WASHINGTON STATE UNIVERSITY EXTENSION

Entomology

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Topics covered:

Introduction

Biology

- Anatomy
- Growth and Development

Insect Identification

- Identifying Insect Damage
- Identifying Insects
- Major Insect Orders

Insect Diversity and Natural History

- Host Relation ships
- Life Cycles
- The Insect Success Story
- Social
- Organization/Communication
- Mimicry

Learning Objectives

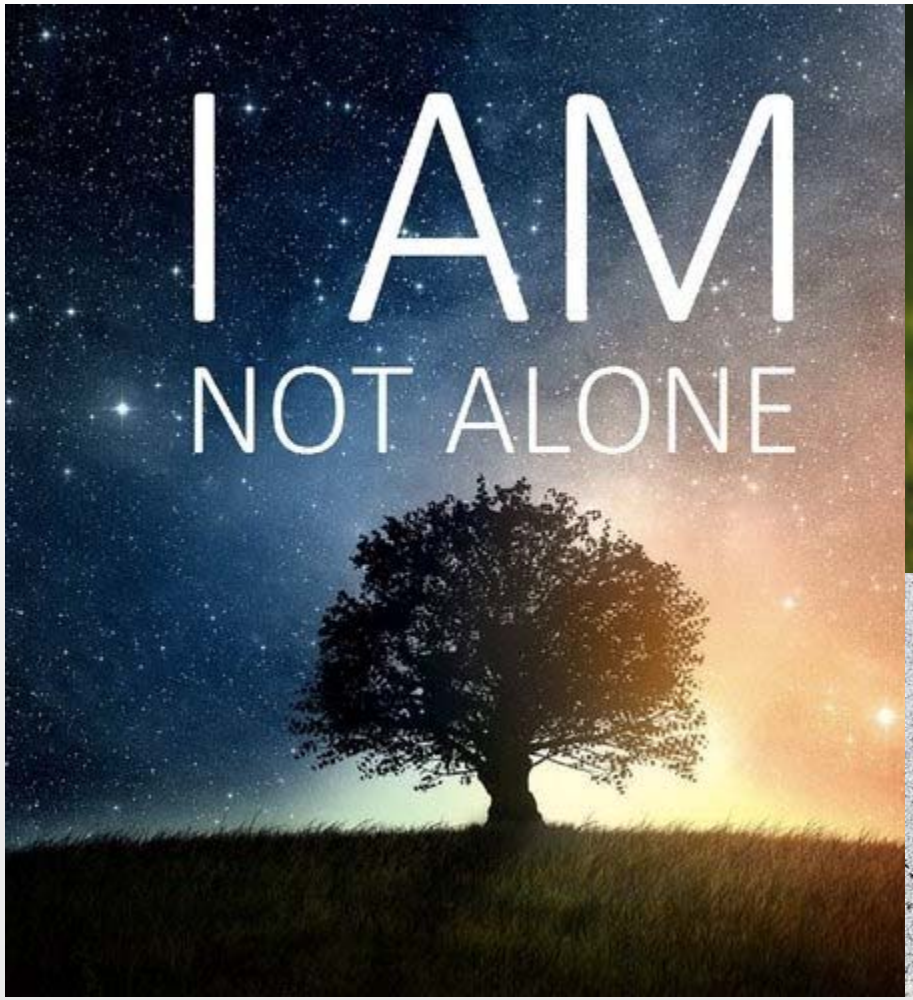
- Terms related to insect classification, identification, and life cycles
- Appreciation of insects' roles in plant pollination, predation of other organisms, recycling of plant nutrients, and how we and other species benefit from insects
- Understand insects' potential as crop, animal, and structural pests

Classroom Rules

- Feel free to ask Questions at any time
- Don't let talking about Insects "Bug" You!

Pay Attention

Not Just Me…



World Full of Insect Arthropods

10,000,000,000,000,000,000

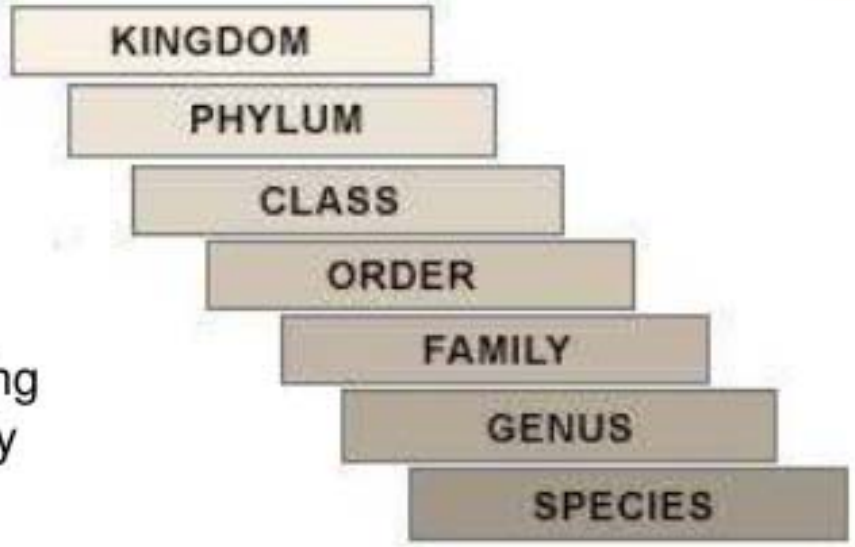
History of taxonomy

*A Swedish naturalist named **Carolus Linnaeus** is considered the **'Father of Taxonomy'** since 1700s

*His two most important contributions to taxonomy were:
- A hierarchical classification system
- The system of **binomial nomenclature**

*He proposed that there were three broad groups, called **kingdoms**, into which the whole of nature could fit. These kingdoms were **animals, plants, and minerals.**

***Binomial nomenclature** meant naming species in 2 words : genus , followed by species.



www.tutorvista.com

Phylum arthropod

- **Class insecta (insects)**
- **Class crustacea (lobster, crabs, pill bugs)**
- **Class chilopoda (centipids)**
- **Class diplopoda (milipids)**
- **Class arachnida (spiders and mites)**



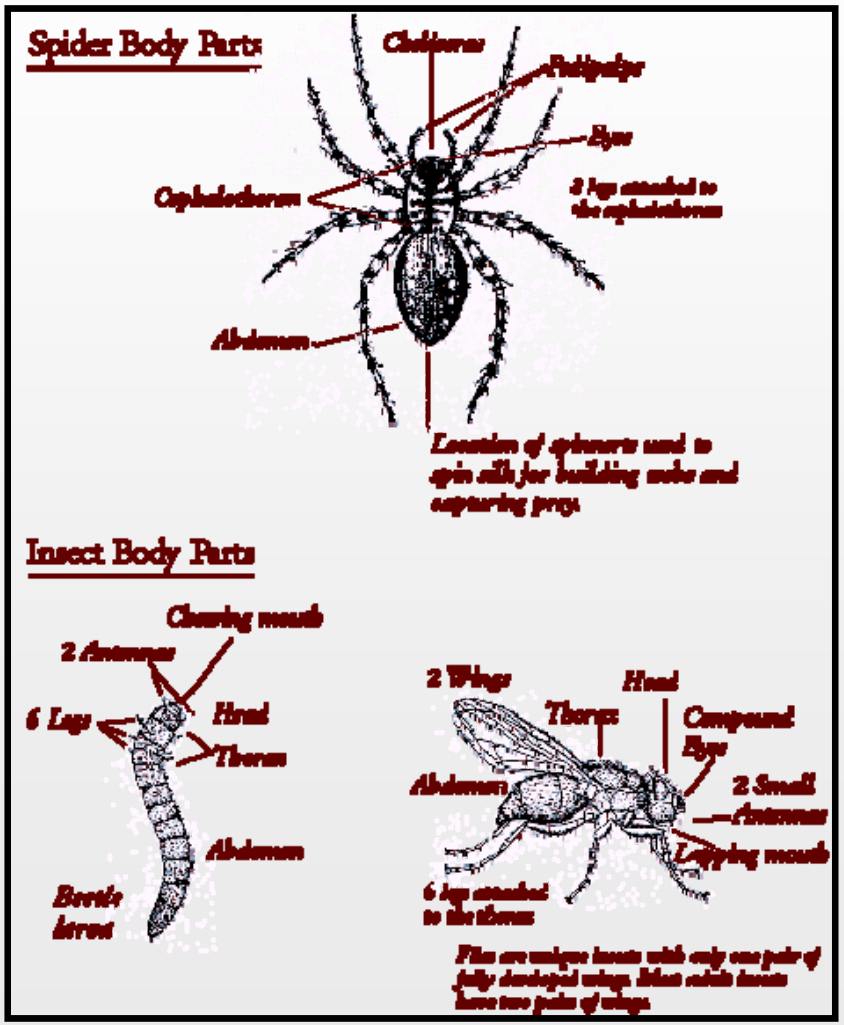





phylum (n.): division of the plant or animal kingdom

"Characteristics of Arthropods"

Arthropod means "joint-foot" in Latin.



http://insected.arl.arizona.edu/graphics/arthrobody.gif

1. Bilateral Symmetry
2. Segmented bodies and jointed appendages
3. An exoskeleton with chitin
4. Molt to grow in size

Class Arachnida

Characteristics:

- Two tagmata: head and thorax combined = cephalothorax and abdomen
- Adults with 4 pairs of walking legs
- No antennae
- Chelicerae near mouth for grasping
- Pedipalpi near mouth, may be similar to legs

Major Orders of Arachnida

Acari: Mites and Ticks

http://atschool.eduweb.co.uk/sirrobhitch.suffolk/key/images/invertebrates/mite.jpg

http://ceinfo.unh.edu/Agriculture/Graphics/mldogtic.JPG

Scorpiones: Scorpions

Opiliones: Harvestmen

http://zoologie.forst.tu-muenchen.de/HEITLAND/DETINVERT/SYSTEMATICS/ARACHNIDA/IMAGES/opiliones_01.jpg

Pseudoscorpiones: pseudoscorpions

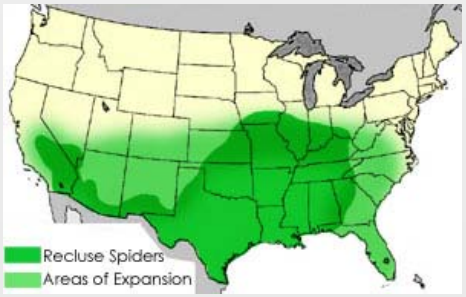
Order Araneae: Spiders

Golden Orb Weaver Spider

Poisonous Spiders of North America

(Arachnida Order Araneae)

Brown Recluse
(*Loxosceles reclusa)*



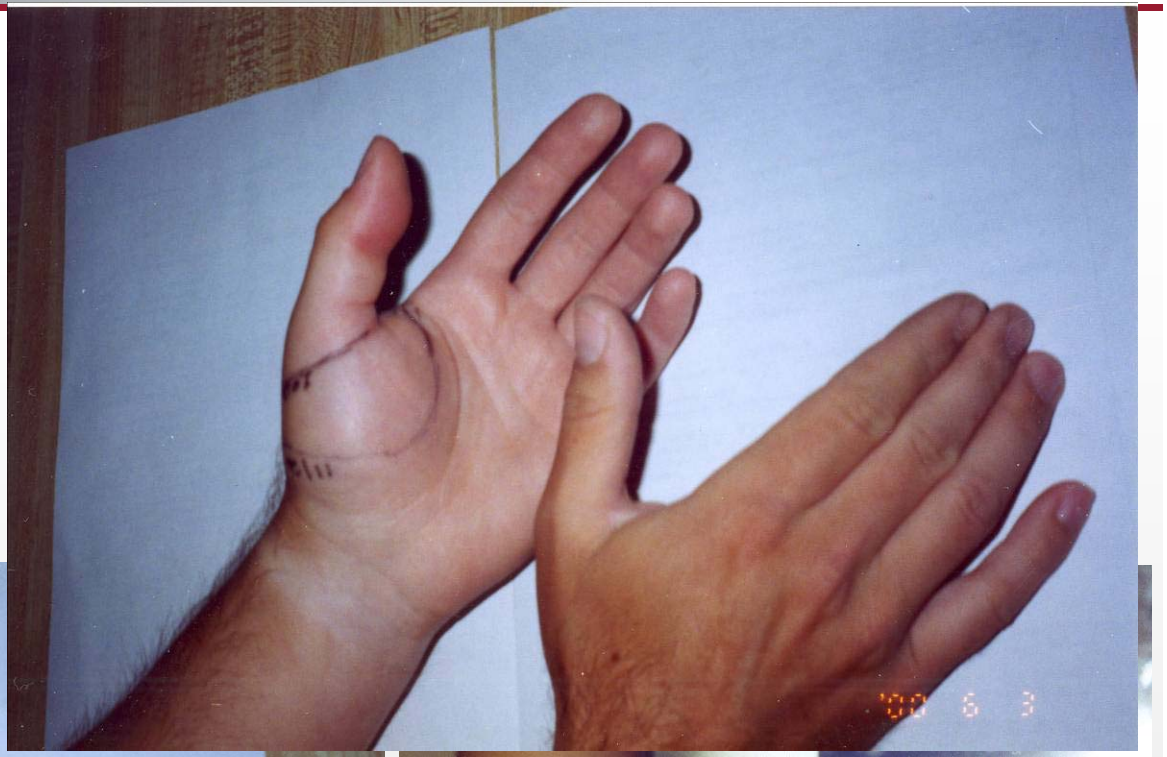
Hobo Spider
(*Tegenaria agrestis)*

Black Widow
(*Latrodectus* spp.)

Brown Recluse or Violin Spiders

- Southern States (not WA)
- Dark violin pattern on front portion of body
- 3 pairs of eyes (not 4)
- Hide during day in baseboard or ceiling cracks, behind or in furniture, and undisturbed piles of clothing
- Bite may go unnoticed
  - severe localized reaction (scabbing)
  - dead tissue
  - very slow healing
- Consult physician

Rattlesnake Bite



Hobo or Aggressive house spider
(Agelenidae)

- **Day 1**
  The Hobo Spider Bites. Reddening of skin followed by a blister forming at the bite site. Mild to intense pain and itching for 2 to 8 hours.

Hobo or Aggressive house spider
(Agelenidae)

- Day 5
  Intense swelling and continued discoloration of the skin.

Hobo or Aggressive house spider
(Agelenidae)

Day 6
The affected skin starts to die.


Day 9
HOUSTON We Have a Problem!!!

