deutonymph



adult





Female spider mite with eggs



Male spider mite

**Photographs courtesy of
David Shetlar**

Spider mites lay eggs that are quite large in proportion to their body size



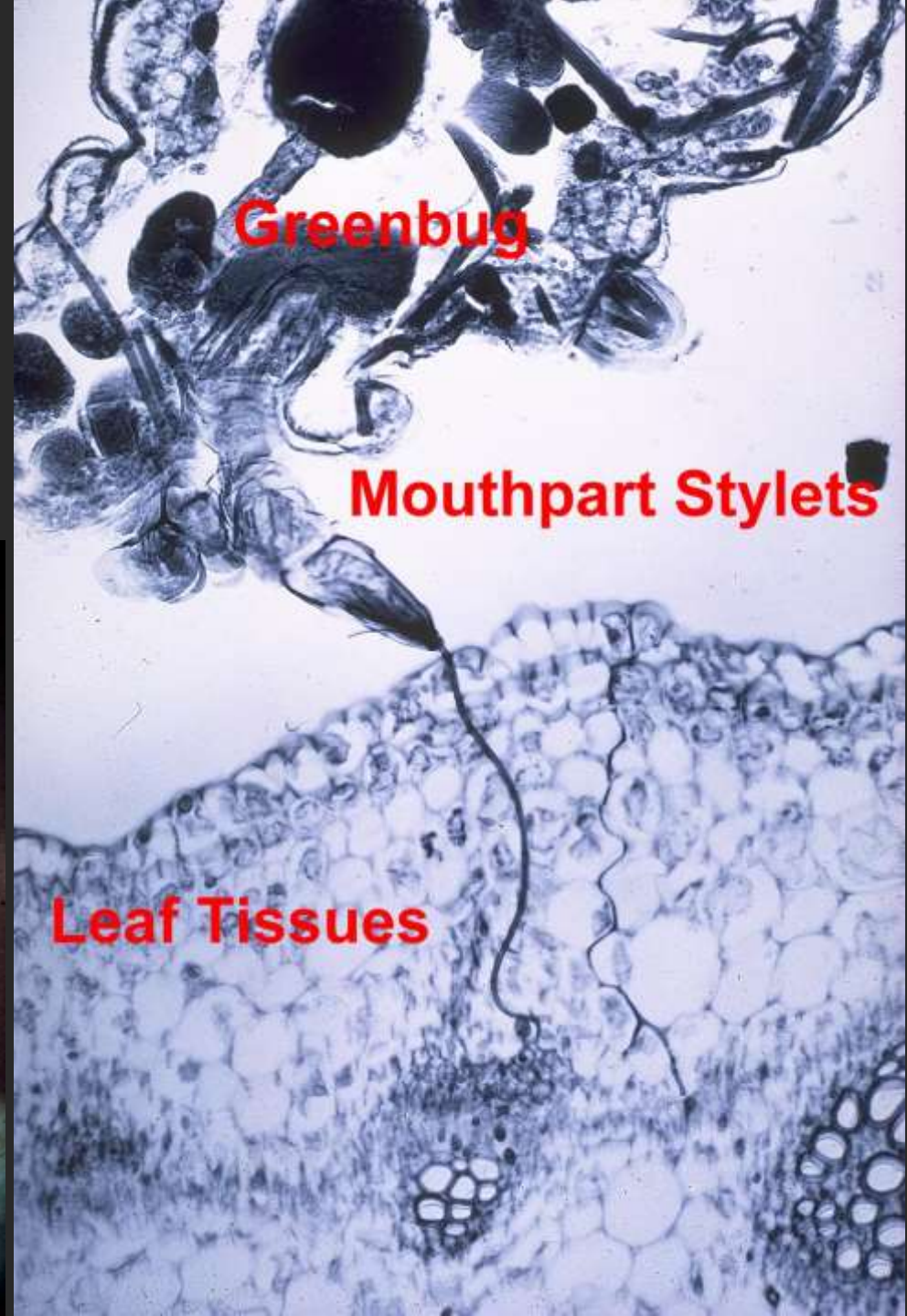
**Spider mites always leave
behind cast skins and egg
shells – *great for diagnostics!***



Live spider mites, eggs and cast skins

Phloem feeding species use their mouthparts to tap into **the fluids carried in the phloem.**

Most cause very little, if any, cell injury.



