Basic Entomology

Insects:

- Arthropoda: largest phylum in animal kingdom
- Arthropoda: joint-footed
- Class ‘Insecta’ Crustacea, Archinida…
- More numerous than any other group
- Major groups have coevolved with flowering plants.

Arthropods: sowbugs, millipedes, centipedes, scorpions, spiders, mites, ticks, crabs, lobsters, shrimp and insects.

- bilateral symmetry
- chitinous exoskeleton
- segmented body
- paired, jointed legs & antennae


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- Arthropoda divided into classes.
- Class: ‘Insecta’
- 26+ kinds of insects (Orders)
- Most importance: beetles, moths and butterflies, wasps, aphids, scale, leaf hoppers, true bugs

Why so successful?

- diversity
- reproductive potential
- protective exoskeleton
- adaptability
- small size
- great mobility - walk, run, jump, swim, and fly

- most beneficial (predators, parasites, pollinators, scavengers, some eliminate weak and old, reduce competition)
- recycle nutrients
- maintain forest health
- food and economics
- can be destructive

- destroy wood
- eat or spoil stored grains, crops
- kill/damage trees
- transmit disease (plant and human)
- nuisance

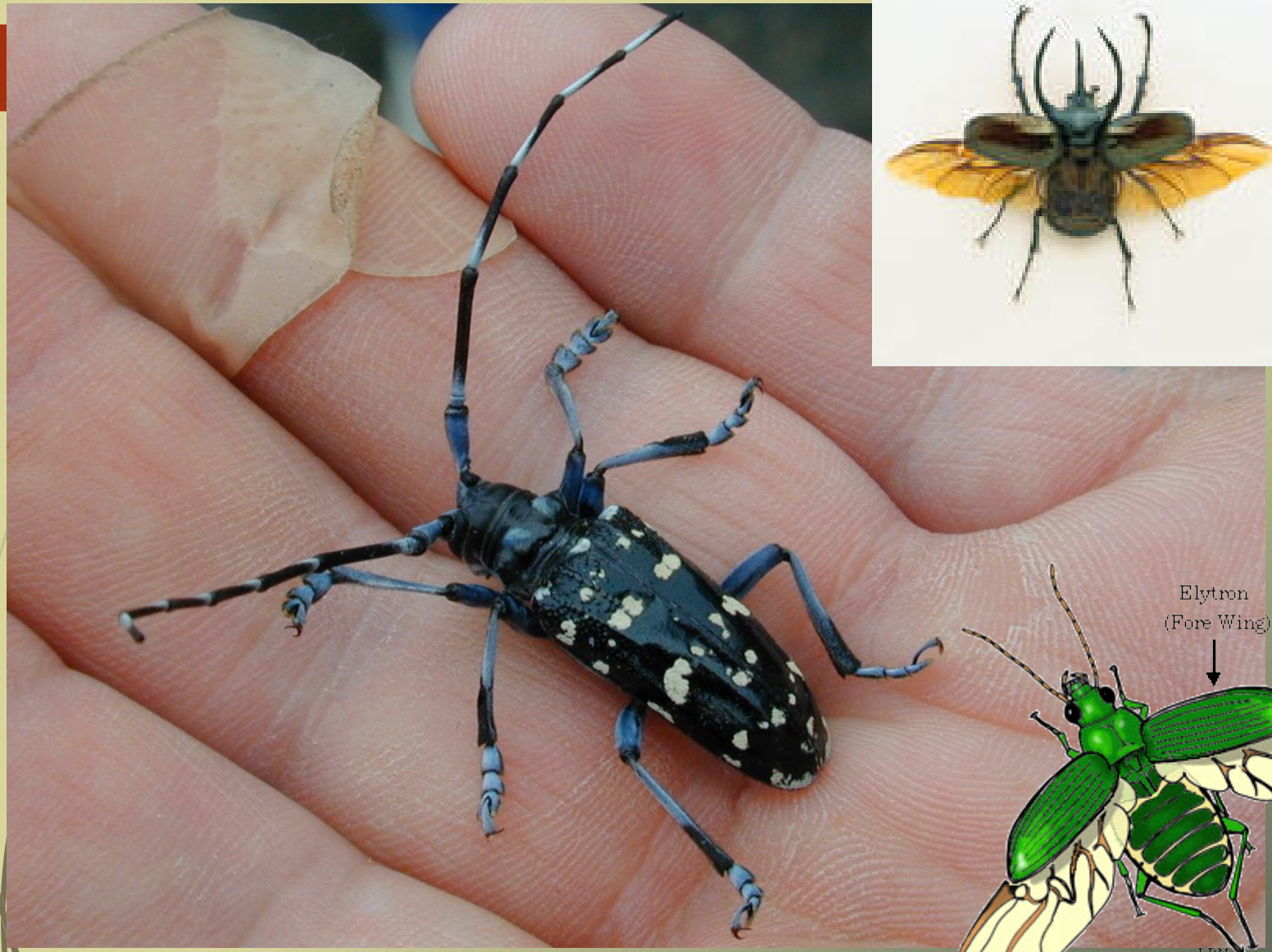
What can insect do?

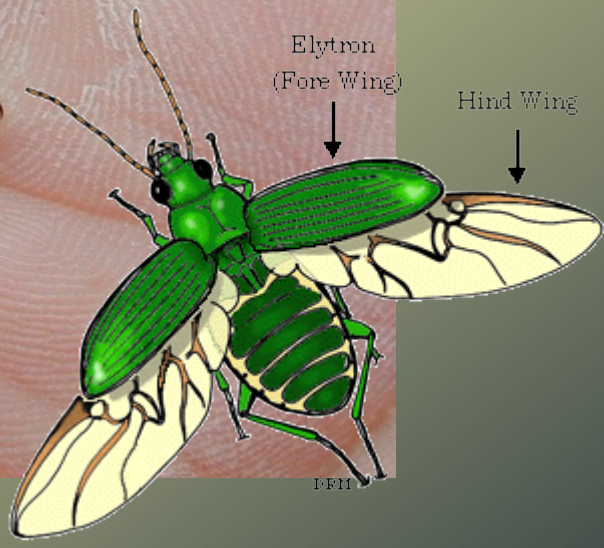
- reduce growth, impair health
- affect appearance
- defoliate
- suck sap
- cause deformities, galls
- spread plant diseases
- burrow in wood, under the bark

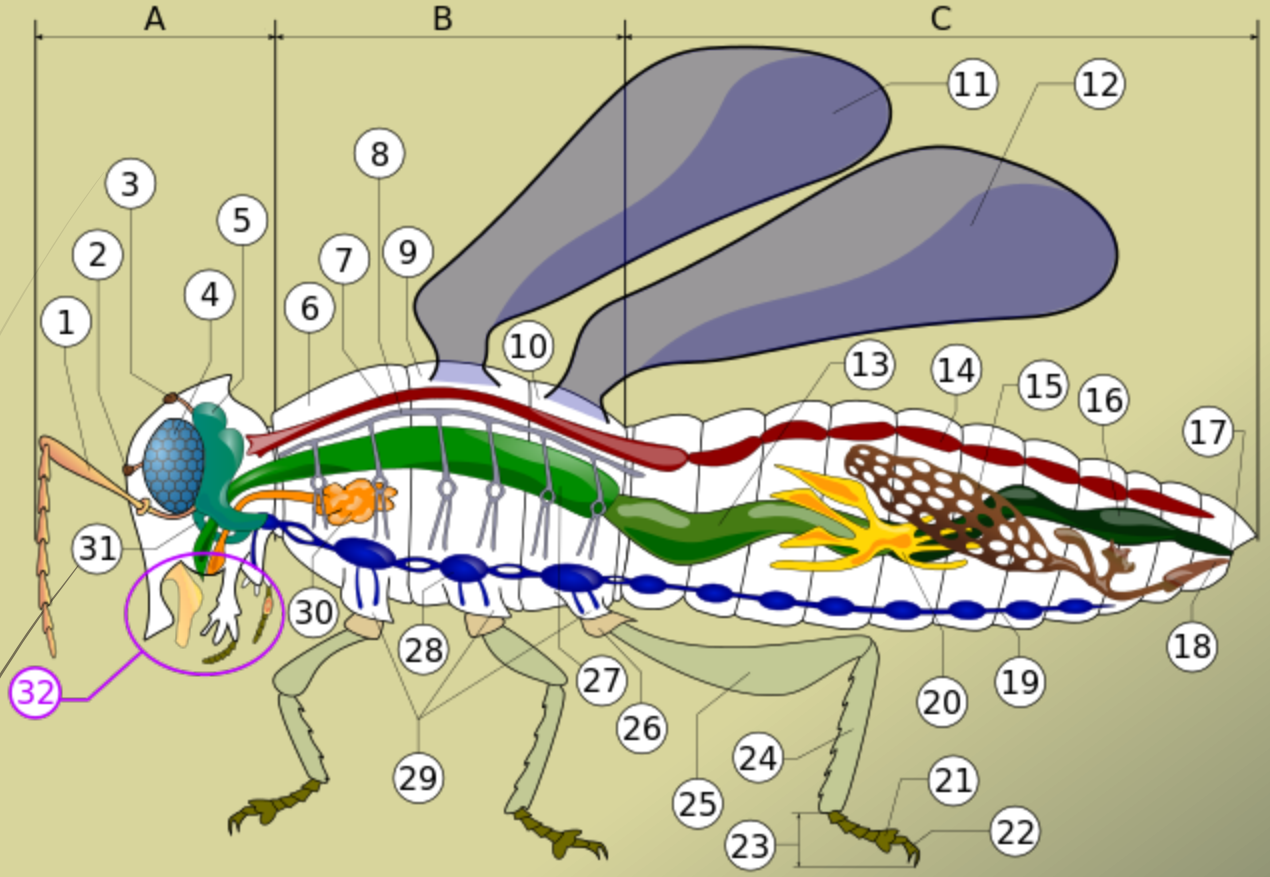
- girdle branches
- create a nuisance: honeydew, sooty mold
- eat seeds
- seldom kill (native v. introduced)
- cause mortality: secondary pests
- repeated defoliation, root loss, drought, excessive pruning