Order Solifugae: Windscorpions

Class Crustacea (Two Orders of)

Isopoda (Pill and Sow Bugs) and Decapoda (Crabs, Crayfish, Lobsters)

Isopoda

http://www.ces.ncsu.edu/depts/ent/notes/O&T/flowers/note11/pillbug1.jpg

Decapoda

http://geochange.er.usgs.gov/pub/info/facts/chesapeake/crabs.jpg

http://www.nbb.cornell.edu/neurobio/harris-warrick/lab/Lobster%202.jpg

http://www.rollanet.org/~streams/macroinv/crawdad.jpg

Difference between Pill and Sow Bugs…

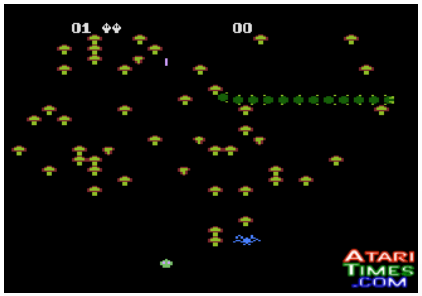
Class Diplopoda

(*Millipedes*)

Characteristics:

- Two tagmata: head and body
- Round or blocky" in cross-section
- Many legs, 2 pairs of legs per segment
- Feed on fungi and decaying plant matter

http://www.cals.ncsu.edu/course/ent525/soil/soilpix/images/miilipede_jpg.jpg

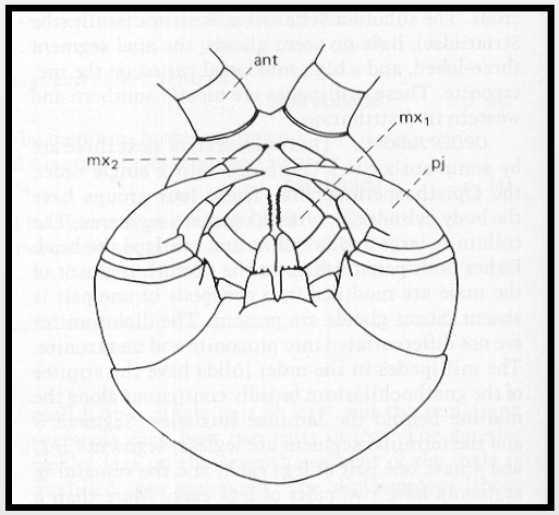


Class Chilopoda

(*Centipedes*)

Characteristics:

- Two tagmata: head and body
- Body segments flat in cross-section
- Many legs, 1 pair of legs per segment
- “Poison jaws" are modified legs



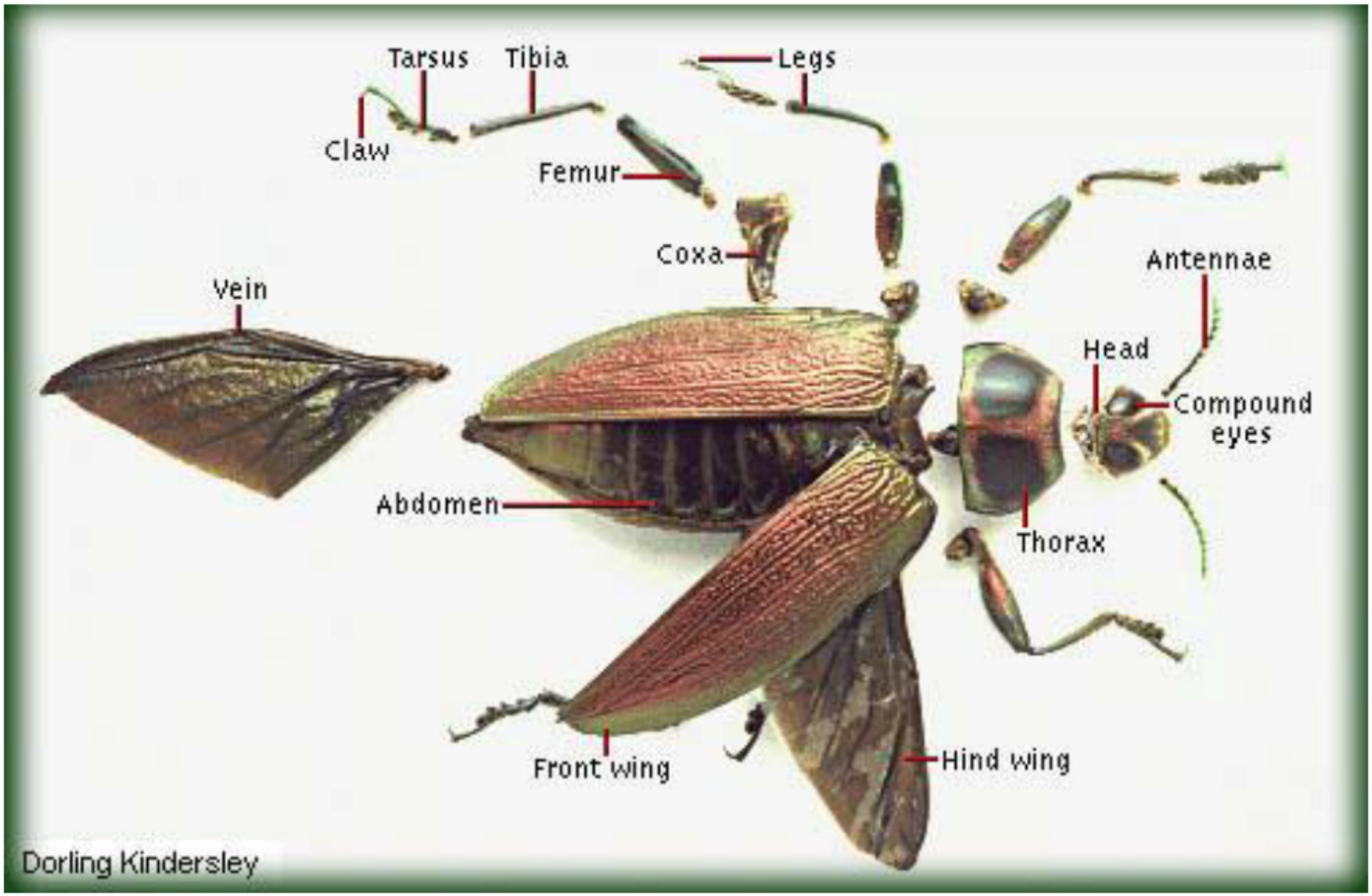
Giant Centipede on the Hunt for a Meal

Biology

- Anatomy
- Growth and Development

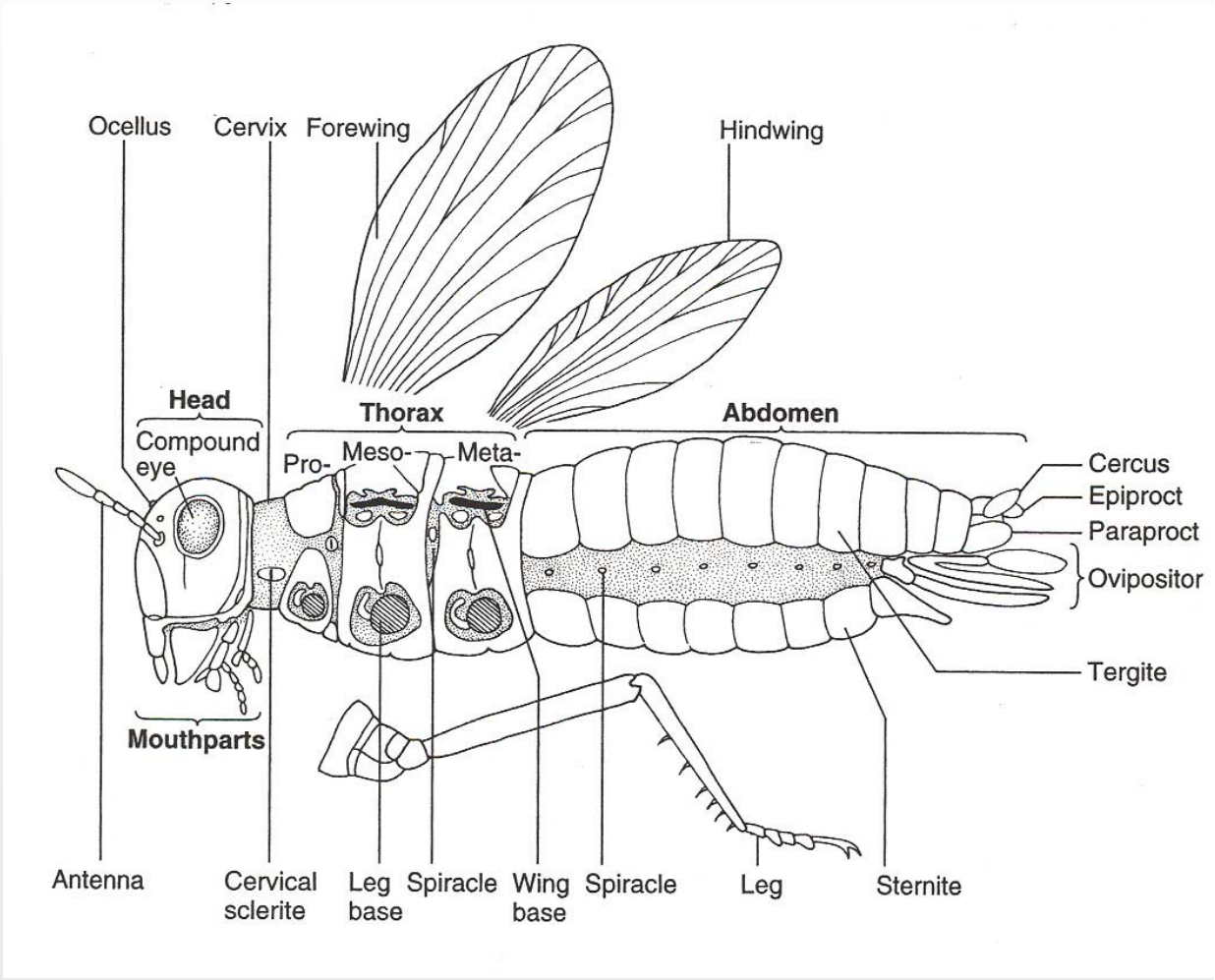
PHYLUM ARTHROPOD

Arthropod: “those with jointed feet”; arthro= “a joint”; pod= “feet”



The Grasshopper (Orthoptera; Acrididae): the Prototypical Insect

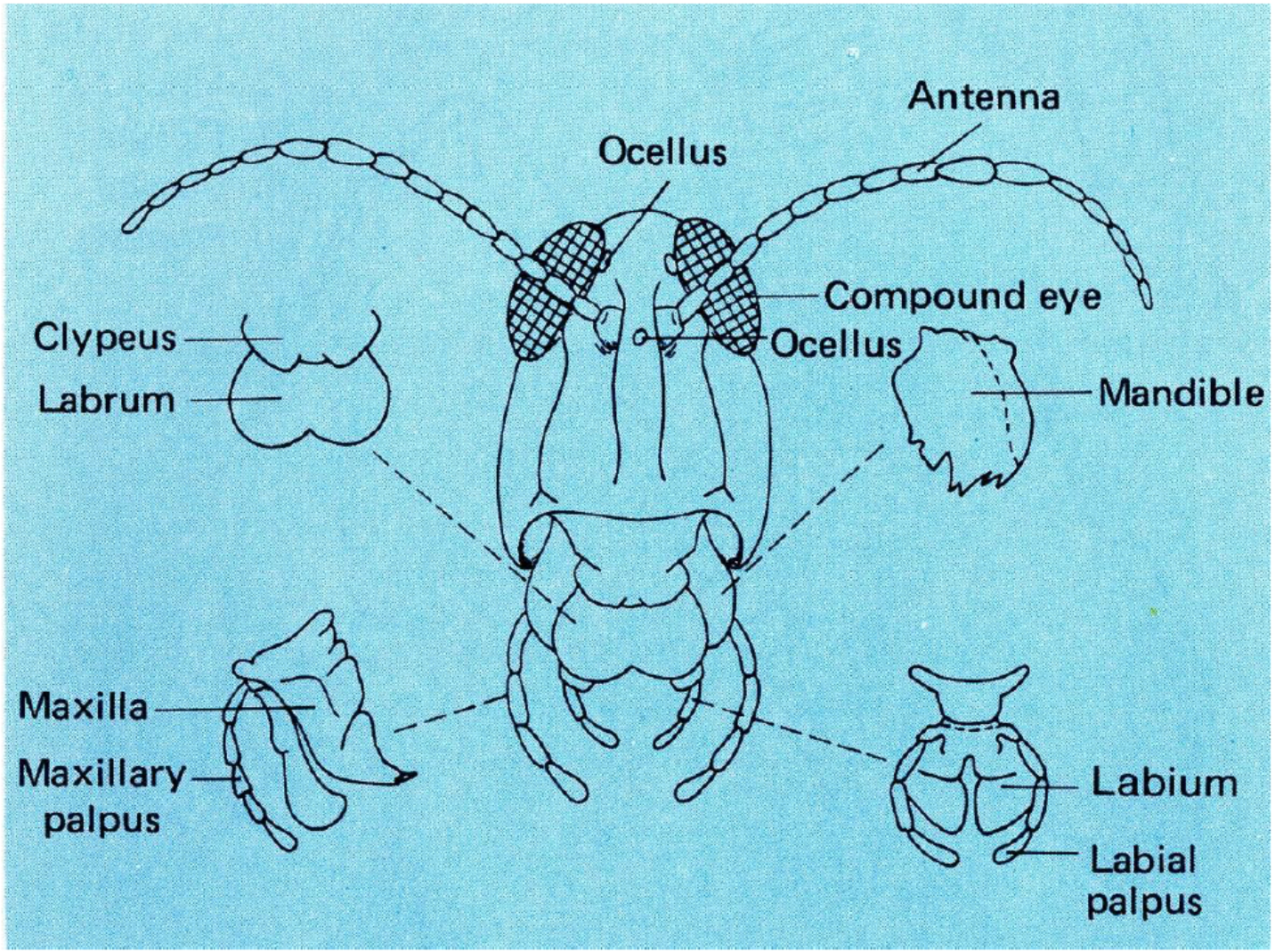
Insect are comprised of three major body divisions: the head, thorax, and abdomen. Each of these three sections are in turn comprised of individual segments.

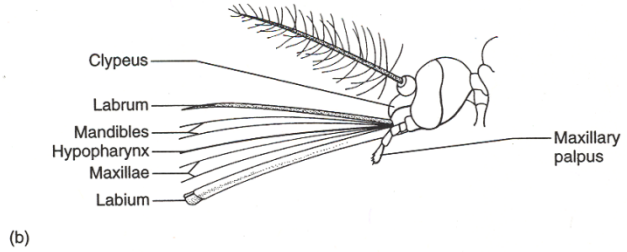


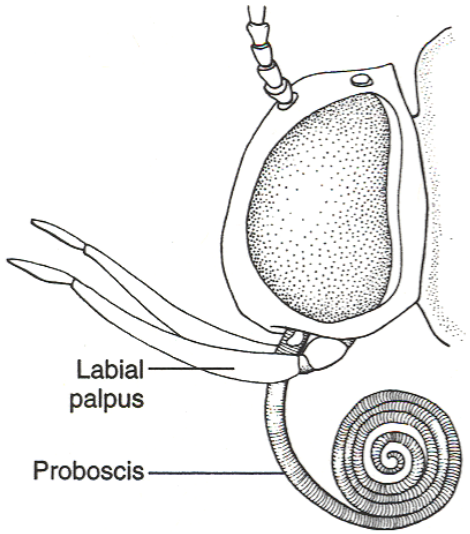
Function of the Three Tagmata of Class Insecta

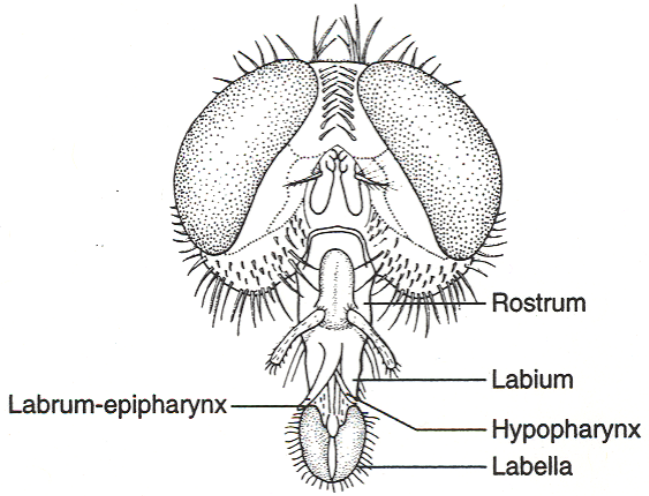
1. **The Head**: Specialized for Sensory input (vision, chemoreception, sometimes vibration) feeding and defense.
2. **The Thorax**: The "motor or powerhouse" housing the musculature and attachment points for the legs and wings.
3. **The Abdomen**: The "Breadbasket" housing the bulk of the digestive and reproductive structures. It may also house defensive structures in some insects (stingers etc).