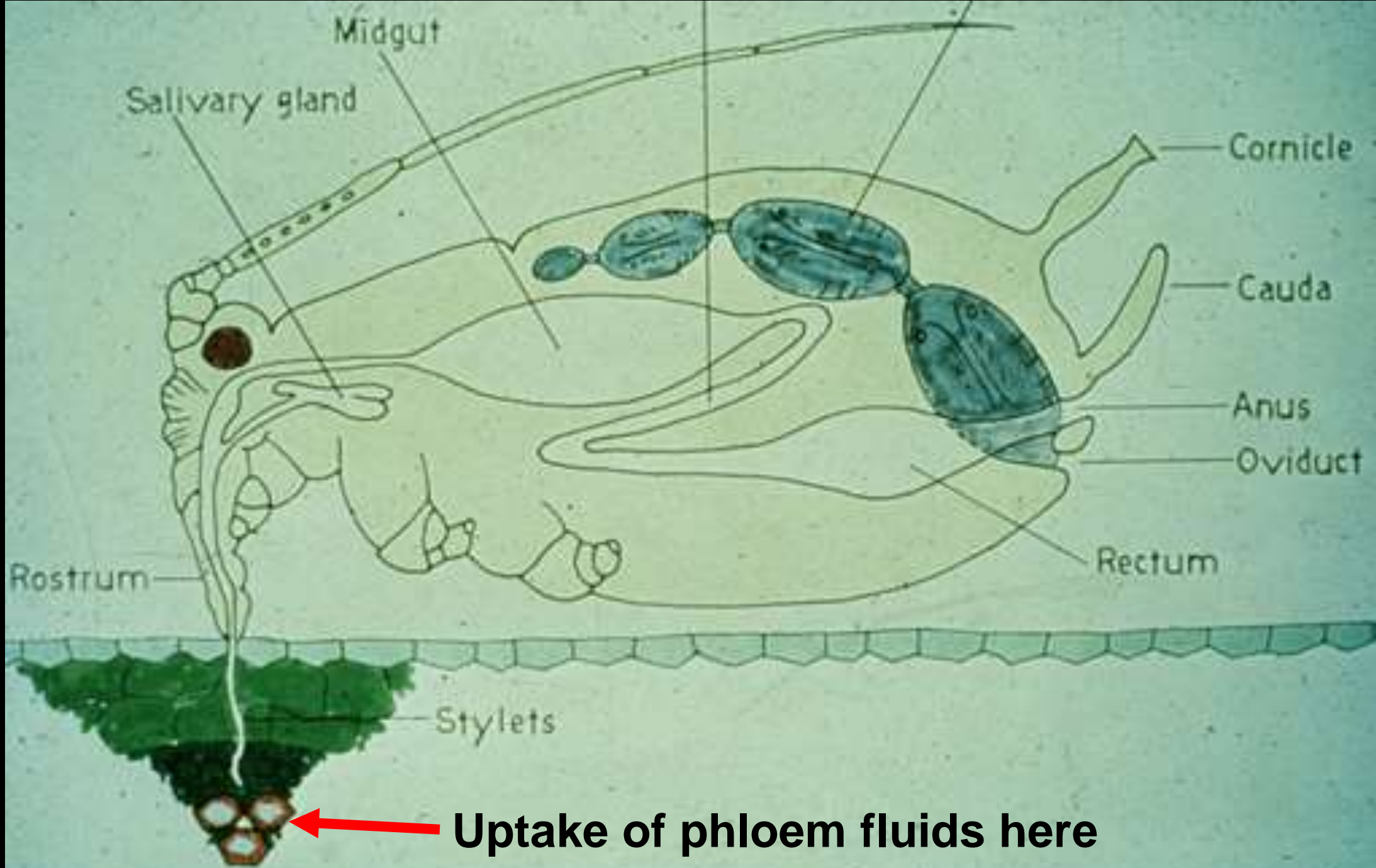
Honeydew production



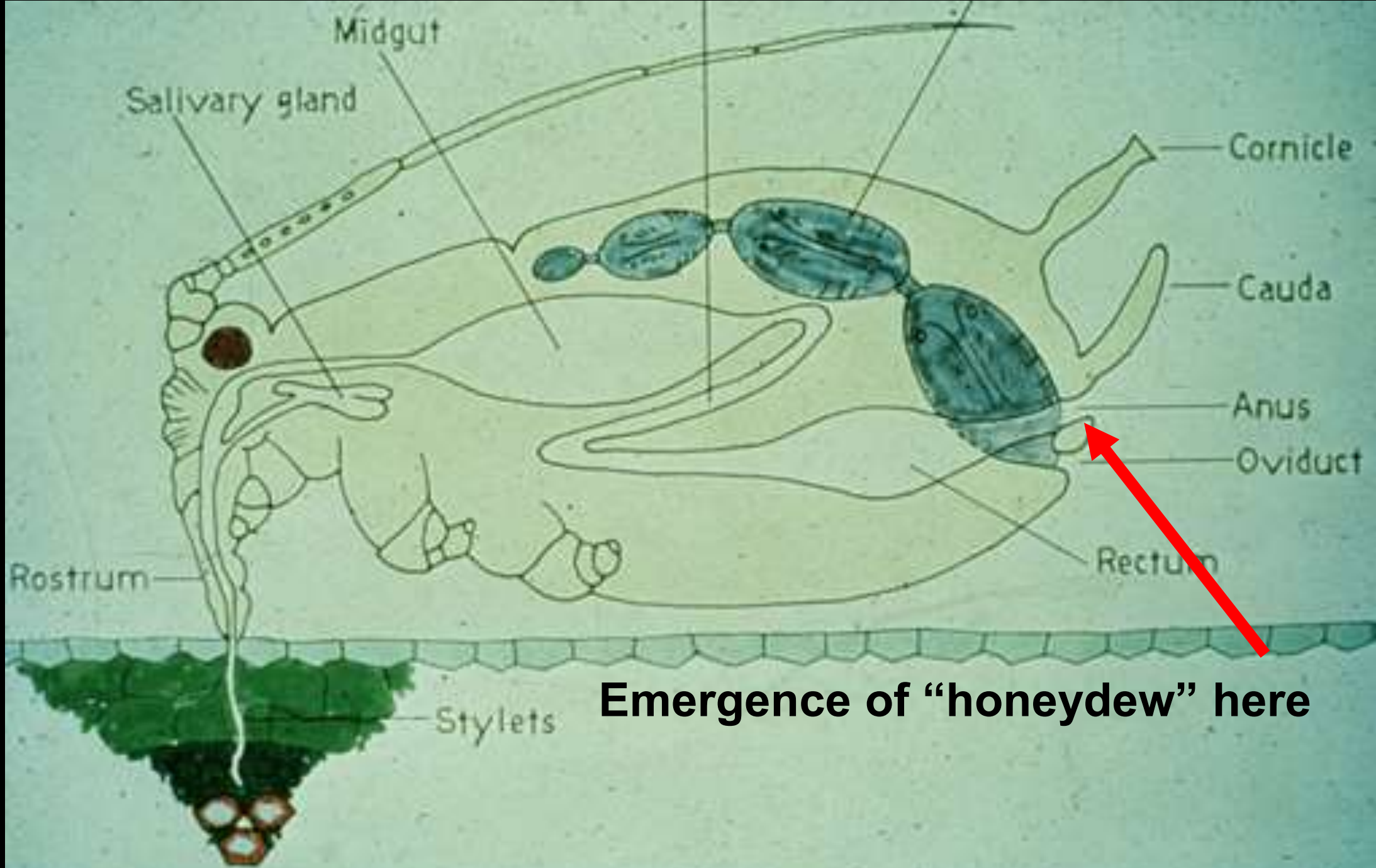


**Honeydew droplets
on a leaf**





Uptake of phloem fluids here



Emergence of "honeydew" here

Leaf with sparkles of honeydew – *and* cast skins





The leaf above the
honeydew – *an aphid
colony*

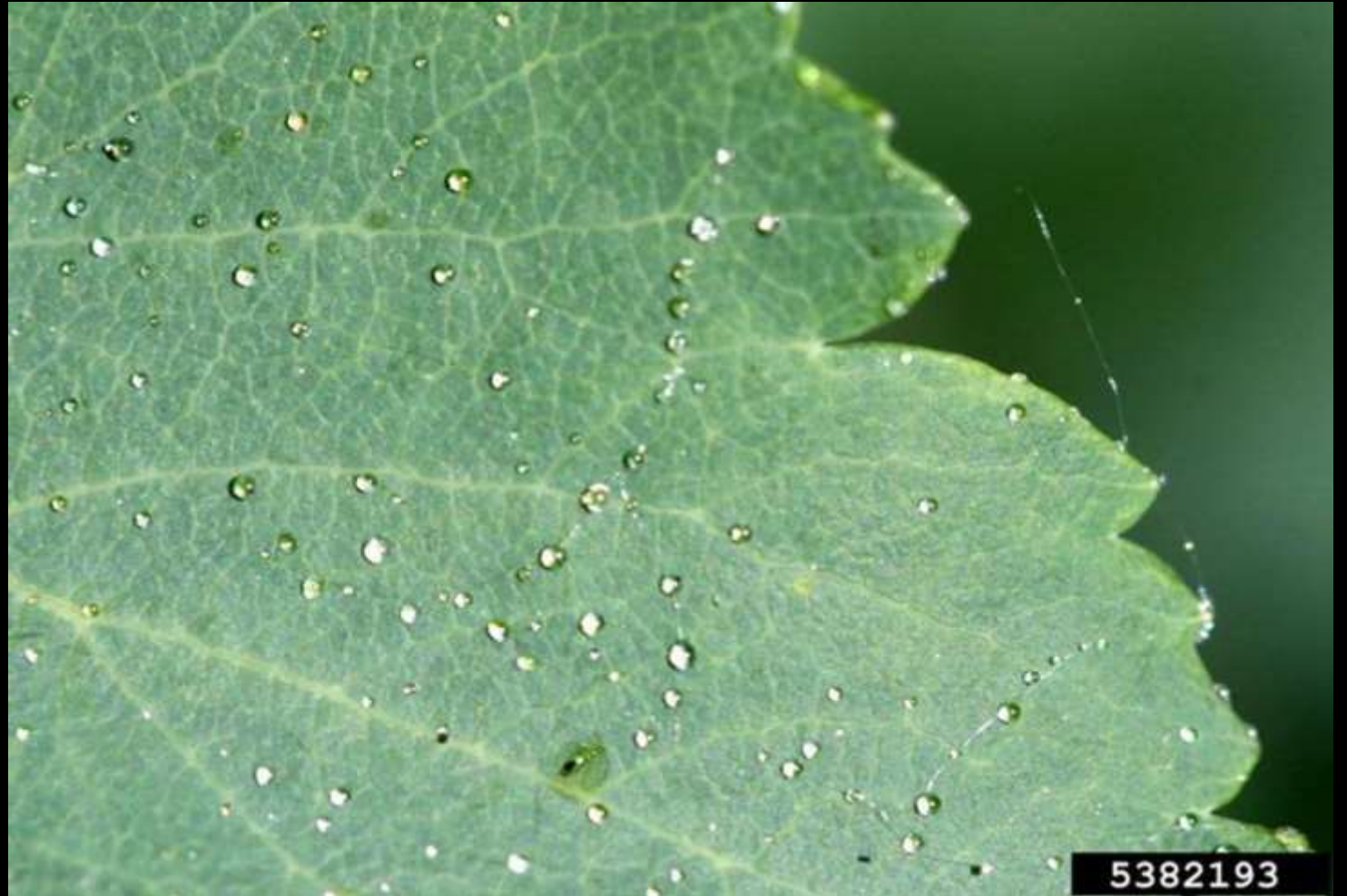


Leaf with sparkles of honeydew – *and* cast skins



Honeydew Producing Insects*

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



***All suck sap from the phloem**

Some non-aphid honeydew producing insects



Honeydew on underside of leaf – no insect on leaf



Soft brown scale can flick its honeydew

Soft brown scales were on the leaf below

Some soft scales, mealybugs, leafhoppers and whiteflies have an “anal cannon” that can direct honeydew some distance



The scale insect is here

The honeydew was expelled about about one inch

Sooty Molds

Fungi that grow on honeydew-contaminated surfaces



Sooty mold may grow on the upper surfaces of branches and root flares – areas that intercept dripping honeydew