What's unique?

- 3 body regions - head, thorax, abdomen
- 3 pairs of jointed legs
- wings - usually 2 pair
- simple or compound eyes
- antennae




Elytron
(Fore Wing)
Hind Wing



"Insect anatomy diagram" by Piotr Jaworski, PioM - Current version is the source of Image:Robal.png. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Insect_anatomy_diagram.svg#mediaviewer/File:Insect_anatomy_diagram.svg

Classification:

- Kingdom: – Animalia
- Phylum: – Arthropoda
- Class: – Insecta
- Order: – Lepidoptera
- Family: – Dioptidae
- Genus: – *Phryganidia*
- Species: – *californica*

- Scientific name: *Phryganidia californica*
- Common name: California oak worm

Insect mouth-parts:

Chewing – beetles, moth and butterfly larvae, sawfly larvae, grasshoppers, termites, ants

Piercing and sucking – aphids, scale, mealy bugs, leafhoppers, plant bugs, lacebugs, stink bugs, some flies (mosquitos, black flies)

Chewing and lapping – bees and wasps

Sponging – certain flies

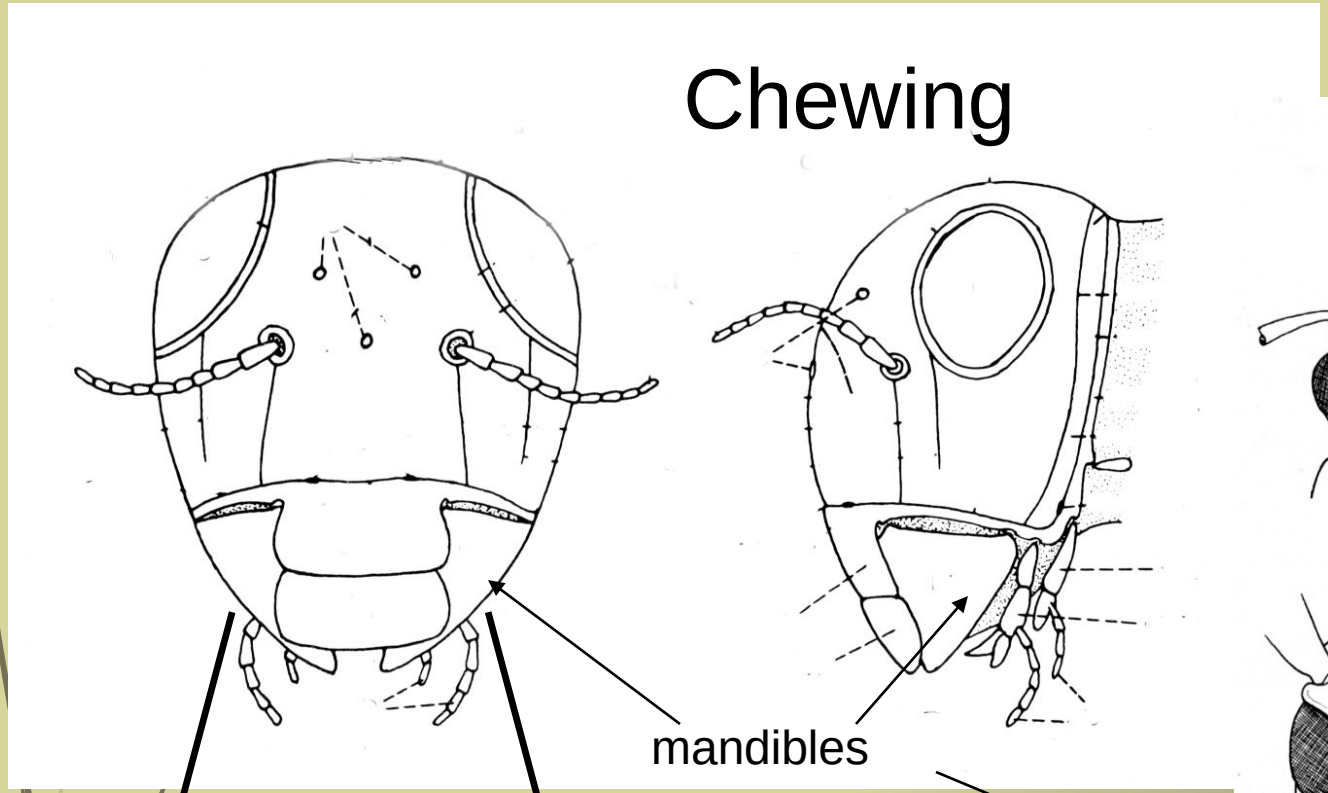
Siphoning – moths and butterflies

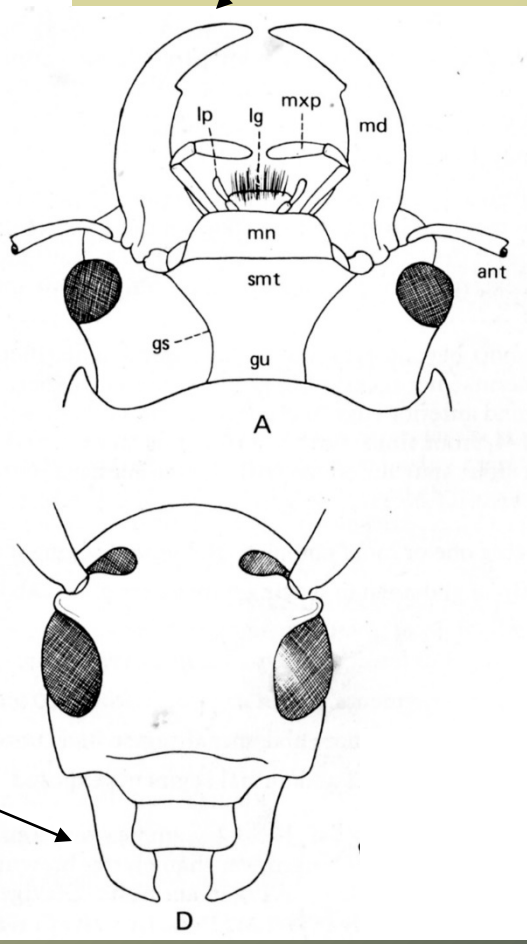
Mouth parts

Mouthparts:

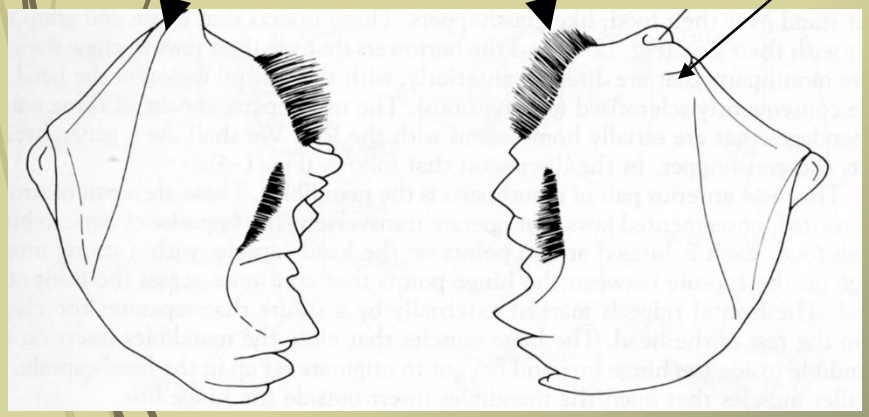
mandibles

Chewing

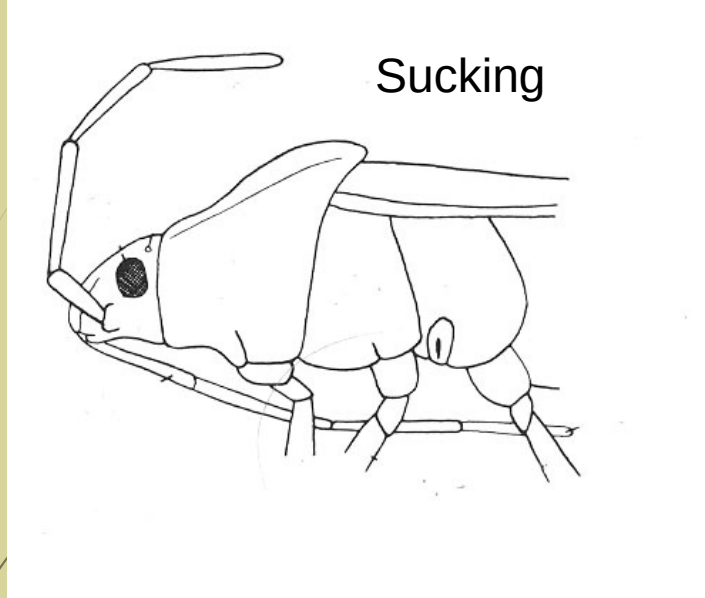


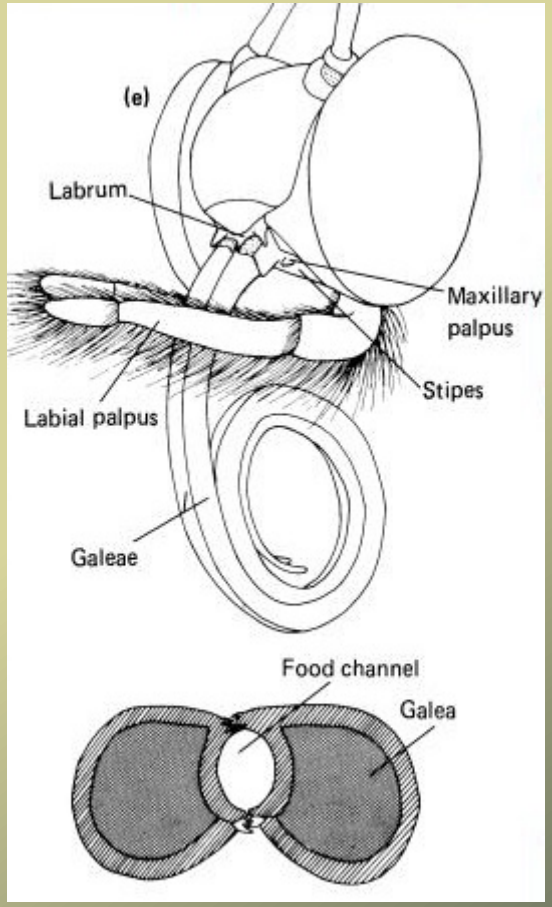


mandibles

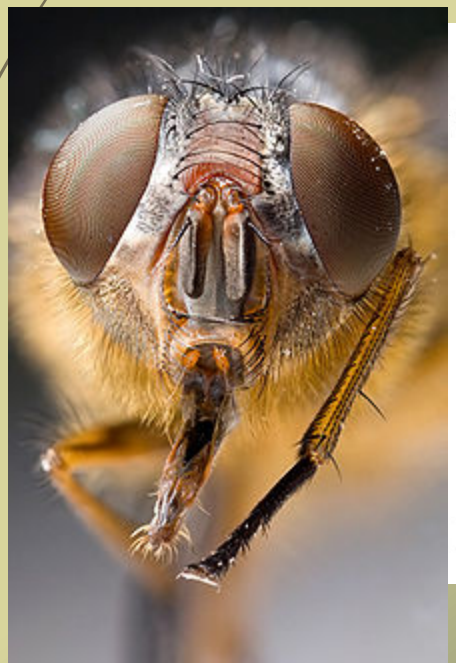


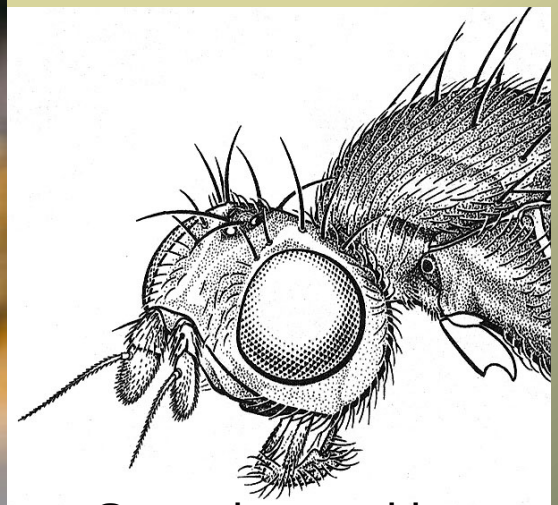
Mouthparts:





Siphoning



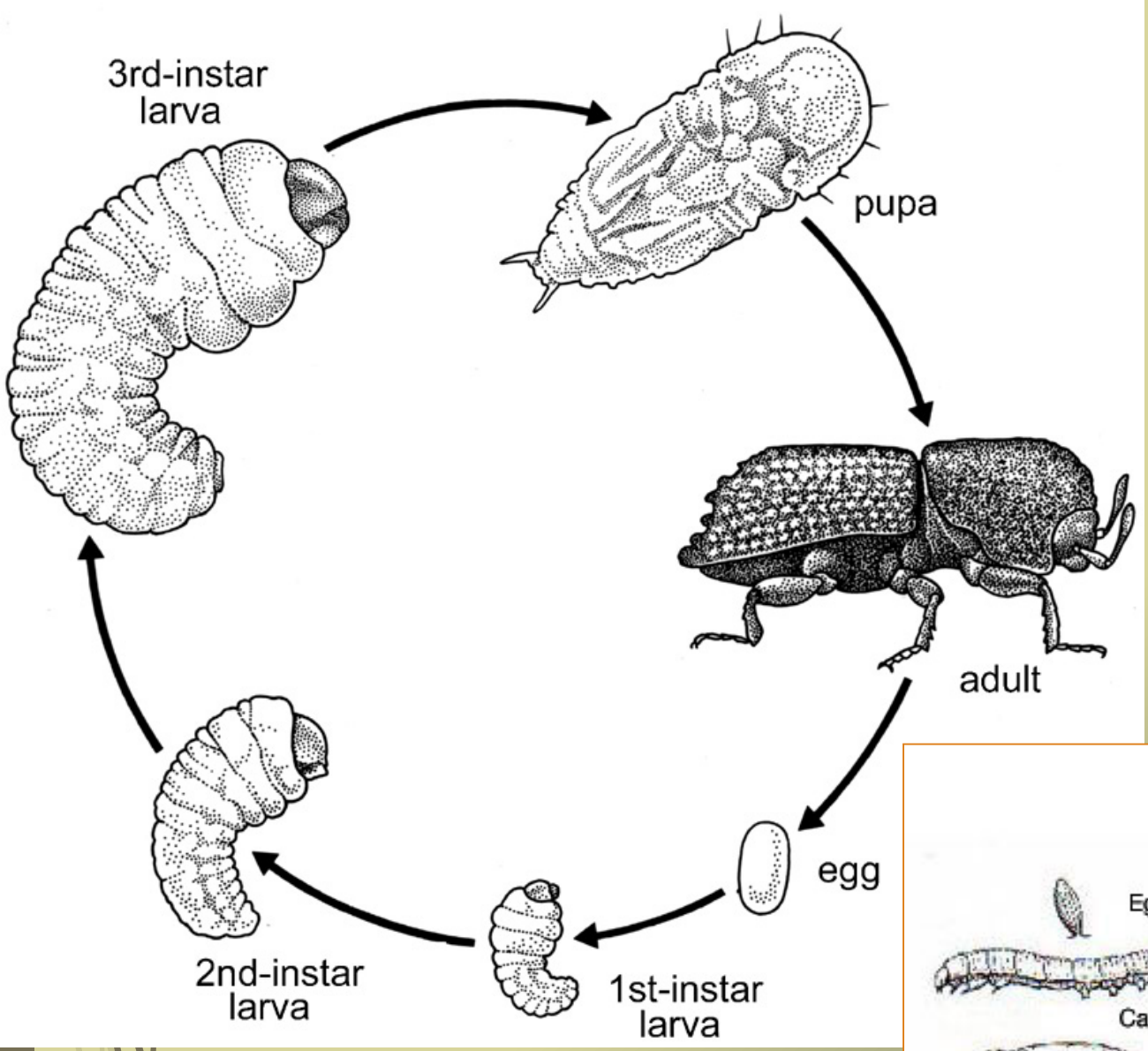


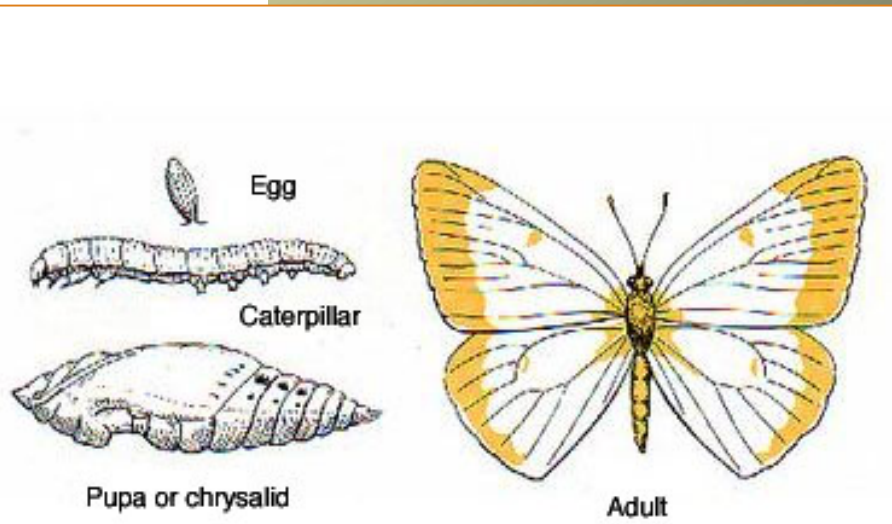
Sponging-sucking

Insect development:

- Insects go through several life stages
- Metamorphosis
- Most completely change form
- Complete development:
  - Four stages - egg, larva, pupa, and adult.
  - Examples: beetles, moths and butterflies, ants, bees, wasps, etc.

Complete development

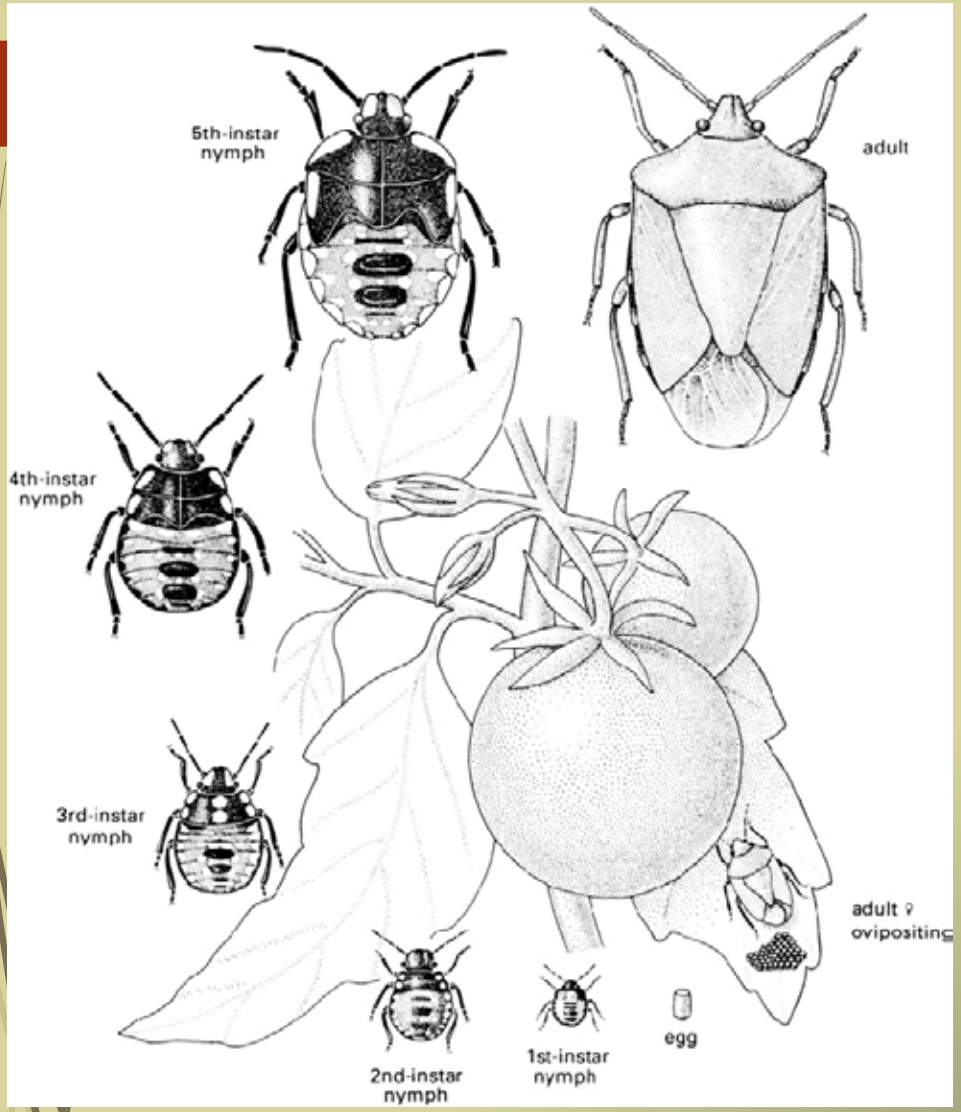


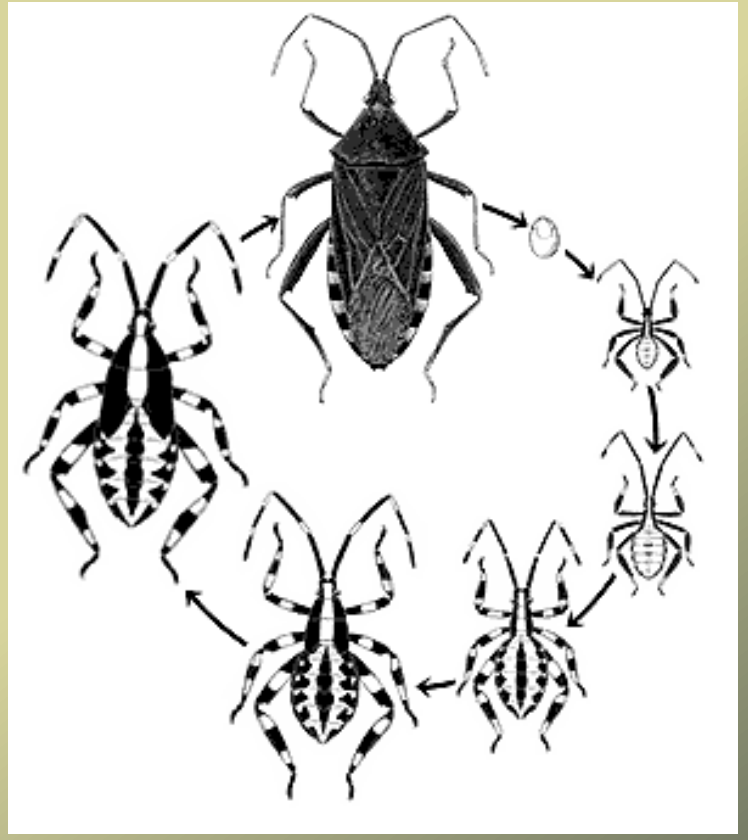





Incomplete metamorphosis: aphids, scales and true bugs

- only 3 stages - egg, nymph and adult
- nymph (immature stage) resembles adult
- changes are in size, body proportions, development of the eyes, wings and other body parts


5th-instar nymph
adult
4th-instar nymph
3rd-instar nymph
adult ♀ ovipositing
2nd-instar nymph
1st-instar nymph
egg



Stages of metamorphosis:

- Egg: embryonic stage
- Larva or nymph: feeding stage -- limited movement.
- Pupa: inactive, non-feeding stage where structural reorganization takes place.
- Adult: reproductive and dispersing form.
- Specialization or division of labor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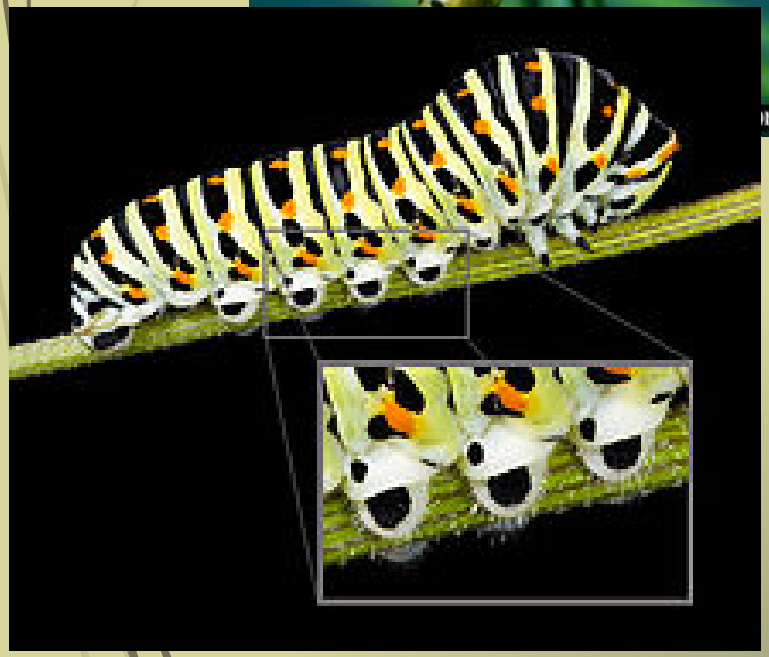
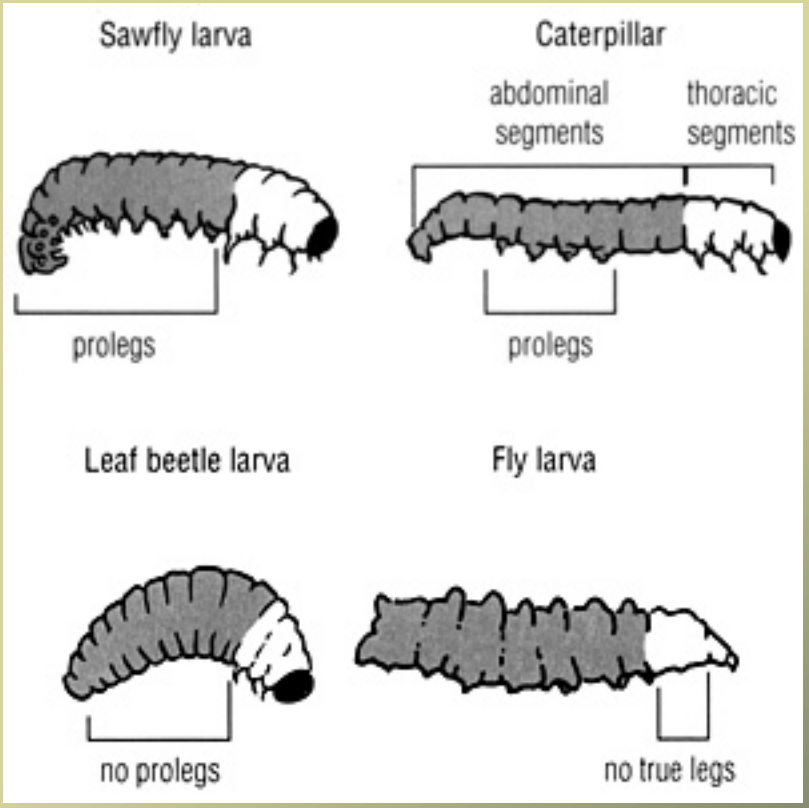
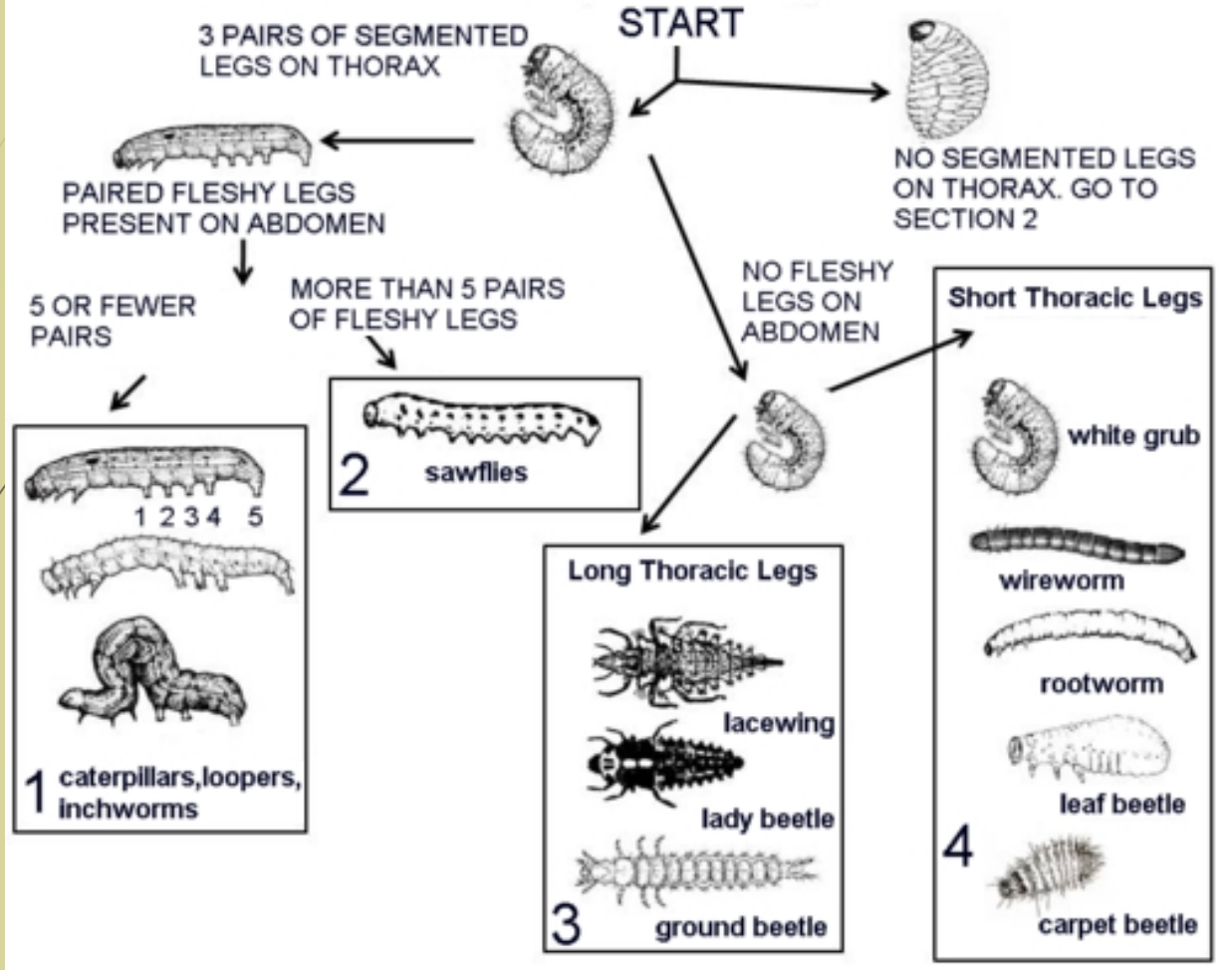



Sawfly larva
Caterpillar
abdominal segments
thoracic segments
prolegs
prolegs
Leaf beetle larva
Fly larva
no prolegs
no true legs