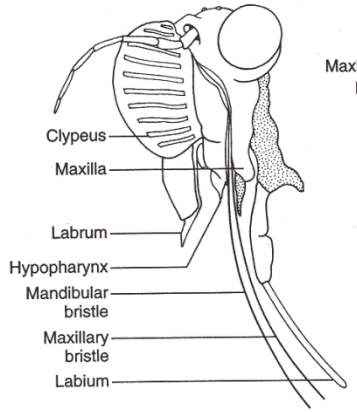
HEAD - MOUTHPARTS

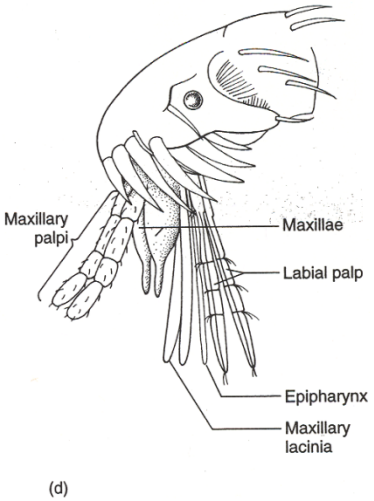




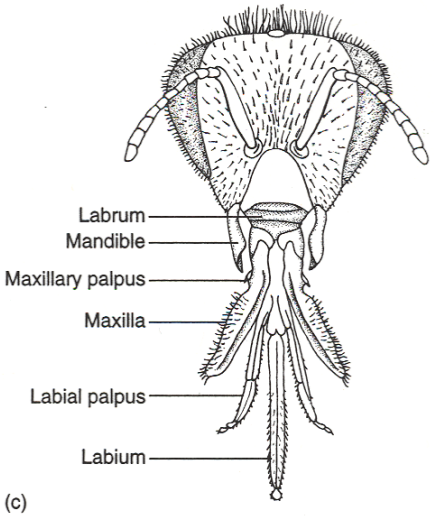




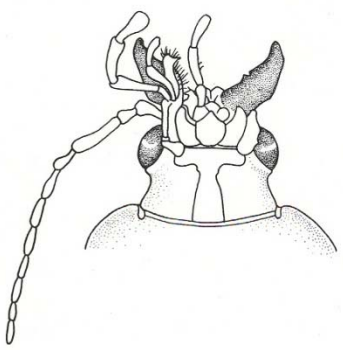


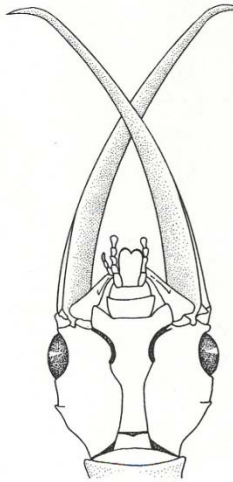


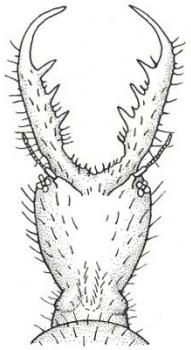
Piercing-sucking

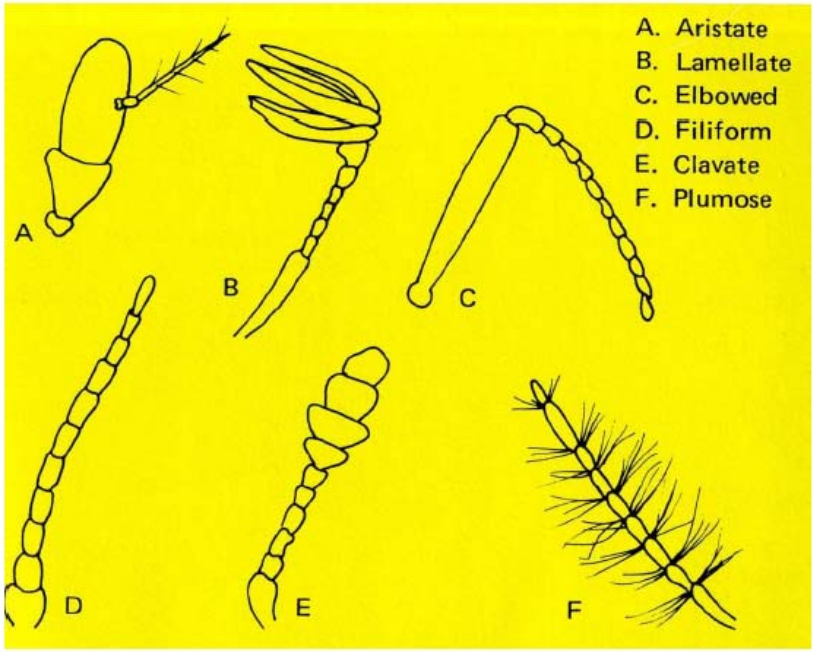


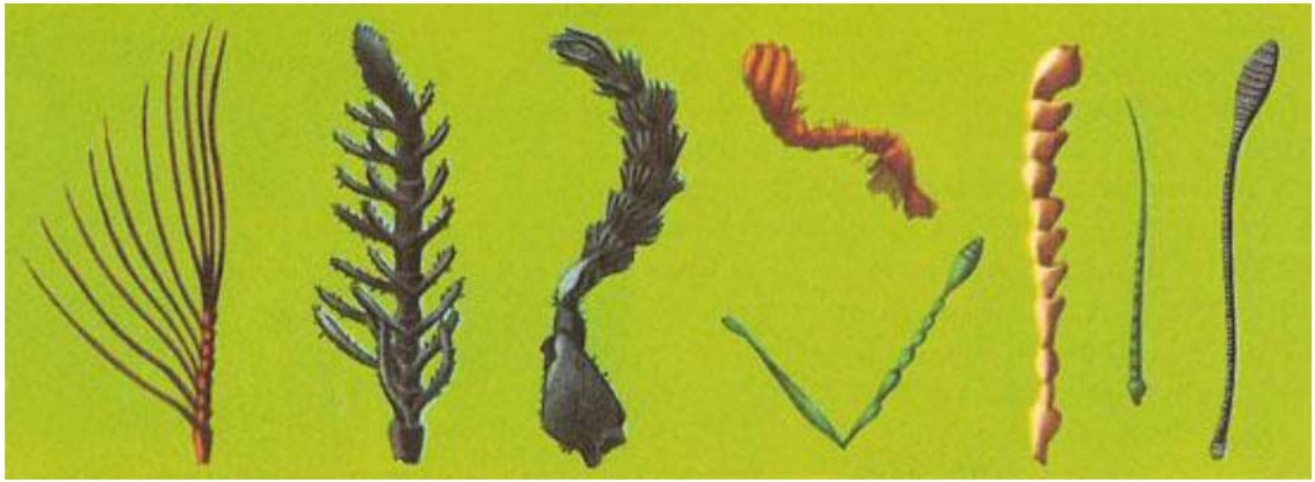
wing-ing



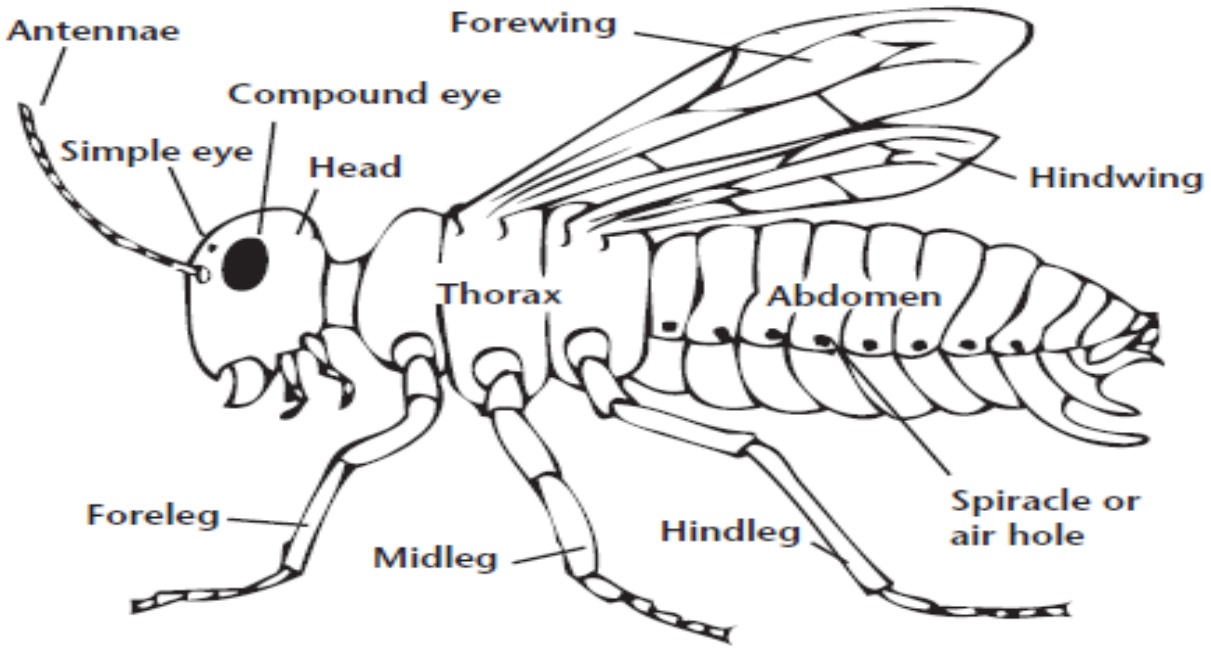




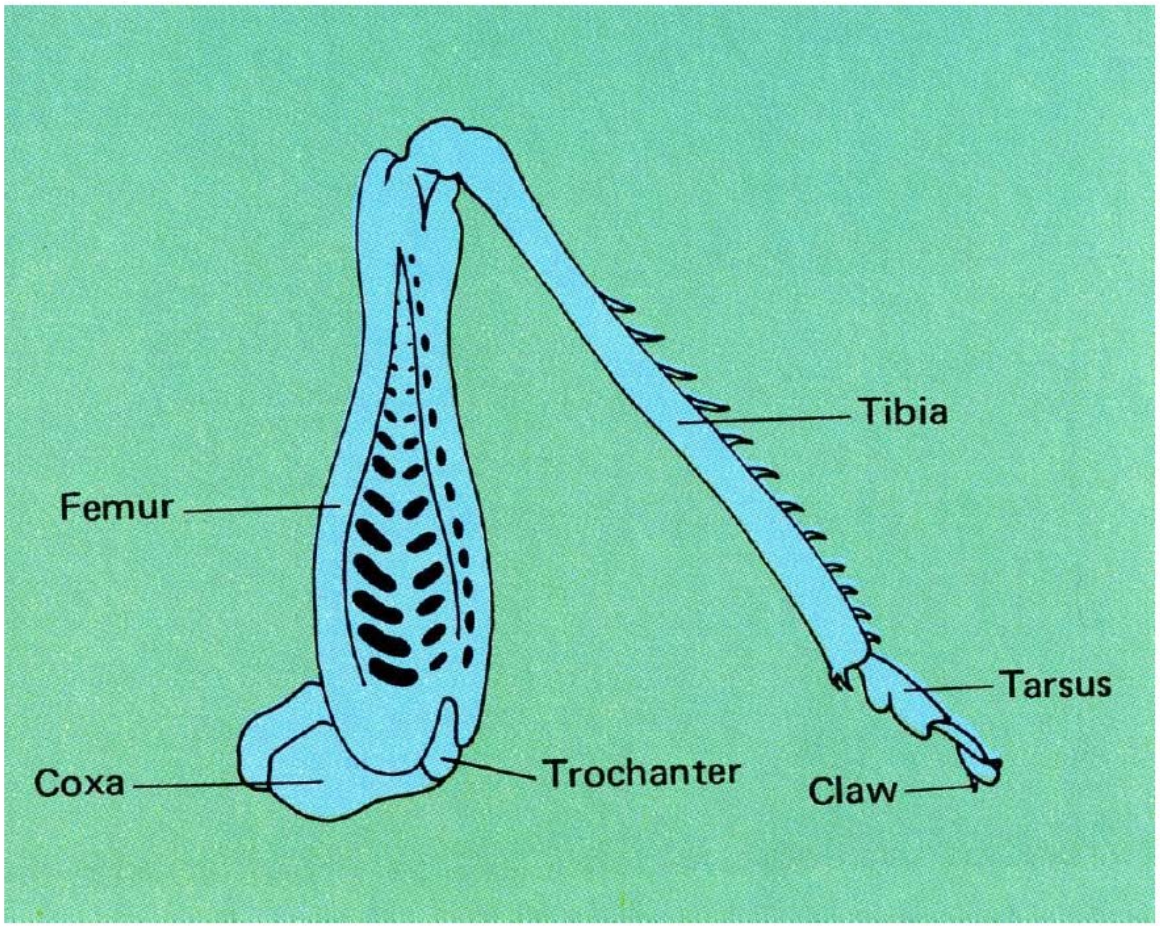

A. Aristate
B. Lamellate
C. Elbowed
D. Filiform
E. Clavate
F. Plumose
A
B
C
D
E
F

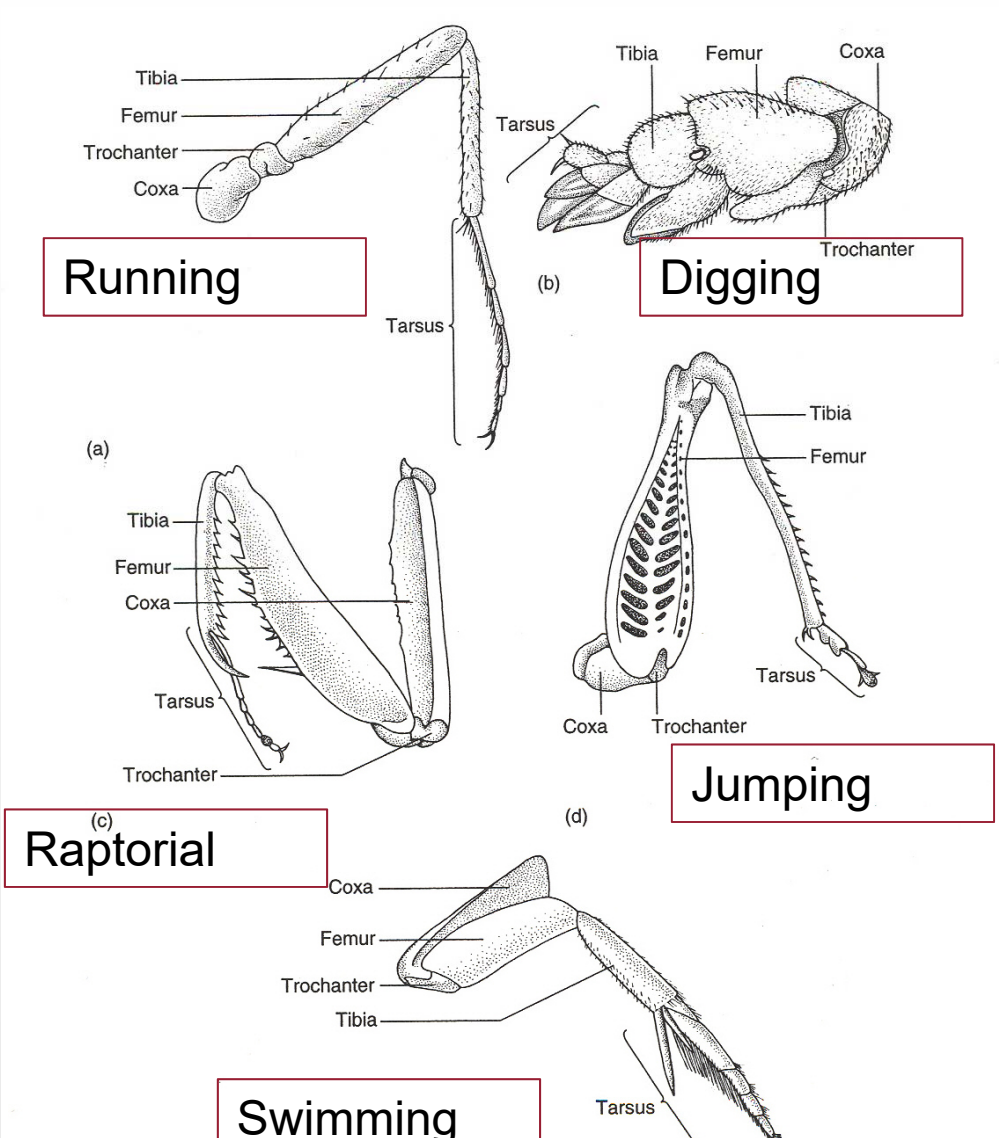


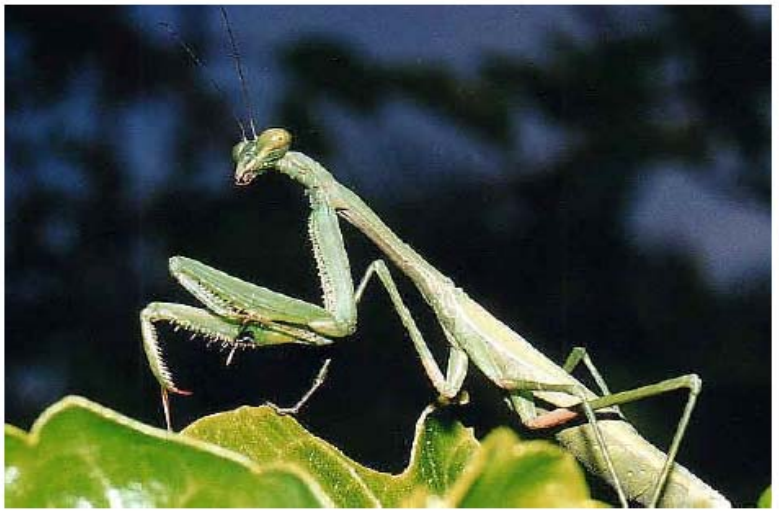
THORAX


Antennae
Forewing
Compound eye
Simple eye
Head
Hindwing
Thorax
Abdomen
Foreleg
Midleg
Hindleg
Spiracle or
air hole