Sooty mold on the upper surface of branch



**Sooty mold on sidewalk -
to dripline of the tree**





Sooty mold developing underneath a linden tree that is chronically infested with aphids





Sooty mold developing underneath a linden tree that is chronically infested with aphids

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



**So are wasps, bees,
flies and other insects**



Ants and Aphids

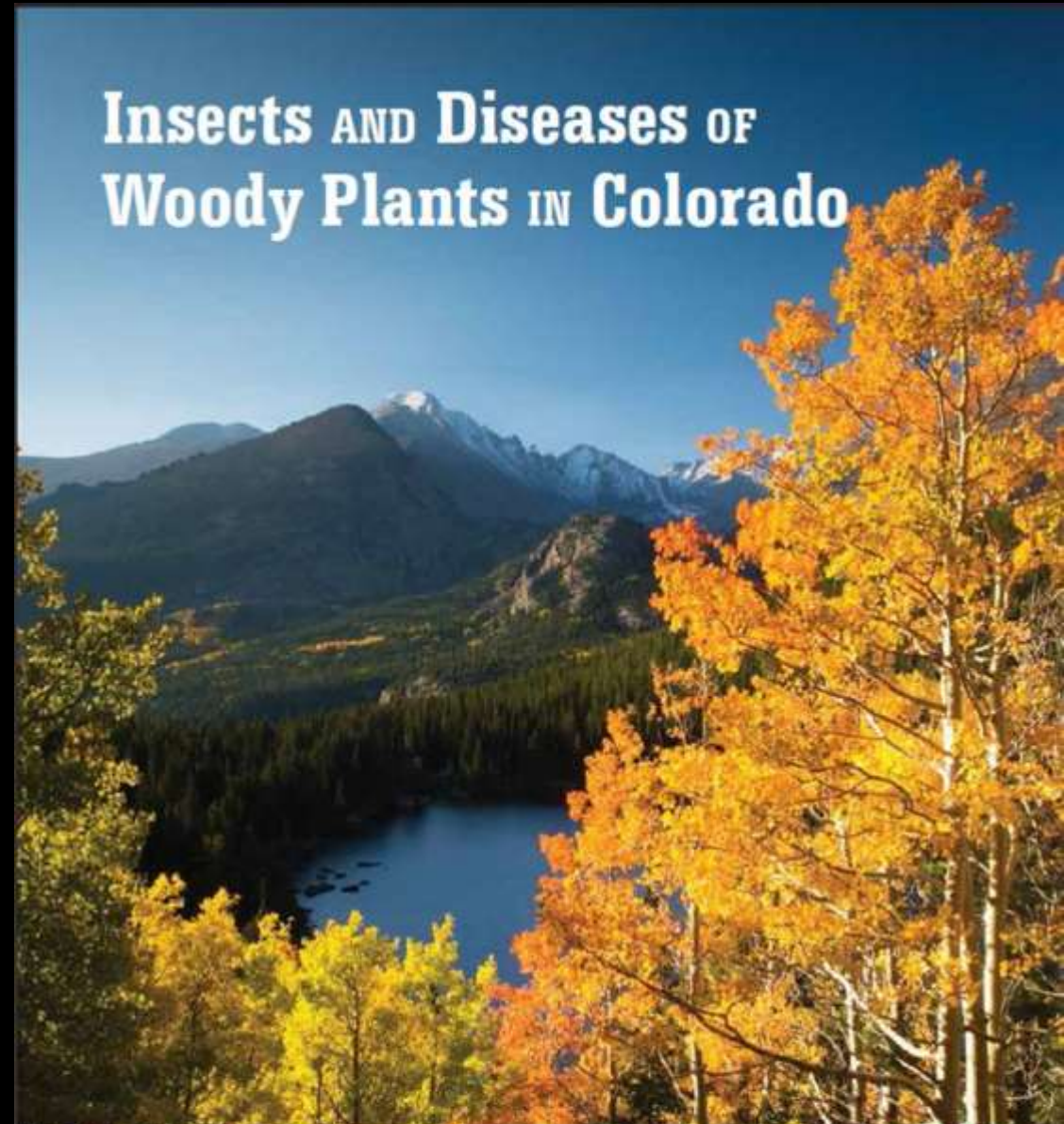
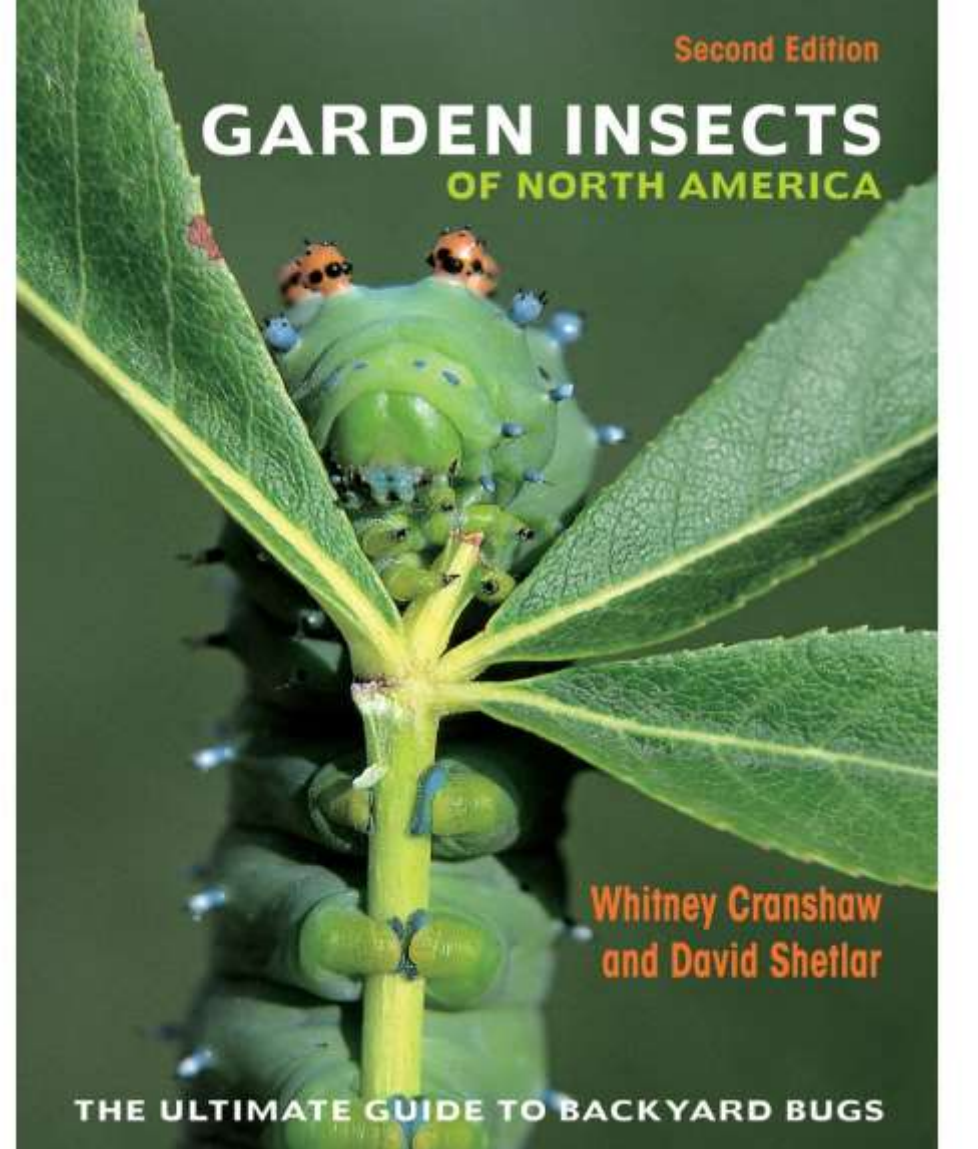
A Mutualistic Relationship

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





Photograph by Brian Valentine



Two publications that can assist with diagnostics related to insects/mites on plants – *for sale here!*



Colorado State University
Extension



**This presentation will be posted at the Colorado Insect
Information Website**

- **Housed at** Department of **Bioagricultural
Sciences and Pest Management**
 - **Search “BSPM CSU”**
- **Click on “Entomology”**
- **“Insect Information”**
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