PICTURE KEY TO INSECT LARVAL TYPES: SECTION 1



PICTURE KEY TO LARVAL INSECT TYPES: SECTION 2

START

DISTINCT HEAD

5  weevil grub

6  midge

7 mosquito 

8 drain fly 

9 fungus gnat 

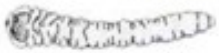
10  soldier fly

HEAD MOSTLY HIDDEN OR NO DISTINCT HEAD

11  crane fly

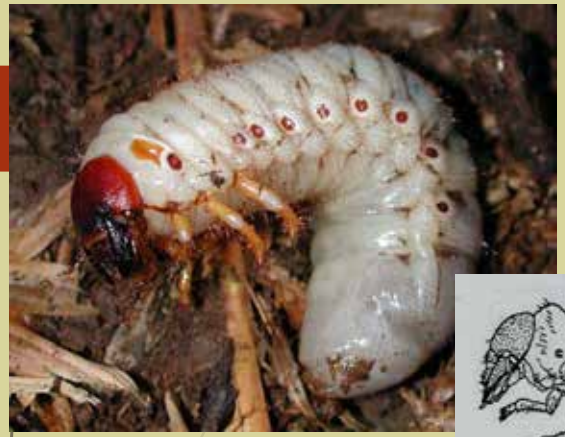
12  rat-tailed maggot

13 flatheaded borer 

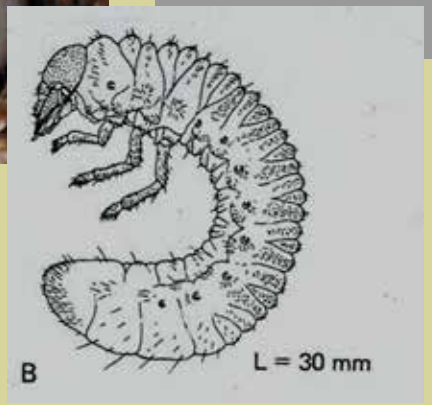
14 roundheaded boroer 

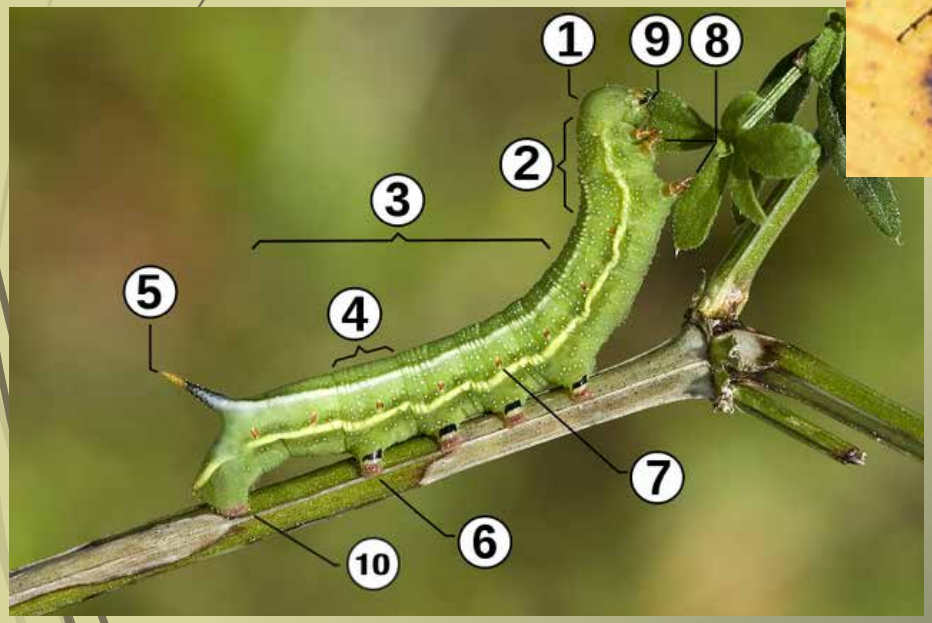
15  maggot

16  aphid predator

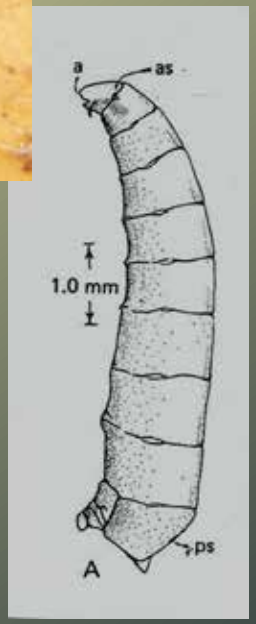


Rhinoceros palm beetle





Red palm weevil

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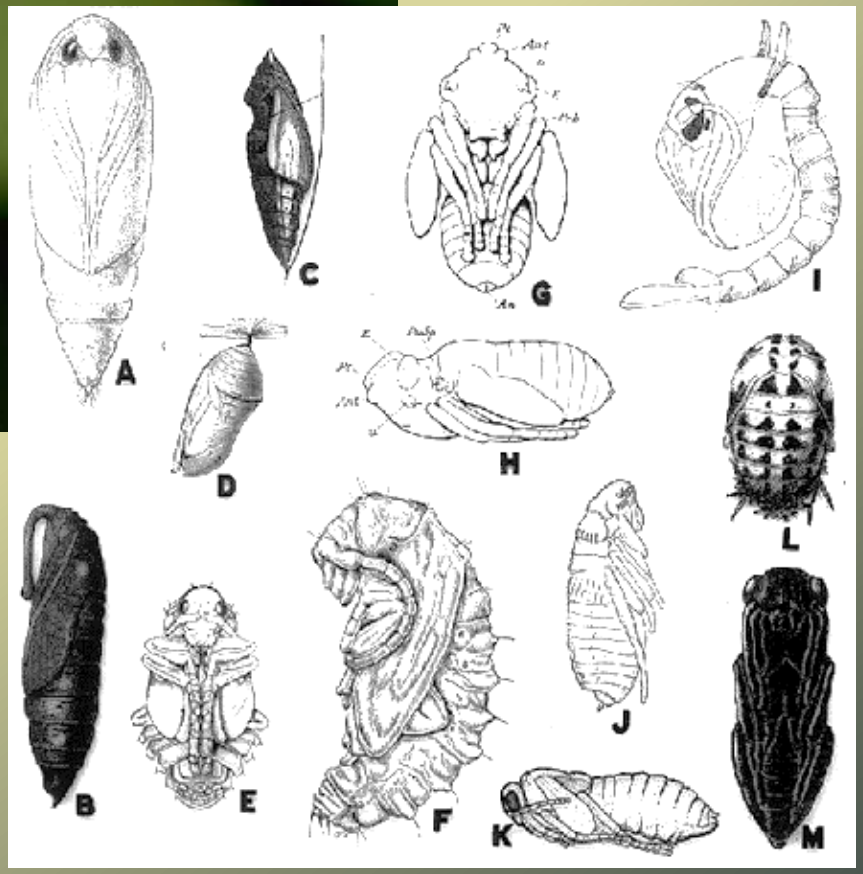
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Monarch butterfly: pupation and emergence (eclosion)

Growth

- Growth is accomplished by molting.
- Immature Insects have several to many molts, adults don't increase in size.
- ecdysis

Important orders:

Orthoptera – grasshoppers, crickets, katydids

Diptera – flies, mosquitos

Coleoptera – beetles, weevils

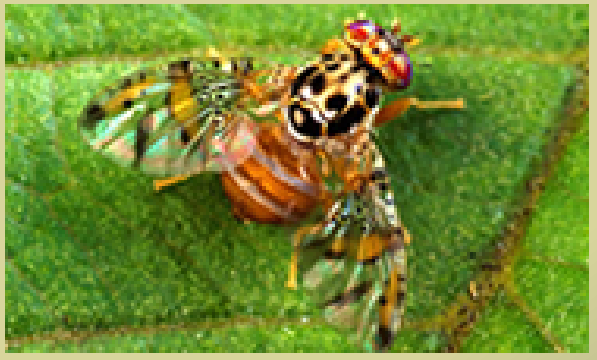
Lepidoptera – moths and butterflies

Hemiptera – cicadas, treehoppers, leafhoppers, spittle bugs,, aphids, psyllids, whiteflies, scales, mealybugs, true bugs: squash bugs, stink bugs,