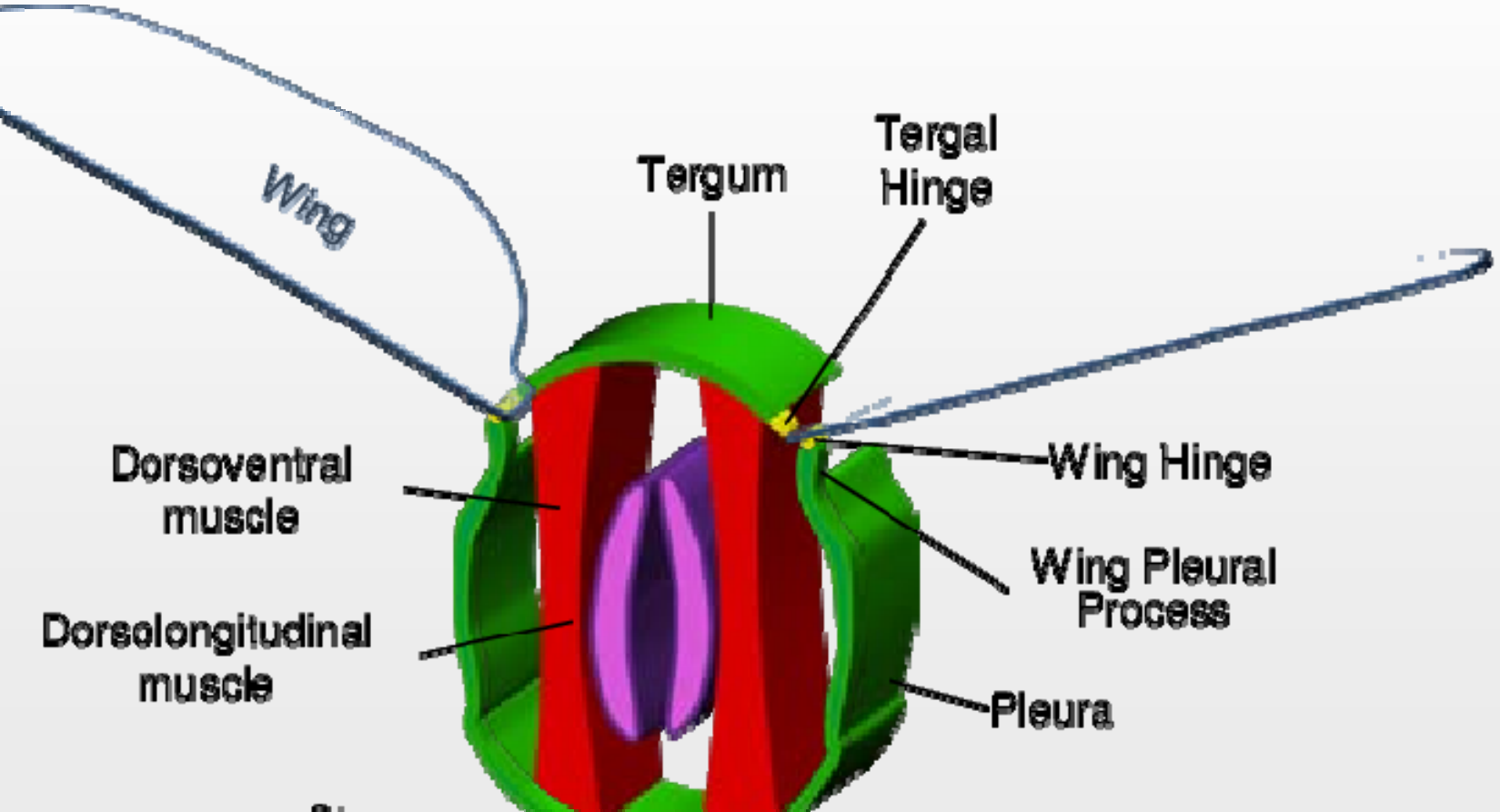
LEGS



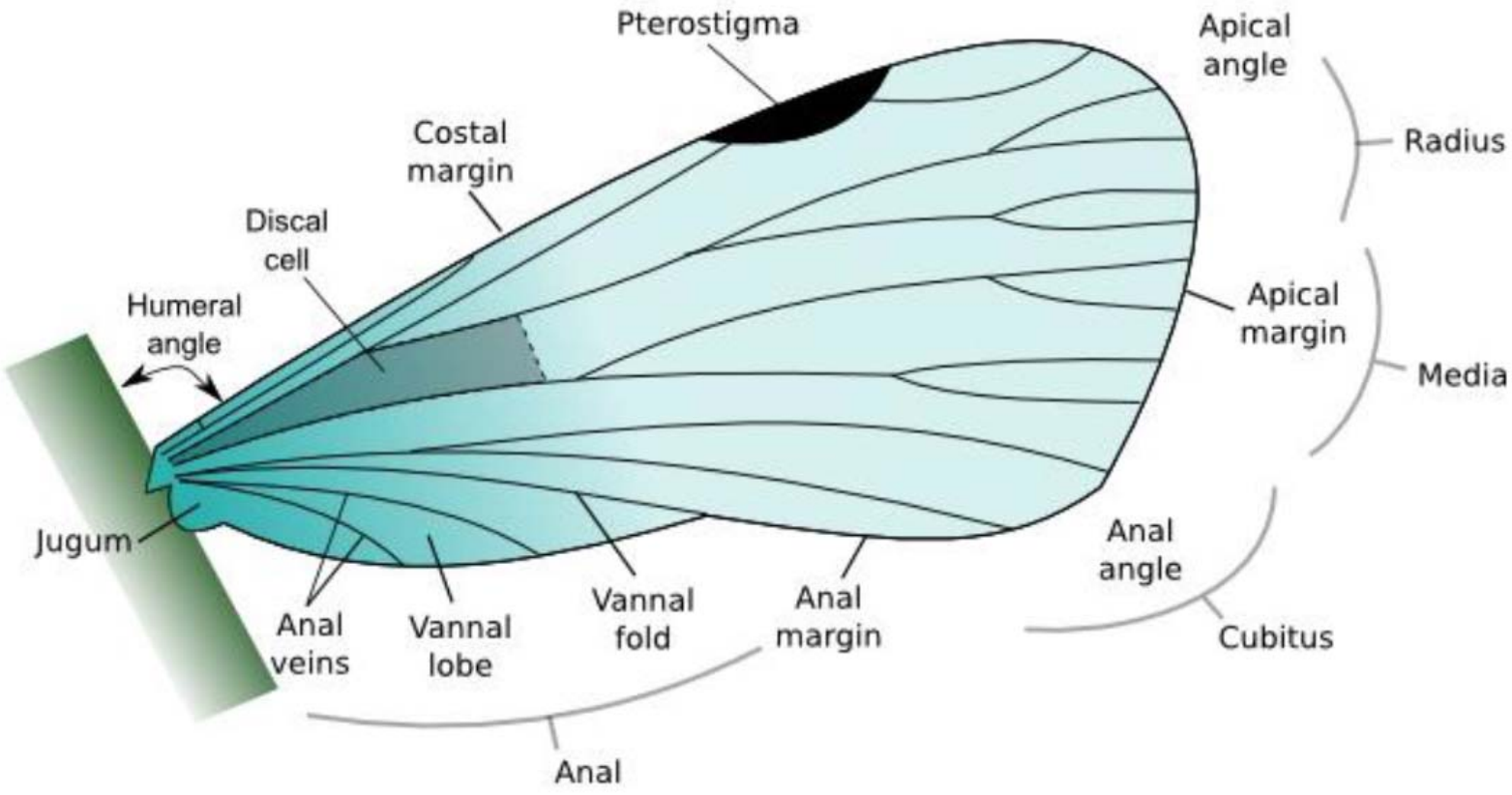

Tibia
Femur
Trochanter
Coxa
Tarsus
(a)
Running
Tibia
Femur
Coxa
Tarsus
Trochanter
(b)
Digging
Tibia
Femur
Coxa
Trochanter
(c)
Raptorial
Tibia
Femur
Tarsus
Coxa
Trochanter
(d)
Jumping
Coxa
Femur
Trochanter
Tibia
Tarsus
Swimming



Higher Insects Will Have 1 or 2 pairs of Wings



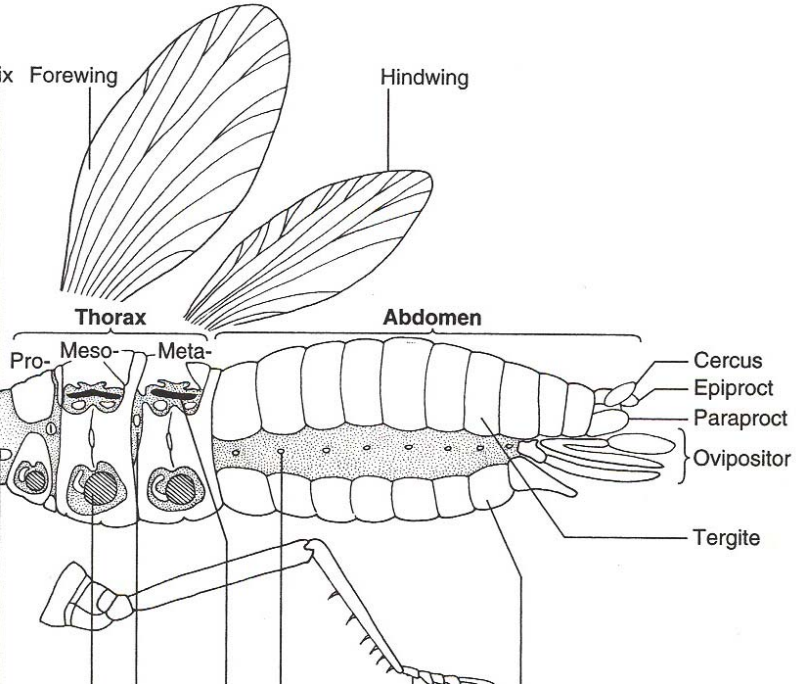
WINGS

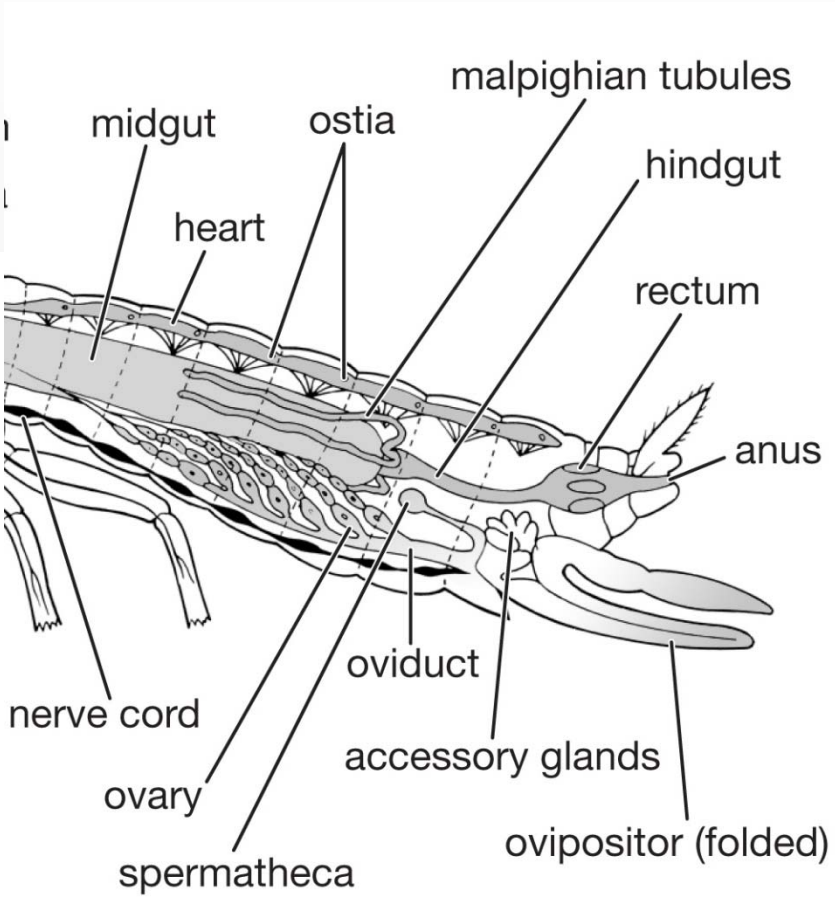


http://upload.wikimedia.org/wikipedia/commons/a/a9/Indirect_flight_in_insects.gif

Abdomen

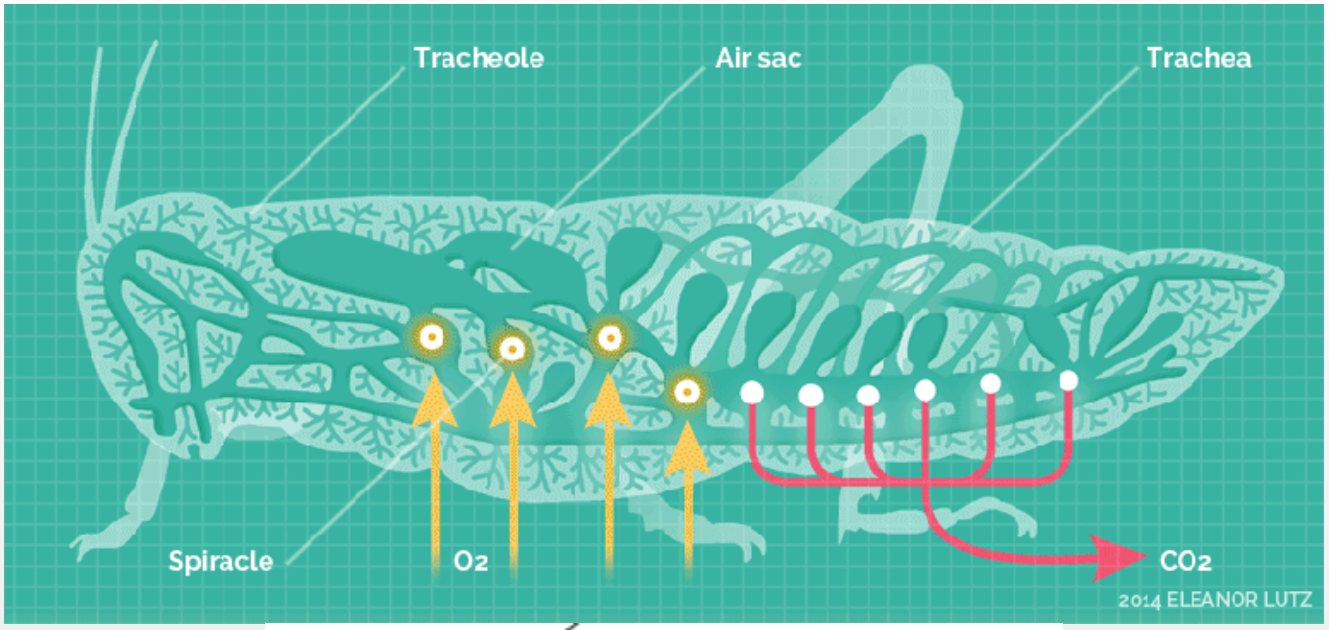
e **Abdomen** is composed of subsegments Notable parts lude: **Spiracles** (three noted), **Ovipositor** (female), **bgenital Plate** and **Claspers** ale) or **Cerci** and the **mpanum** (hearing organ).

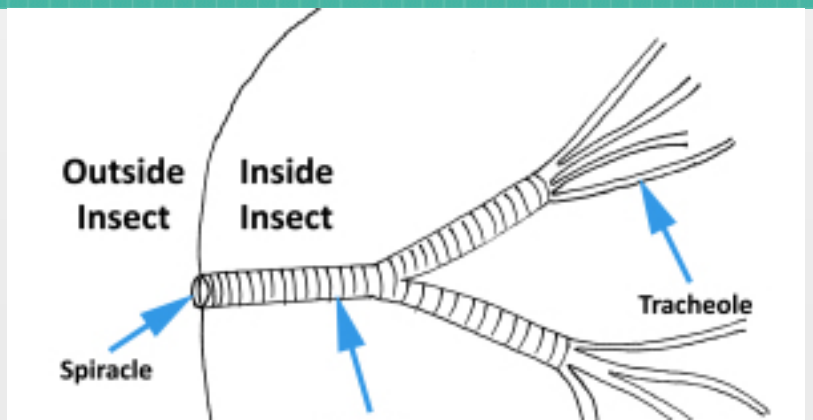




Haemolymph = insect blood

Insect Respiration





Insect Respiration

Cana lily skipper (a butterfly) larvae have an almost completely transparent exoskeleton, thereby allowing a good vie of the tracheal system.

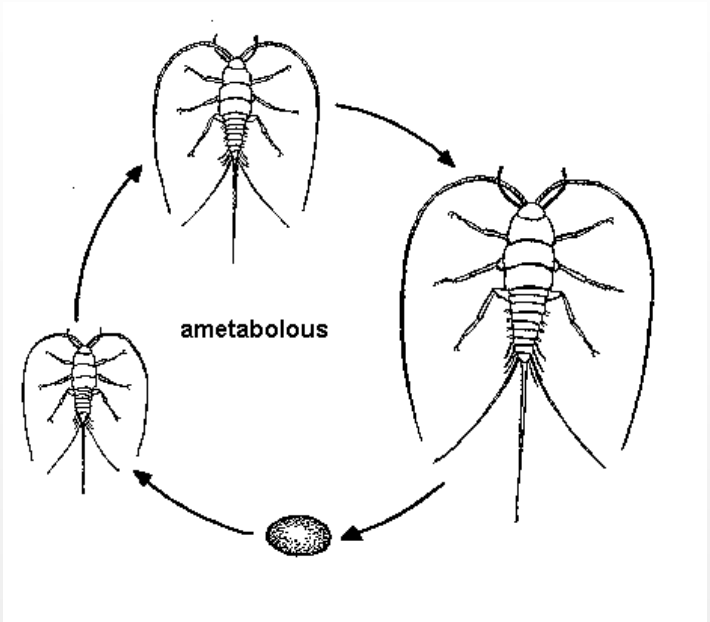
erci (singular Cercus) are paired
ppendages on the abdomen of many
pecies of insect. Cerci perform a
ensory function. The size of cerci
aries between species with some
aving barely discernible cerci while
thers, like earwigs, having stout and
pvious cerci (sometimes called
ncers).

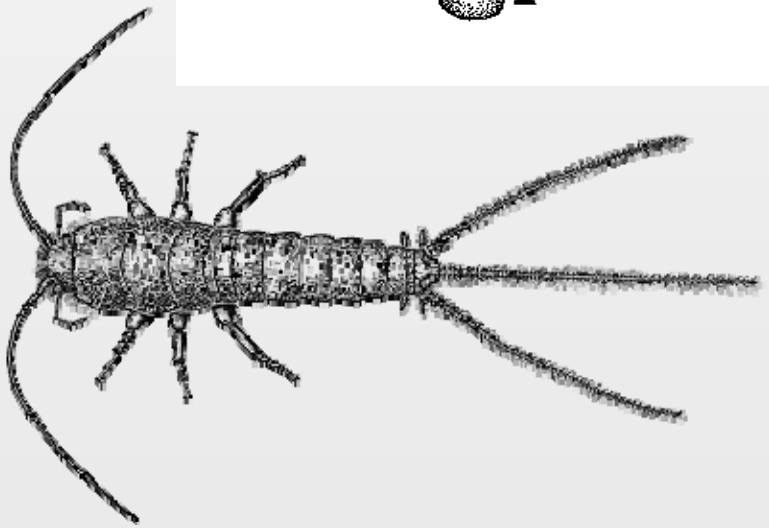
Metamorphosis, which means “a change in form.”

- In higher insect this change in form can be quite radical and dramatic or simple
- There are 3 main types:
  - Ametabolous or “No” metamorphosis
  - Simple or Gradual
  - Complex or Complete

Ametabolous or "No" Metamorphosis

This group includes the springtails and silverfish. The only change they undergo during development from egg to adult is an increase in size.





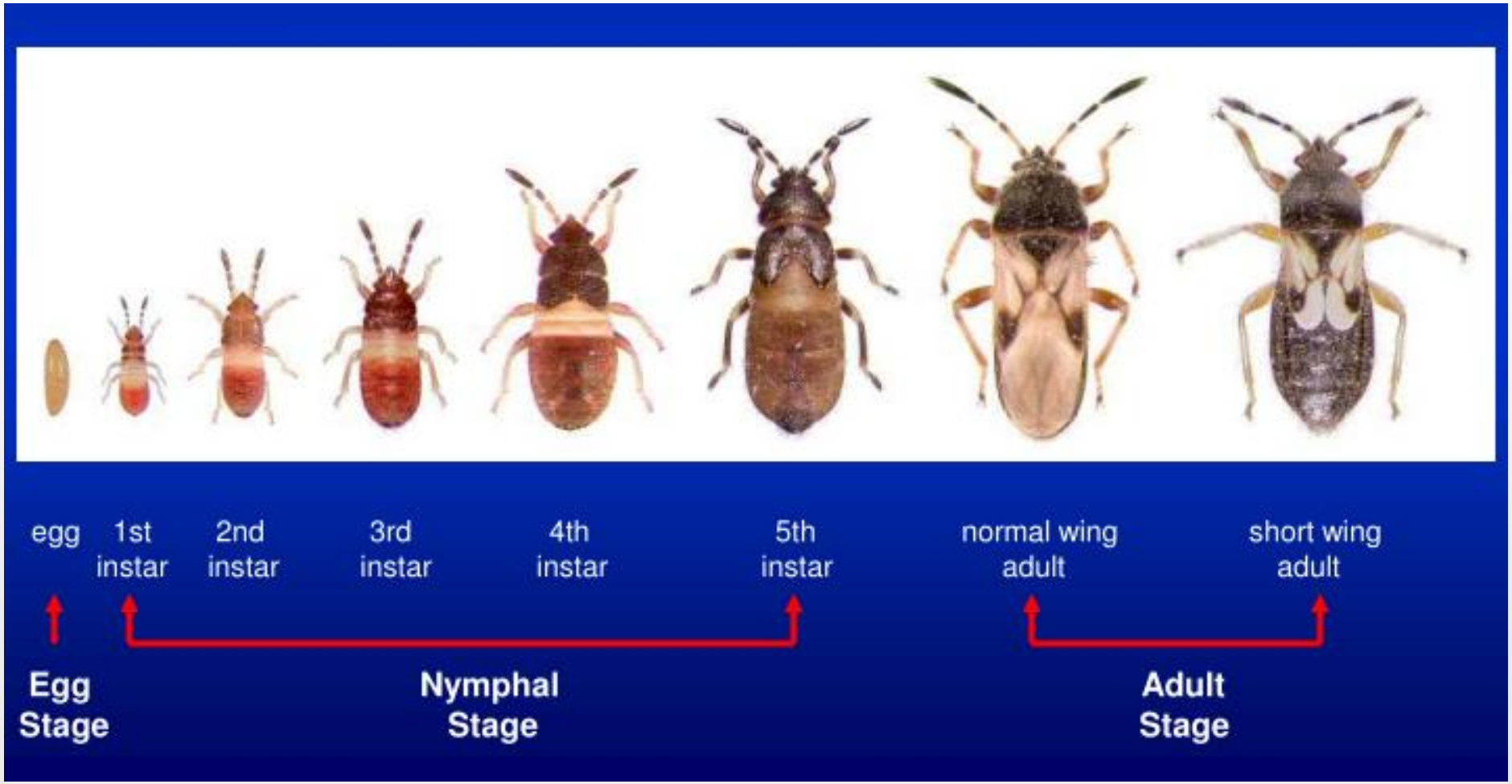
Simple or Gradual Metamorphosis

- Insects that undergo this type of metamorphosis experience very little change during development.
- (3) stages: the egg, nymph, and adult
- Nymphs have undeveloped wings in the form of “buds”
- Nymphs usually resemble adults closely and have similar feeding habits.

Incomplete Metamorphosis

- walking-sticks
- mantids
- dragonflies
- crickets
- cockroaches
- termites
- grasshoppers
- lice
- true bugs (stink bugs, water bugs, aphids, cicadas, bed bugs)
- earwigs

Incomplete Metamorphosis Example – Hairy Chinch Bug



Complete or Complex Metamorphosis

- This type of development is seen in our more highly developed insects
- Egg -> Larva -> Pupa -> Adult
- Larva has many common names:
  - Caterpillar, looper, cutworm, leafroller, borer, webworm, Grub, wireworm, Maggot
- In pest species, the larval stage is usually most destructive, although the adult also may cause damage…

Complete Metamorphosis

- butterflies
- moths
- mosquitos
- lady bugs
- flies
- fleas
- honeybees
- ants
- wasps
- lace wing
- beetles

Complete or Complex Metamorphosis Example – Northern masked chafer

Pupal Stage

- Allows insects to completely change from specialized feeding organisms into adult insects that are specialized for dispersal and mating

- Adults' food often is entirely different from the larval stage

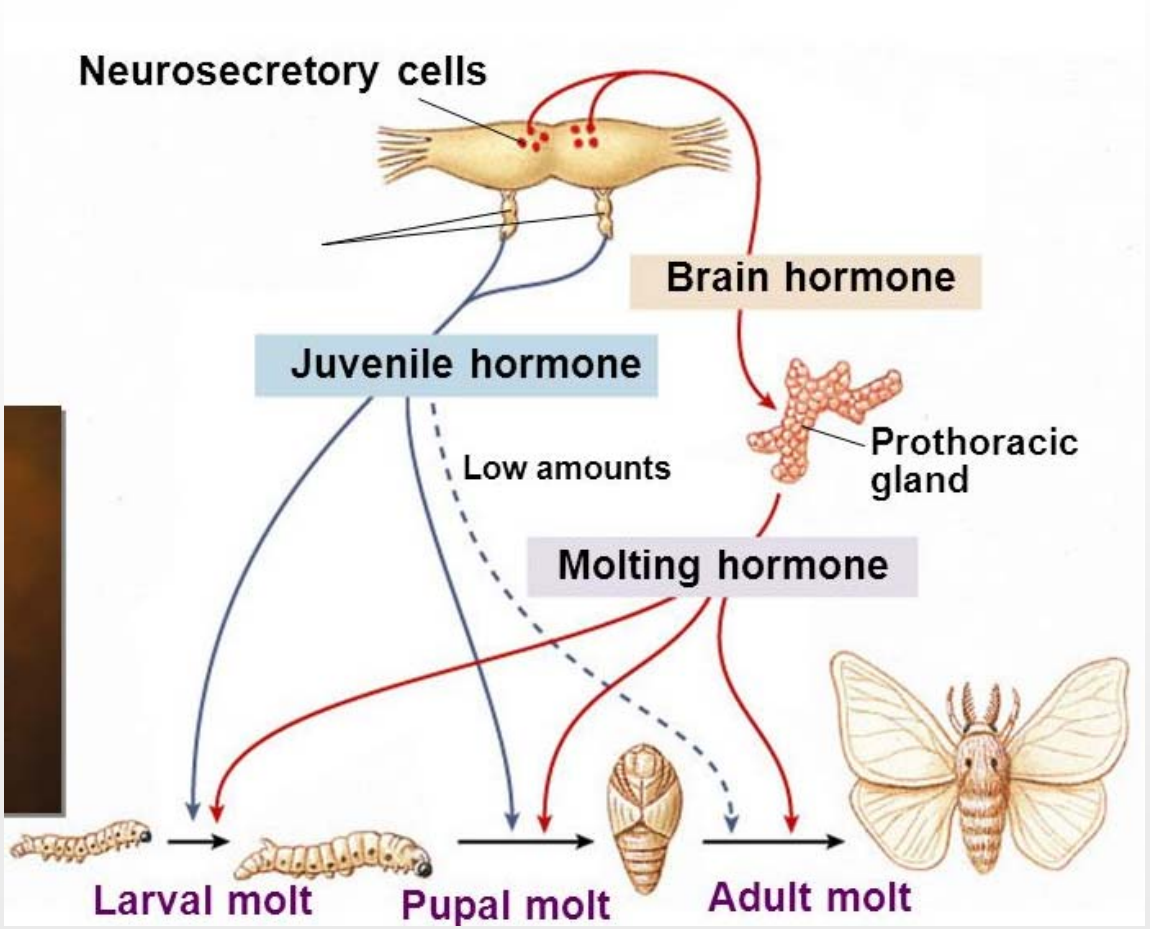
How Insects Grow

- EXOSKELETON fixed in size
- Must MOLT (shed) old skeleton as they develop
- Develop through several INSTARS (stage between growth)
- Adult females lay eggs where there is plenty of food

How Insect Molts

Juvenile hormone (JH) effectively inhibits molting between stages. Chemicals such as artificial JH are called “insect growth regulators” and function as insecticides.

They have proven very effective in indoor flea and cockroach control and whitefly control, etc.