Blatodea – cockroaches, termites

"Mantis-greece-alonisos-0a" by Adamantios - Wikimedia Commons -

Diptera

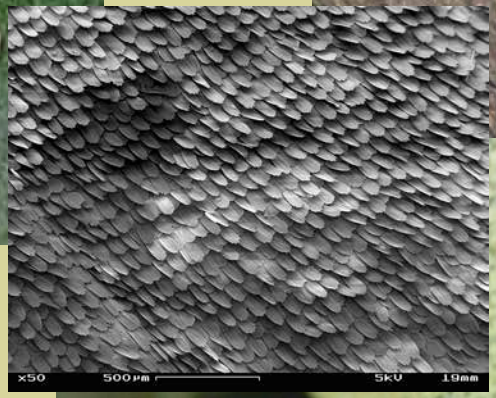


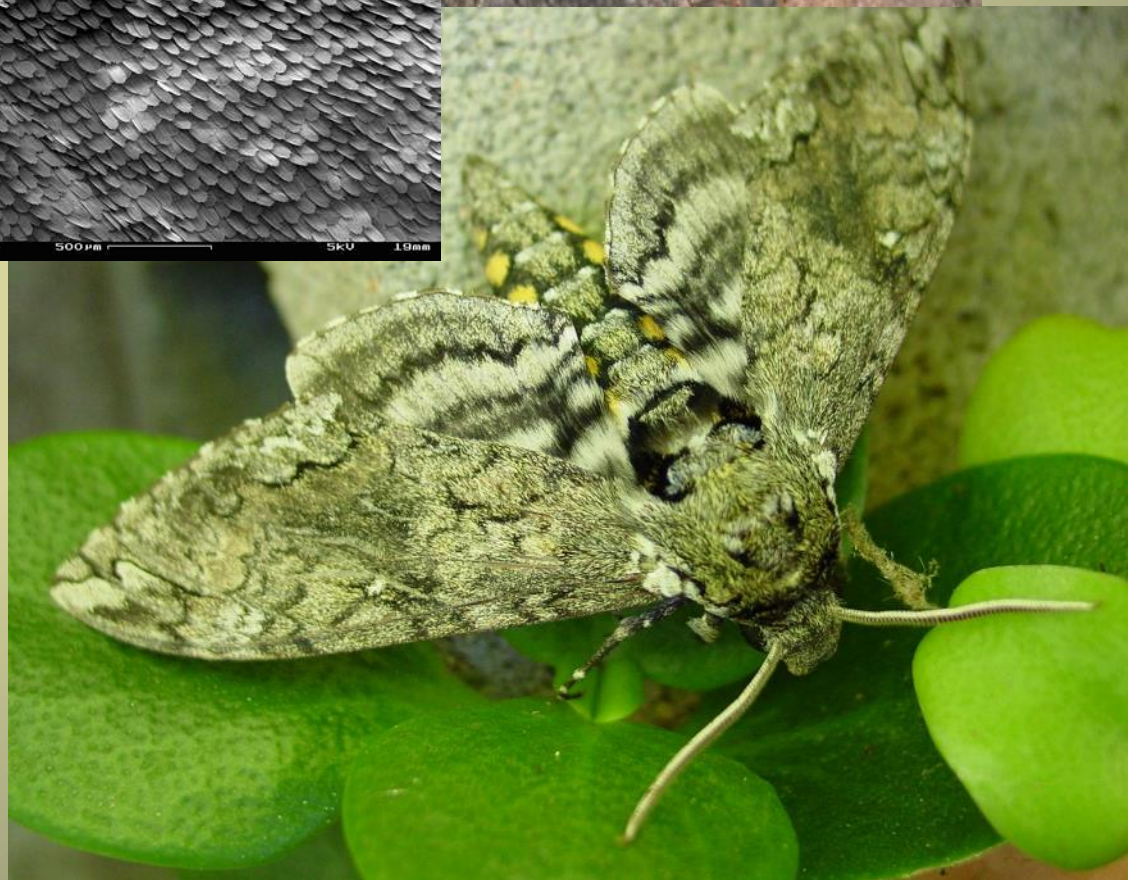
Coleoptera

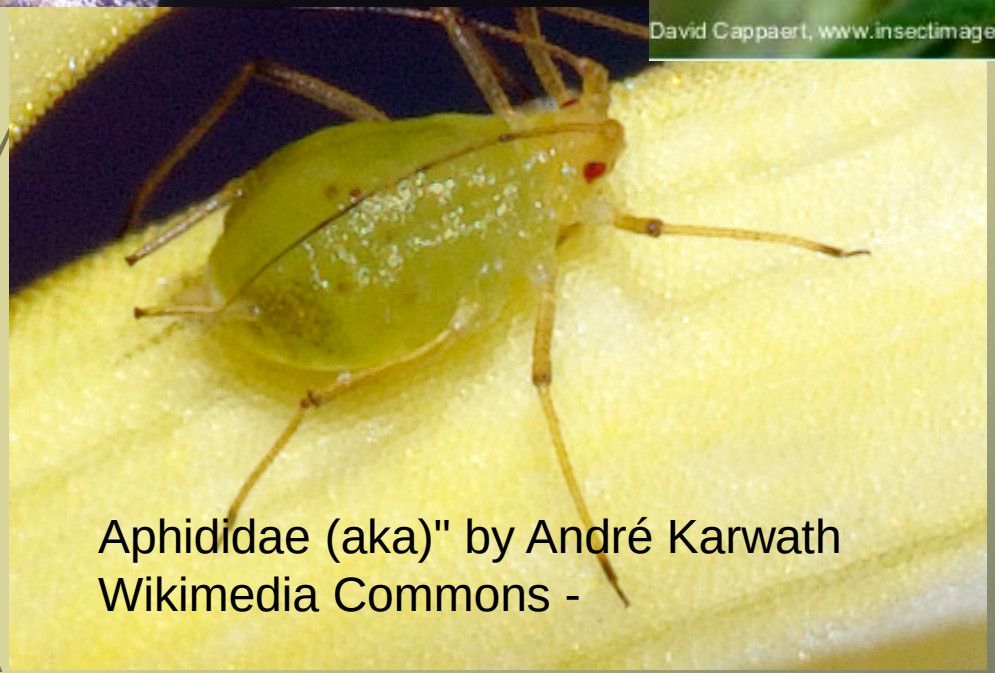
Monkeypod Round-Headed Longhorn Beetle – *Xystrocera globosa*

Hymenoptera

Lepidoptera







Aphididae (aka)" by André Karwath
Wikimedia Commons -

Hemiptera

Insects categorized by damage

Leaf feeders:

Symptoms: leaves partially or totally consumed, skeletonized, mined, scalloped or riddles with holes.

Signs: fecal pellets, webbing,

Examples: moth, butterfly and sawfly larvae, leaf beetles, grasshoppers, etc.

Impact: defoliation, reduced growth and impaired health,

Chinese rose beetle

Fuller rose weevil

Koa moth

Omnivorous looper

Fruittree leafroller

Light brown apple moth

Coconut leaf roller, Scot Nelson

Phloem feeders:

- **Symptoms:** wilt, dieback of leaves, shoots, branches, and entire trees. Look for frass, bleeding,
- **Signs:** pitch tubes, sap flow, and exit holes
- **Examples:** bark beetles, borers, pitch moths, clear winged borers, etc.
- **Impact:** tree mortality, branch, tip or shoot dieback, tree stress, introduction of decay causing fungi. Death, wounding or dieback is caused by cambial destruction.

Wood borers:

- **Symptoms:** branch dieback, areas of bark,cracked or sunken bark, bleeding
- **Signs:** exit holes, boring dust.
- **Examples:** flatheaded, roundheaded borers, ambrosia beetles.
- **Impact:** tree mortality, stress, internal decay, hazard-potential.

Asian ambrosia beetle, *Xylosandrus crassiusculus*
Polyphagous shot hole borer, *Euwallacea* **sp. Fusarium dieback**

Asian long horned borer

Coconut rhinoceros beetle

Red palm weevil

Sap-feeders:

Symptoms: yellowing, yellow spotting, bleaching, silvering, bronzing, dieback

Signs: honeydew, sooty mold, cast skins, white cottony/waxy material

Examples: aphids, scale, adelgids, psyllids, leafhoppers, plant bugs, mealybugs, lacebugs, thrips, etc.

Impacts: weakens, stunts, deforms or kills

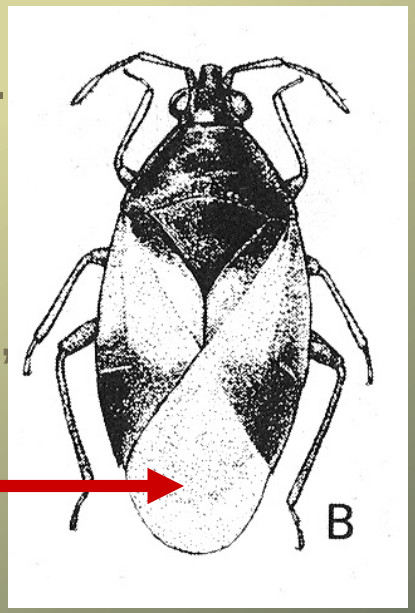
Hemiptera:

Suborders:

Auchenorrhyncha: cicadas, leafhoppers, treehoppers, planthoppers, and spittlebugs.