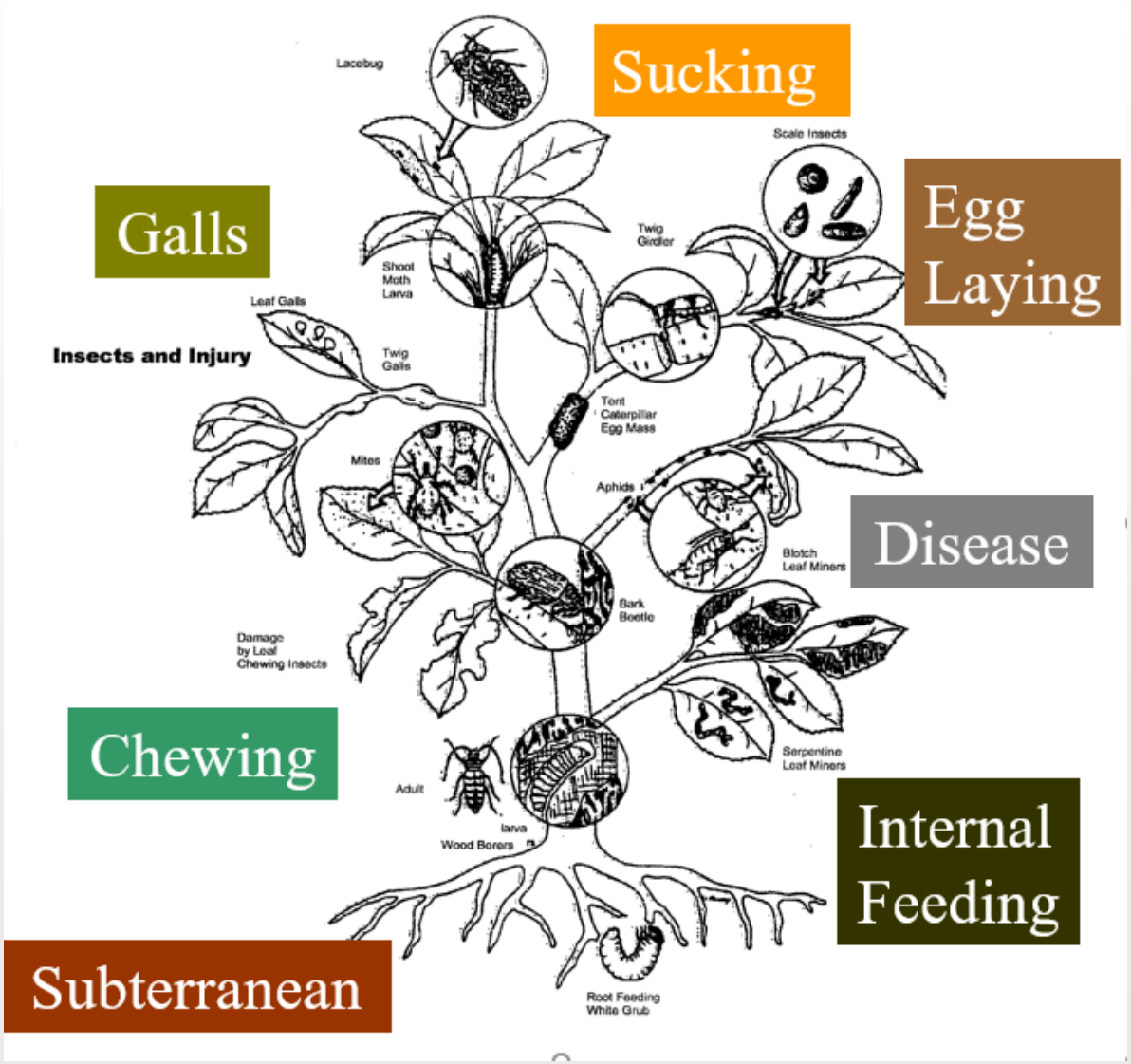
Insect Identification

- Identifying Insect Damage
- Identifying Insects
- Major Insect Orders

Insect Identification

Insect identification operates at two levels: the creature itself and the evidence it leaves or damage that it causes if it's a plant pest.

Ways In Which Insect Injure Plants



Types of Injury

From Chewing Insects

Beetles

Caterpillars

Types of Injury

From Sucking Insects

True Bugs

Scale Insects

Types of Injury

From Internal Feeders

Borers

Leafminers

Types of Injury

Internal

From Feeders

Eriophyid Mites

Gall Wasp

Types of Injury

From Subterranean Insects

White Grub /Root Injury

Wireworm /Seed Injury

Types of Injury

From Egg Laying

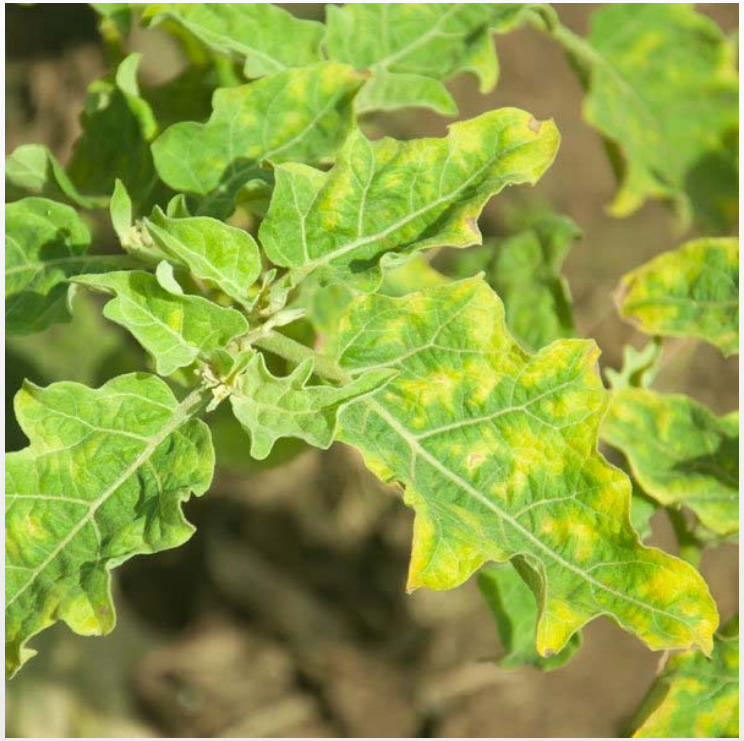
Cicadas

Tree Crickets

Insects as Vectors of Disease

Pests with sucking mouthparts usually leave evidence with predictable symptoms on the plant due to toxins or enzymes in their saliva which may be **Viral**, **Fungal** or **Bacterial**.
These may symptoms include:

- chlorosis or stippling
- leaf curling and distortions
- needle drop
- leaf mining
- galling



Tomato Mosaic Virus (Aphids)

Insects as Vectors of Disease

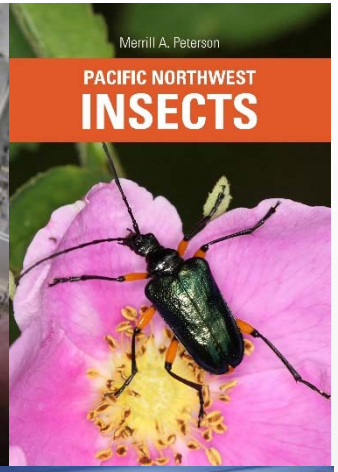
Fungal Diseases, Dutch Elm (Elm Bark Beetle)

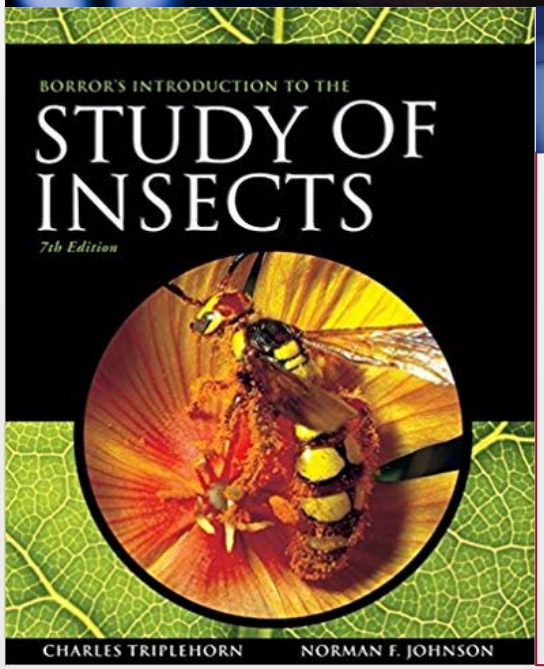
Bacterial Diseases, Bacterial Leaf Scorch (Leaf & Treehoppers)

Insect Damage Only

- In situations where damage is the only evidence, we as “diagnosticians” need to be careful and preface a tentative diagnosis with words like “possible” caterpillar or “may be” beetle damage.
- For accurate id and management recommendations, the organism causing the damage needs to be brought in for proper identification!

I Have an Insect to Identify, Now What?





Amateur Entomologist's Society *http://www.amentsoc.org/insects/what-bug-is-this/adult-key.html*.

Is Knowing the Scientific Name Really That Important???

While you will rarely need to know a pest's genus and species, remember the importance of scientific names to universal accuracy.

But I "Think" I know the Common Name…

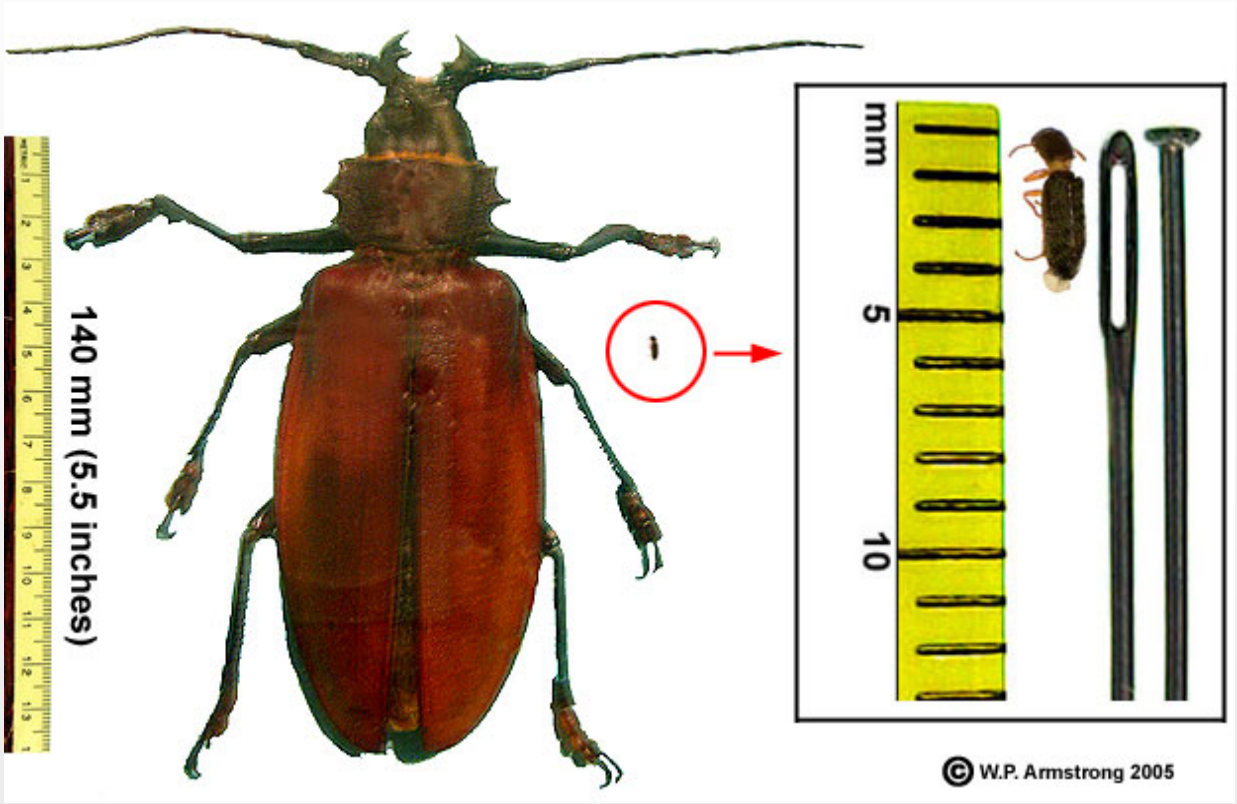
While green apple aphid is a common name for *Aphis pomi* in the PNW, it may have a different common name somewhere else. But it is still *A. pomi* regardless of where it's found. Thus the Latin name avoids common name differences!

Major Insect Orders

Common Insects:	Uncommon Insects:	Scarce Insects:	Rare insects:
Orthoptera	Isoptera	Siphonaptera	Grylloblattaria
Heteroptera	Dermaptera	Pthiraptera	Strepsiptera
Coleoptera	Plecoptera	Phasmatodea	Embiidina
Diptera	Mantodea	Archeognatha	Zoraptera
Lepidoptera	Blattodea	Thysanura	Mecoptera
Hymenoptera	Odonata	Megaloptera	Manto-phasmatodea
	Ephemeroptera	Raphidiodea	
	Trichoptera	Psocoptera	
	Neuroptera		
	Thysanoptera		

Order Coleoptera – “sheathed wing”
Beetles and Weevils

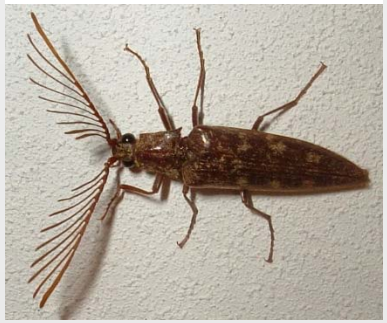
- Some of the largest and smallest insects on the planet belong to this order.



***Titanus giganteus*; up to 17 cm (=6.69 inches) and can weigh 88 grams (453 g = 1lb)**

- Complex metamorphosis
- Chewing mouthparts - larvae and adults
  - Feed on leaves, stems, roots, buds, flowers, fruits, seeds, or woody tissue
- Adults winged

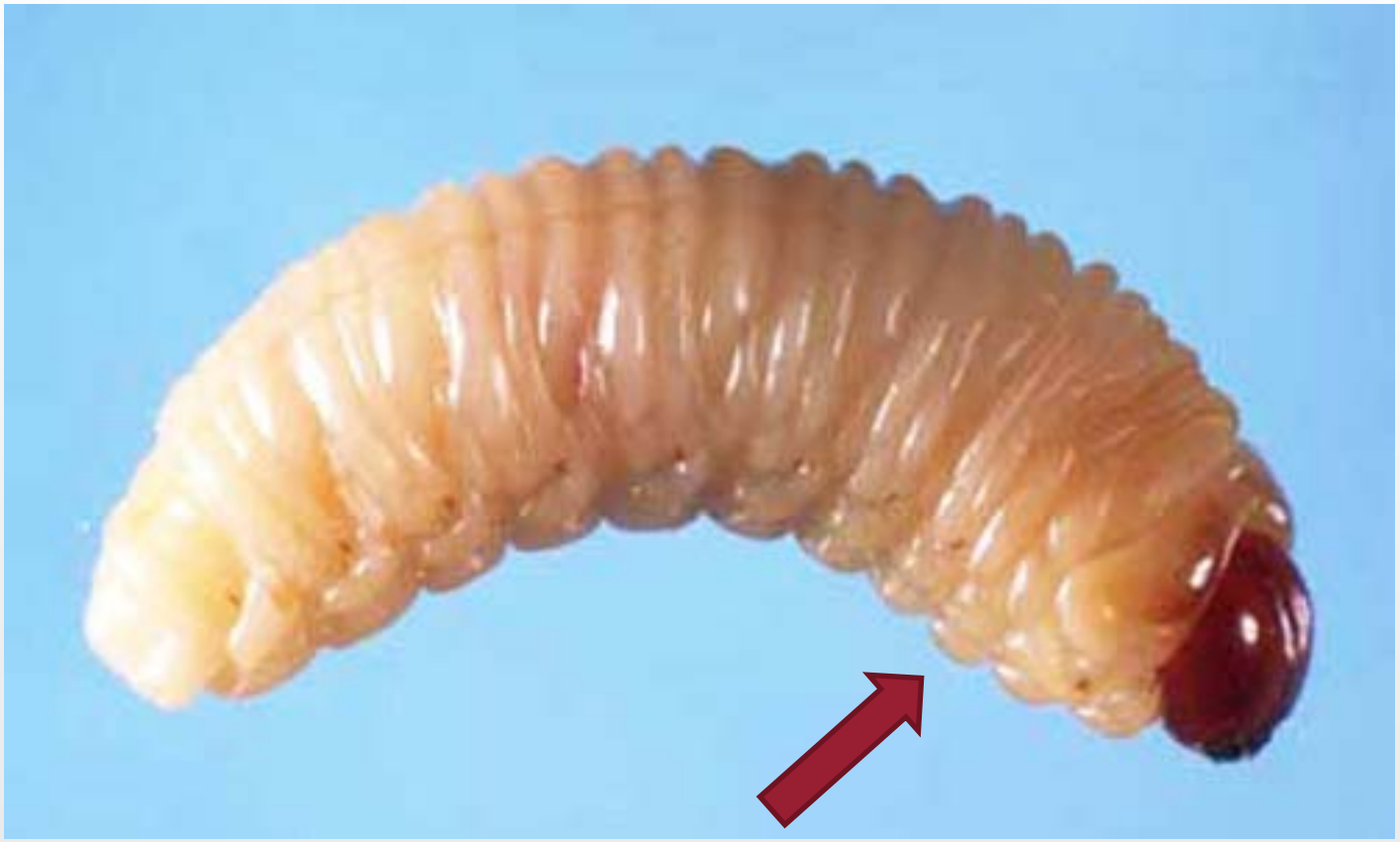
  - outside wing hardened (elytra)
- Noticeable antennae
- Some predators (beneficial)
- Some pollinators (beneficial)
- Some plant feeders (pest)
- Most abundant animal on earth



Beetle Larvae

- 3 pairs of legs on the thorax
- Distinct head capsule w/ chewing mouthparts

Weevil Larvae

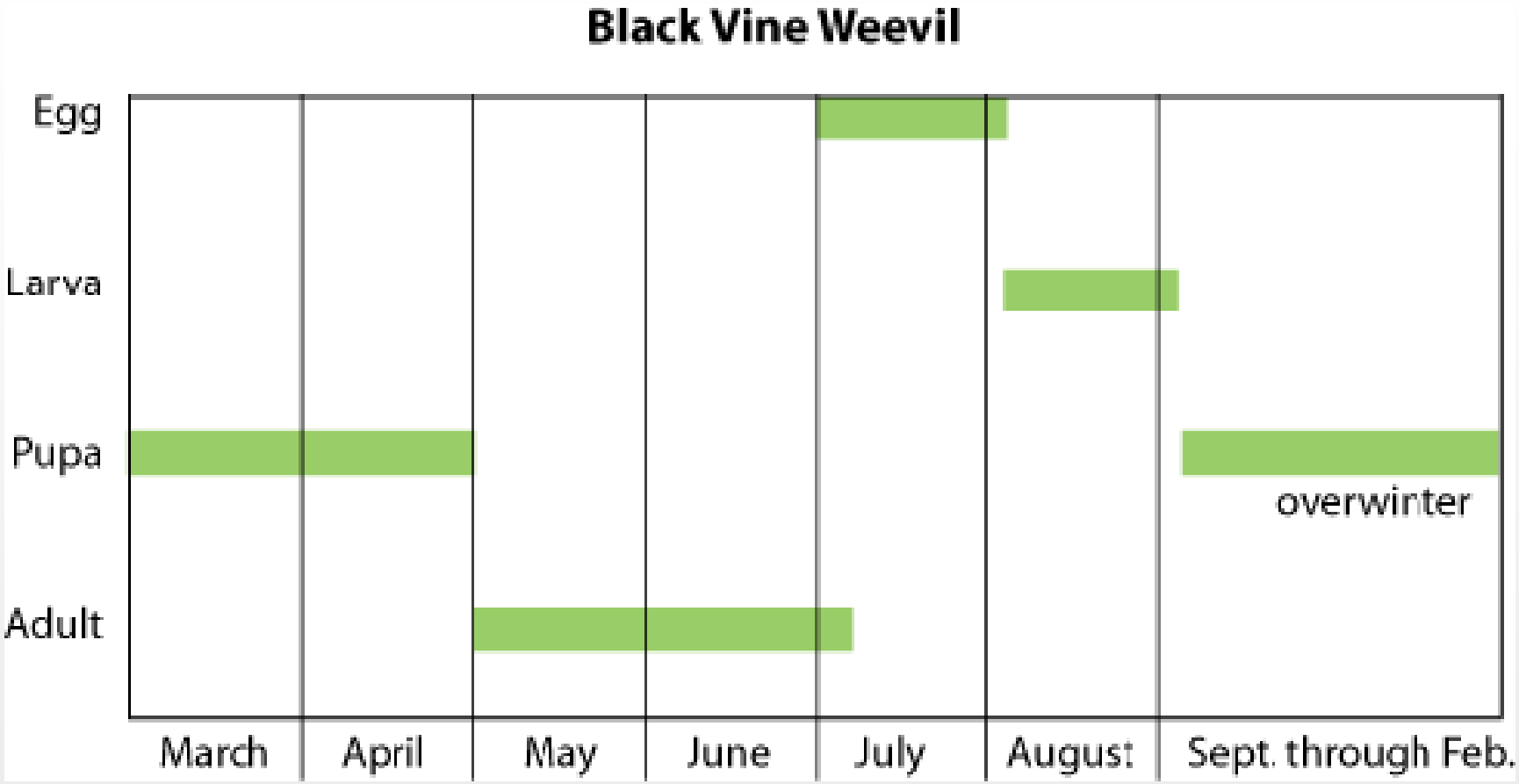


Weevils (Curculionidae)

- One of largest beetle groups are the Weevils
- They have elbowed antenna
- Curved or blunt snout
- Many pest species like the Black Vine Weevil

Black Vine Weevil

- Serious pest in nurseries and established landscape plantings.
- Native of Europe, this species was first reported in Connecticut in 1910.
- Adults and larvae prefer rhododendron, *Rhododendron* sp p., yew, *Taxus* spp., euonymus,*Euonymus* spp., and Japanese holly, *Ilex crenata*.
- Larvae also feed on the roots of hemlock,*Tsuga* spp.
- This pest has been recorded on more than 100 species of cultivated and wild plants.


Black Vine Weevil
Egg
Larva
Pupa
Adult
overwinter
March
April
May
June
July
August
Sept. through Feb.

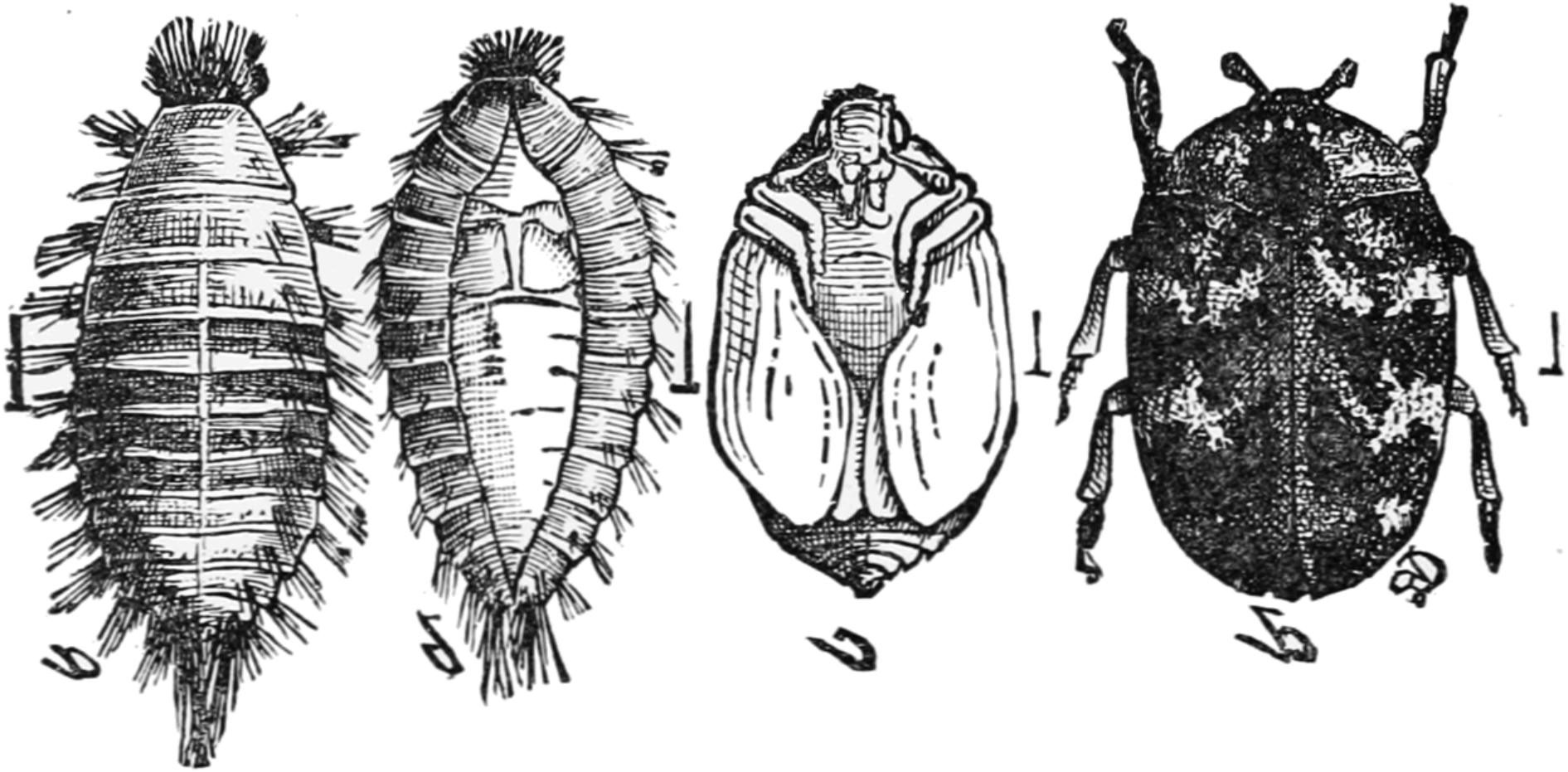
Black Vine Weevil Damage

Black Vine Weevil Control

- Handpick and destroy adults to prevent more serious damage.
- Provide cultural care to keep plants vigorous and better able to tolerate damage.
- Check roots before planting to make sure they are free from larvae.
- Trim branches that provide a bridge to other plants or the ground and apply a 6-inch band of sticky material to trunks to prevent flightless beetles from feeding on foliage.
- Foliar sprays are not generally necessary, however, if treatment is warranted insecticides applied to leaves can control adults.

Dermestid Beetles (a.k.a. Carpet Beetles)

Dermestid Beetle Life cycle



Dermestid Beetle Larva

Dermestid Beetle Damage

Dermestid Beetle Damage

Lady beetles (Coccinellidae)

- Also known as Ladybird beetles
- Adults are rounded, and range in size from tiny to ¼ inch long. Color ranges from black to brightly colored
- Larvae are active and elongate with long legs and look like tiny alligators
- Adults very mobile; will leave to find pest
- Feed on scales, eggs of larvae and other soft-bodied insects and mites
- 5,000 aphids in a lifetime!

Lady beetle Pupa (Coccinellidae)

Lady beetles (Coccinellidae)

Left: *Chilocorus kuwanae* adult. (twice stabbed)
Center: *Coccinella septempunctata* adult.
Right: *Coleomegilla maculata* adult.
(a.k.a pink spotted lady beetle)

Left: *Cryptolaemus montrouzieri* adult.
Adult eating a aphid.
Center: *Harmonia axyridis* adult.
(a.k.a Asian Lady Beetle)
Right: *Hippodamia convergens* adult.

Left: *Pseudoscymnus tsugae* adult.
Center: *Rodolia cardinalis* adult.
(vedalia beetle)
Right: *Stethorus punctum* adult.
(a.k.a. spider mite destroyer)

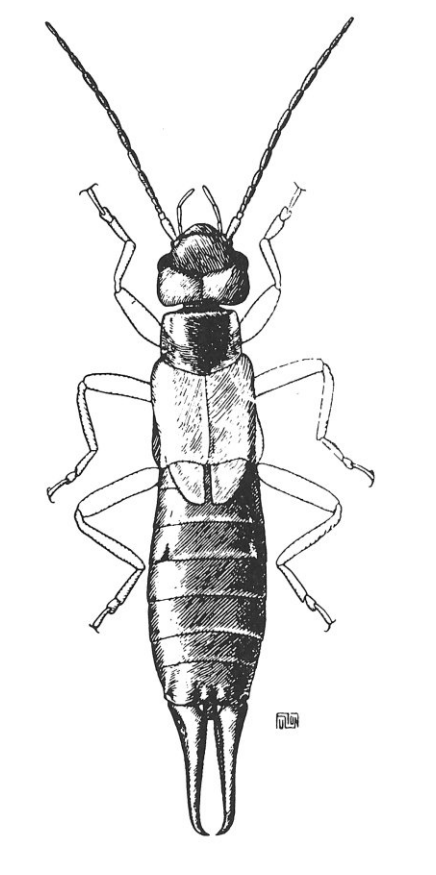
Lady beetles (Coccinellidae)

Asian Lady Beetle

Habitat

- Live in a variety of habitats: aquatic, terrestrial and subterranean feed on Plants/Flowers, Fungus, Dung, Carrion

Order Dermaptera (Earwigs)
"derma = skin; ptera = wing"



1989)

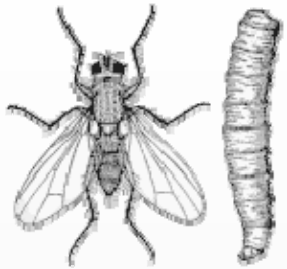
http://zoologie.forst.tu-muenchen.de/HEITLAND/DETINVERT/DERMAPTERA/IMAGES/euro_earwig_01.jpg

Order Dermaptera (Earwigs)

- Moderate-sized insects
- Active at night
- Simple metamorphosis
- Short, hardened outer wings and folded membranous inner wings
- Pair of Cerci (i.e. forceps)
- Mainly scavengers but can be pestivorous…

Earwig Feeding Damage

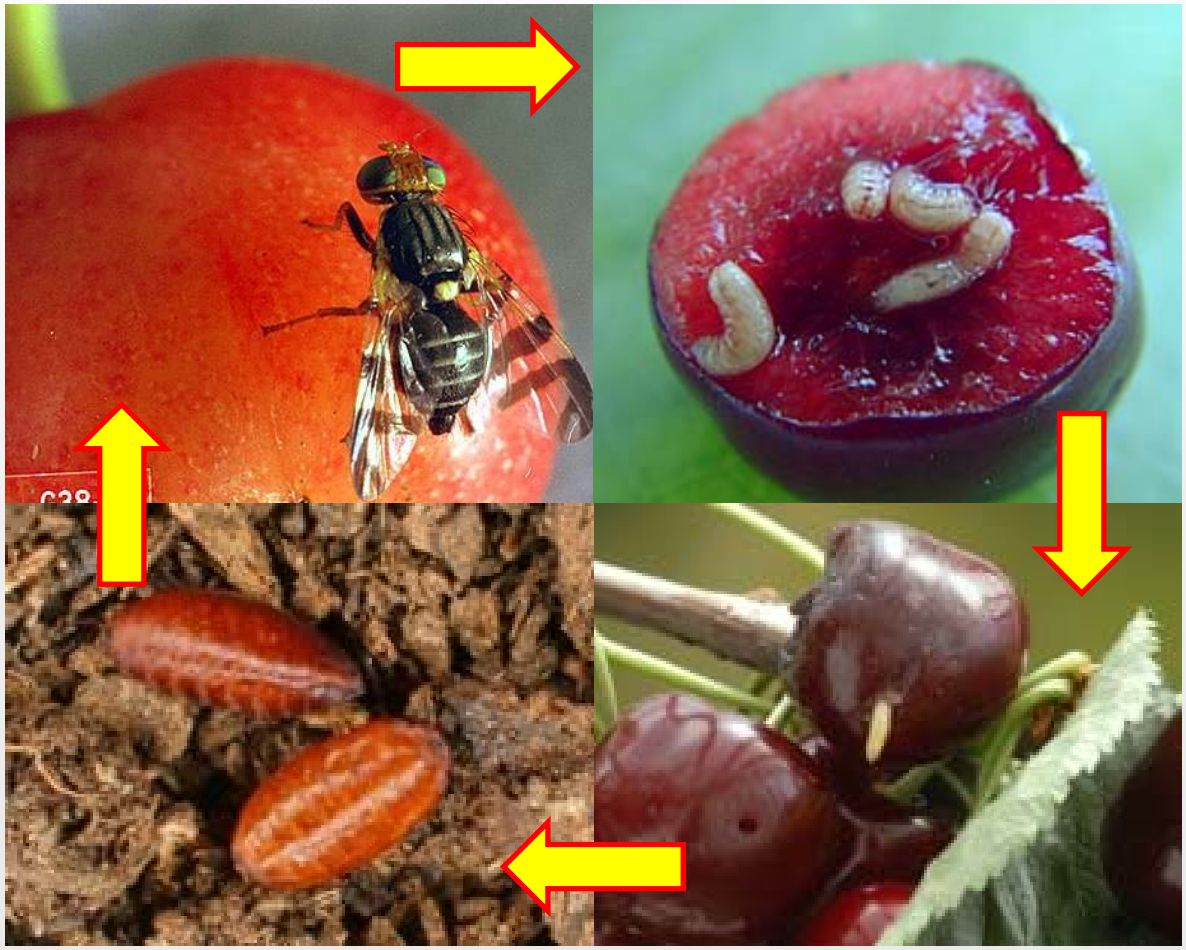
Order Diptera (True Flies)
di = two ptera = wing