Sternorrhyncha: aphids, hard scales, soft scales, wax scales, mealybugs, whiteflies, spittlebugs, psyllids, plantbugs, leaf hoppers,

Heteroptera 'true bugs': assassin bugs, bedbugs, plant bugs, leaf-footed bugs, squash bugs and sweet potato bugs, seed bugs(Lygaeidae), stink bugs or shield bugs, water bugs,

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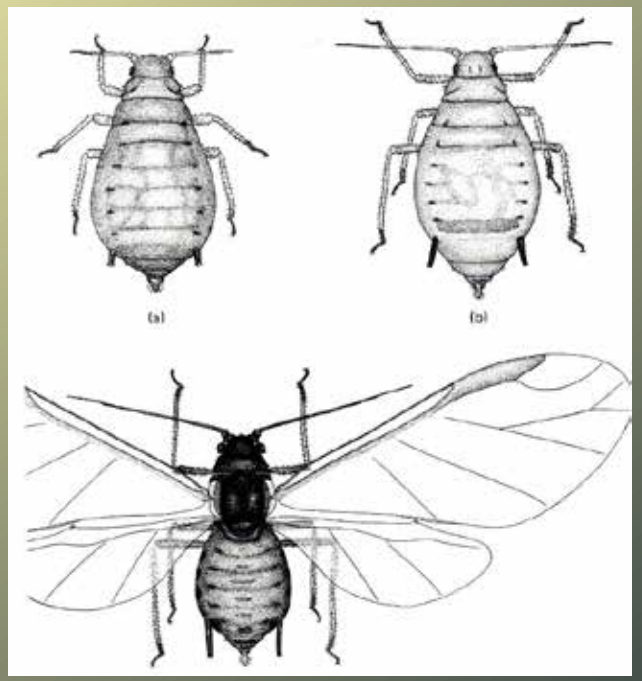
(a)
(b)


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Soft scale


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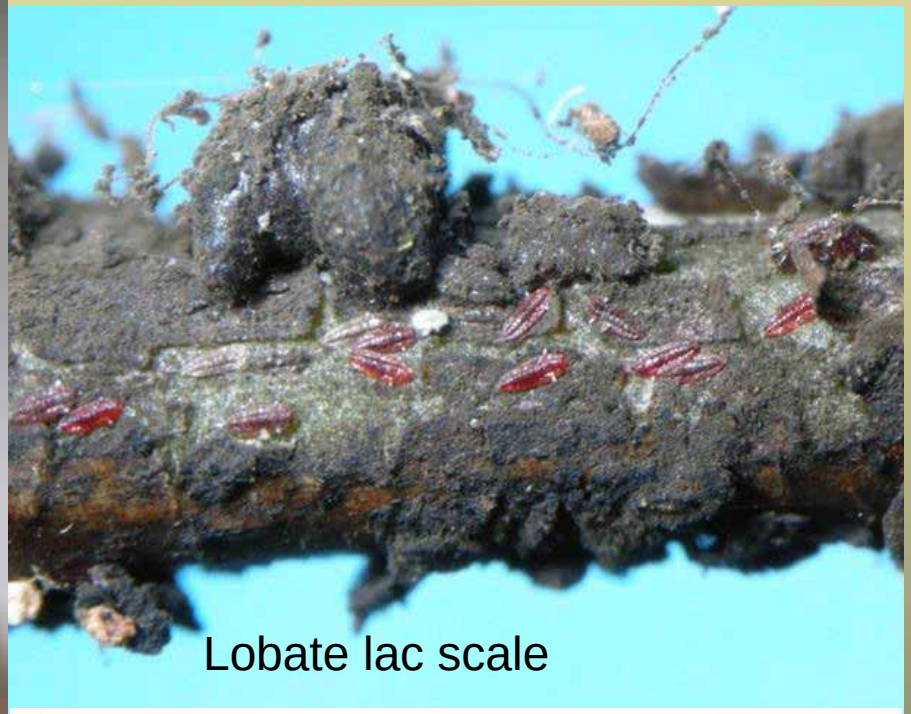

Lobate lac scale

Ficus benjamina

Green shield scale

Cottony cushion scale


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Cycad scale


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spiraling whiteflies (*Aleurodicus dispersus*),

Crown whitefly

Long tailed

Citrus mealybug

Coconut mealybug

Obscure mealybug

Golden mealybug

Pink hibiscus mealybug

Coconut mealy bug, Scot Nelson

Citrus psyllid


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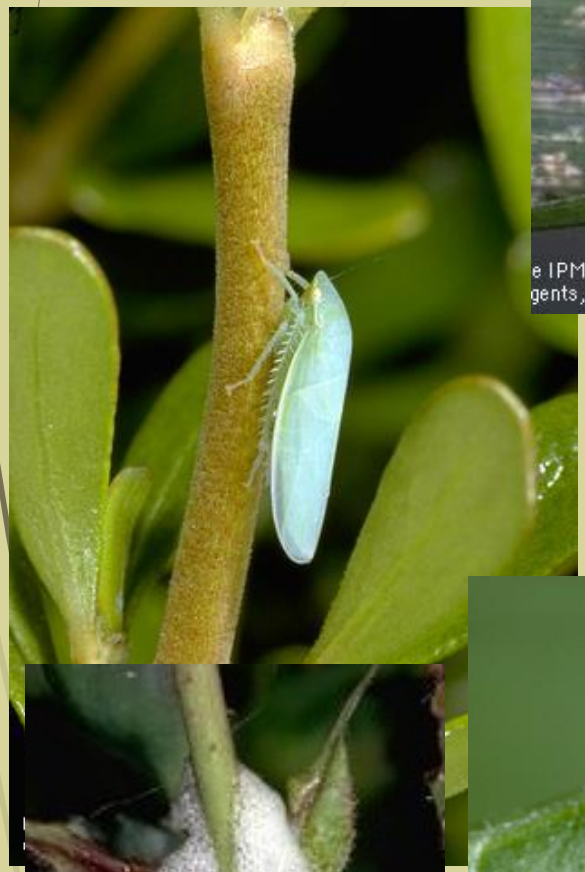


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True bugs- Heteroptera

Bagrada bug


Gevork Arakelian, Los Angeles Co. Dept. ACWM
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lacebugs


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Photo by Gilbert Arakelian


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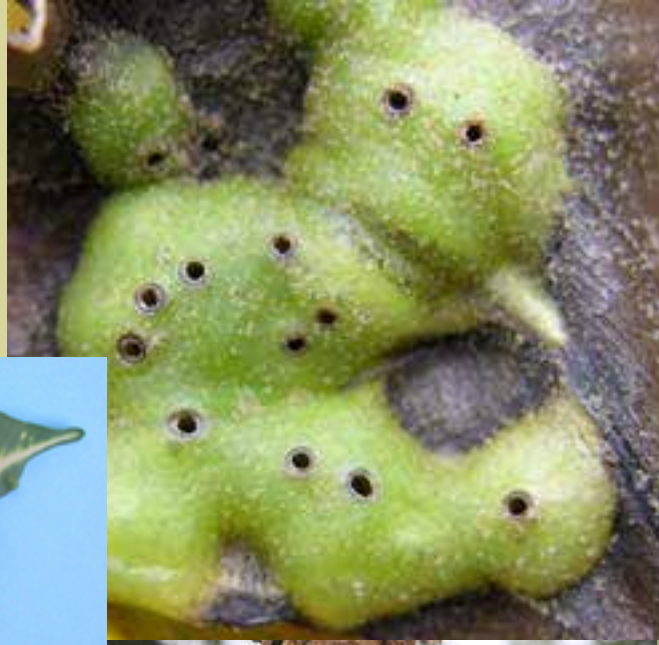
All stages of the myoporum thrips, *Klambothrips myopori.* From left to right, eggs on leaf tissue, first instar larva, second instar larva, prepupa, pupa, female adult, male adult. All stages can be found in twisted leaf tissue including the pupal stages.

Spider mites

Gall formers: abnormal swellings or growths - brightly colored or oddly shaped.

- **Symptoms:** deformities
- **Impact:** distorts parts, weakens, unsightly

Erythrina gall wasp



- Most insects are host-specific
- Indigenous insects less serious
- Introduced pest often serious
- Most serious insect pests are stress-related

Insect abundance:

- developmental stage or condition of host
- host suitability nutrient and moisture content
- environmental conditions
- natural enemies scarce
- pest is new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Native pests:

- coevolved with native plants
- most - host specific
- native plants resistant to most pests
- a few have developed tolerance and strategies
- seldom cause serious damage
- secondary pests an exception

Introduced pests:

- potentially destructive - new hosts typically lack resistance
- typically arrive without their natural enemies.
- ex: Koa moth, *Erythrina* gall wasp

IPM:

- monitor
- act when damage will be unacceptable.
- use most effective, least toxic, least disruptive and long-term methods.
- multiple strategies
- use lowest recommended rate.
- time application to coincide with peak activity of the most susceptible life-stage.
- treat only affected plants

PHC:

- Provide age- and species-appropriate care: soil moisture, nutrition, sunlight and soil aeration
- Manage for longevity: stable structure, avoid site disturbance, maintain environmental stability, mitigating stress, reduce competition
- Treat cause not symptoms
- Ecosystem approach (all of the plants in the context of the environmental conditions