- Mosquitos, flies, gnats and midges
- Complete/Complex Metamorphosis
- Larvae have chewing mouthparts or mouth hooks
- Adults with sucking/sponging mouthparts
- One pair of wings
    - second wing is “haltere” (gyroscope)
- Greater economic impact than any other insect group; disease
- Beneficial; pollinate flowering plants; assist with decomposition of organic matter

Haltere

Western Cherry Fruit Fly – Life cycle & Damage

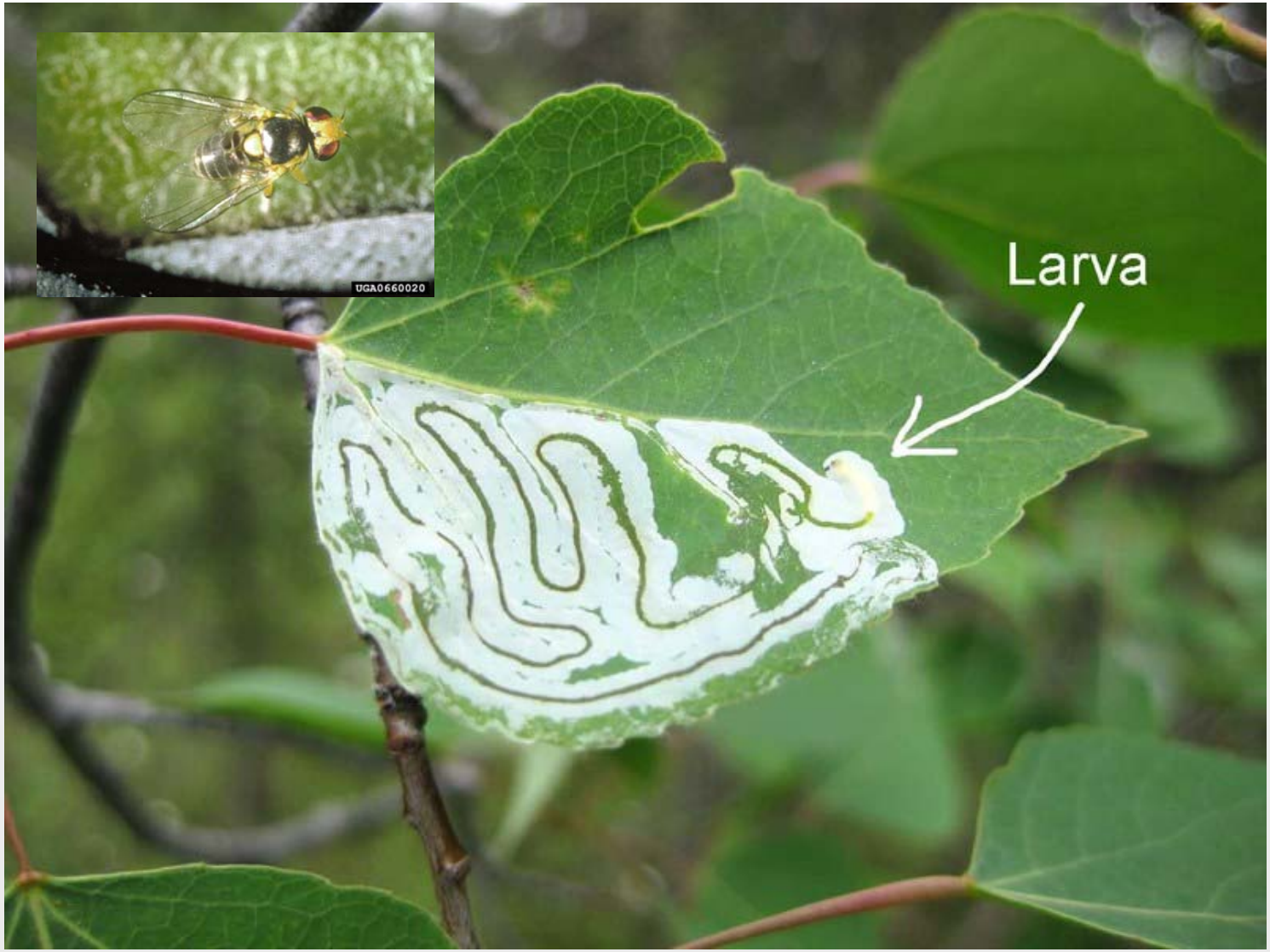


Cherry Fruit Fly Monitoring

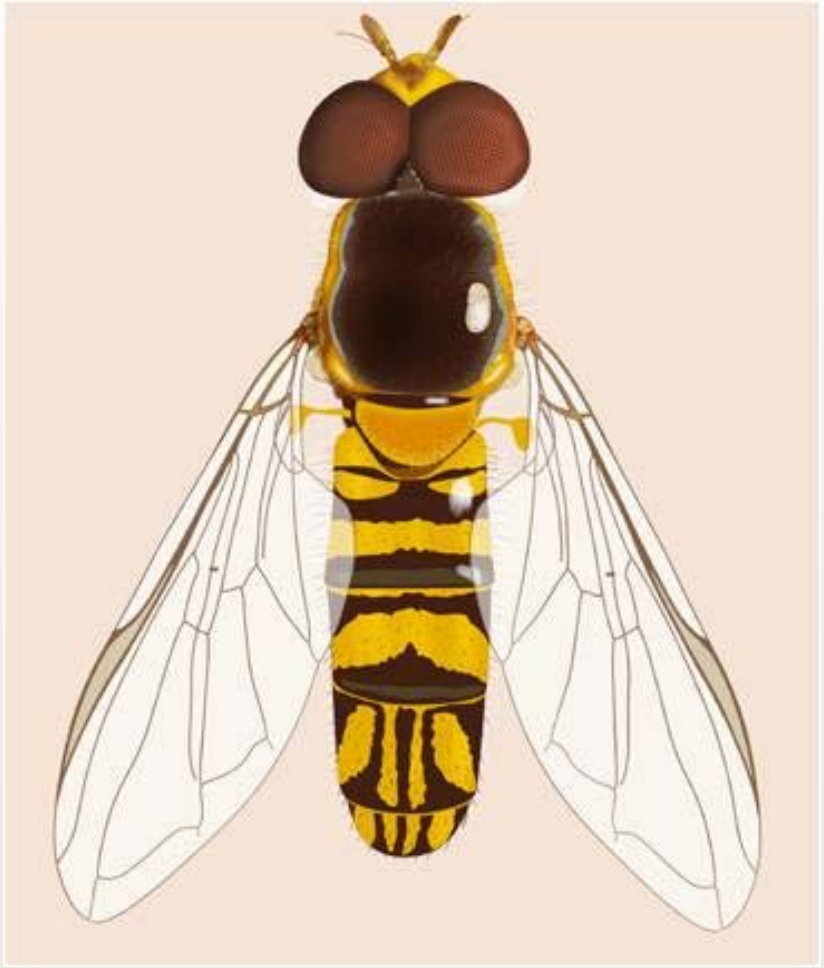
Spotted Wing Drosophila

Spotted Wing Drosophila -Damage

Leaf miners - Agromyzidae



Syrphid flies, flower flies, hover flies (Syrphidae)



Syrphid flies, flower flies, hover flies (Syrphidae)

- Large group of flies.
- 1/4 to 3/4 inch long.
- Most adults eat pollen and nectar (good pollinator)
- Adults are black and yellow, often hover around flowers, and look like bees (but do not sting)
- Larvae feed on aphids, leafhoppers, mealybugs, scale insects, and thrips

Syrphid flies, flower flies, hover flies (Syrphidae)

- Good for slow moving, soft bodied insects
- Early in the growing season
- Single individual can consume up to 400 aphids in a lifetime

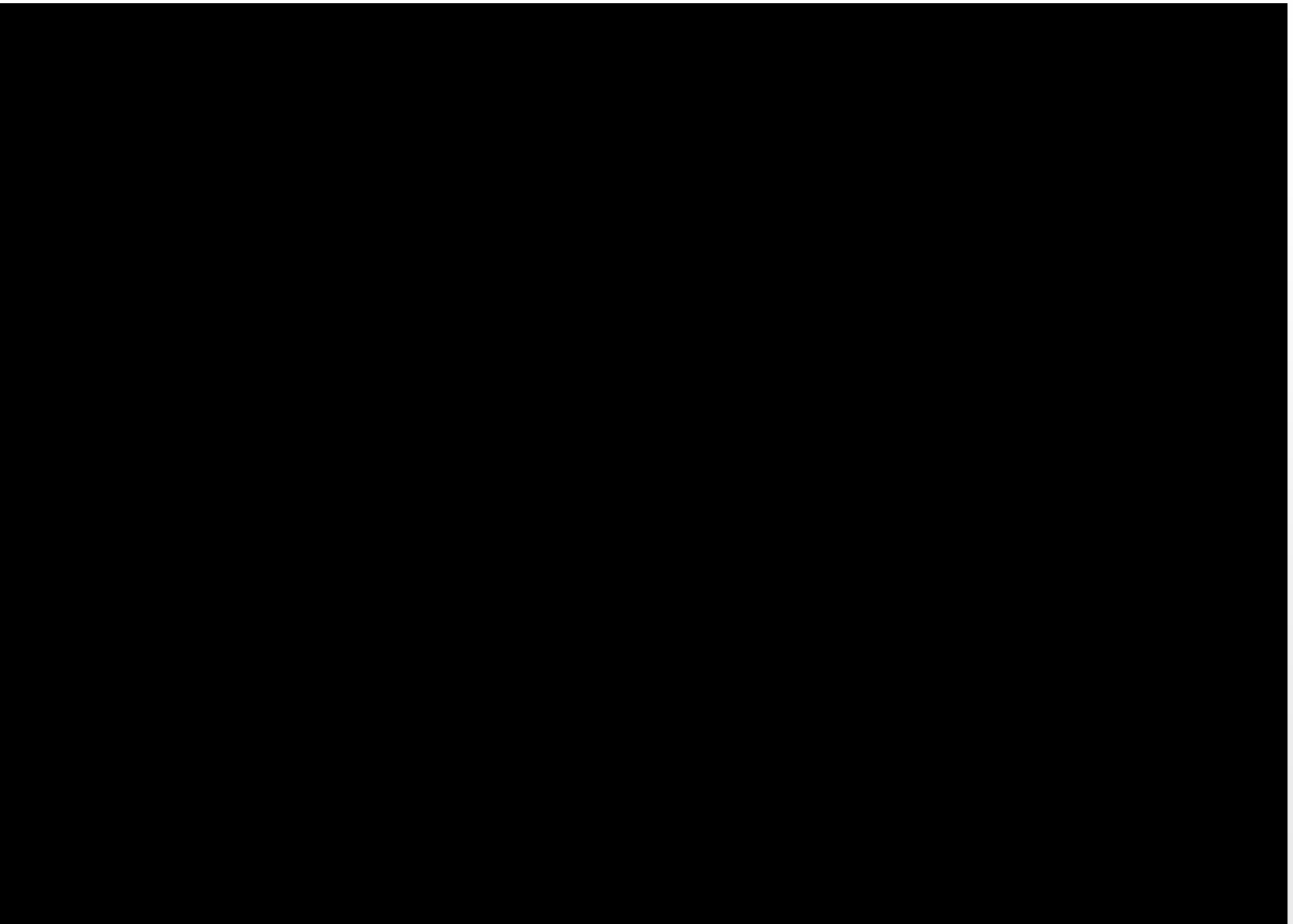
Larvae i.e. Maggots

- Larvae of advanced forms, such as house flies have no head capsule
- Lower forms, such as mosquitoes, have a head capsule

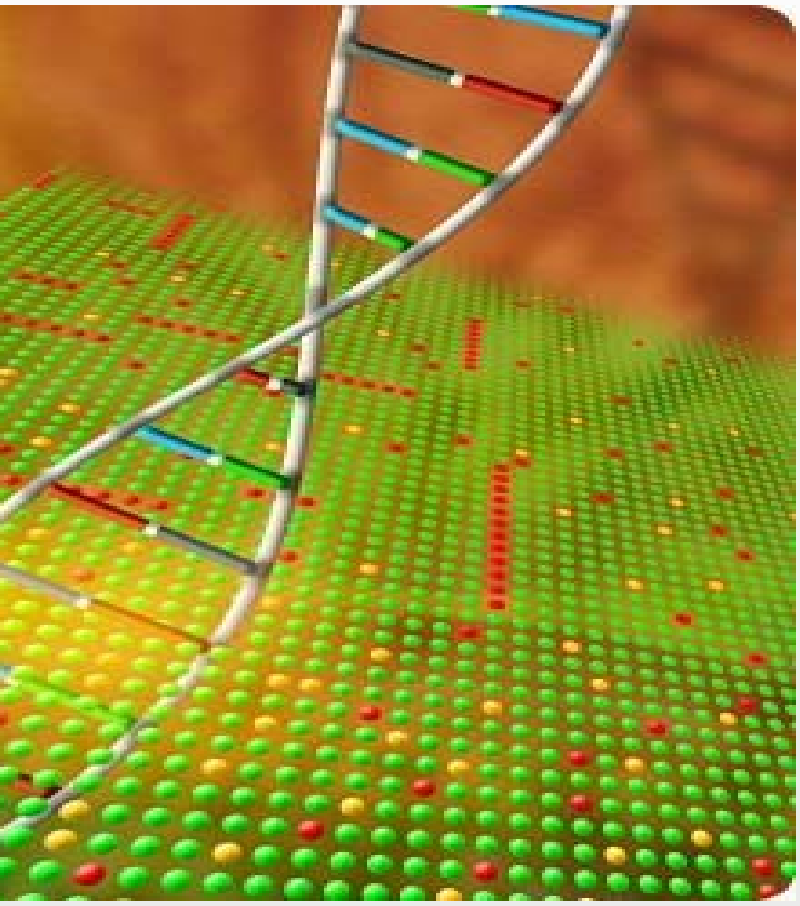
Maggot Therapy - management of necrotic or chronic wounds

- Maggot Debridement Therapy (MDT) is the medical use of specially selected and tested, disinfected fly larvae ("maggots") for cleaning non-healing wounds.

- Medicinal maggots have been found to have four principle actions: 1) they debride (clean) wounds by dissolving the dead (necrotic), infected tissue; 2) they disinfect the wound, by killing bacteria; and 3) they stimulate wound healing; and 4) they break down and inhibit the formation of biofilm.



Most Important Insect Known to Man?



Drosophila – fruit fly

Order Hemiptera, Homoptera, = Heteroptera: Aphids, leafhoppers, scale insects, cicadas and whiteflies

imple Metamorphosis

ucking mouthparts

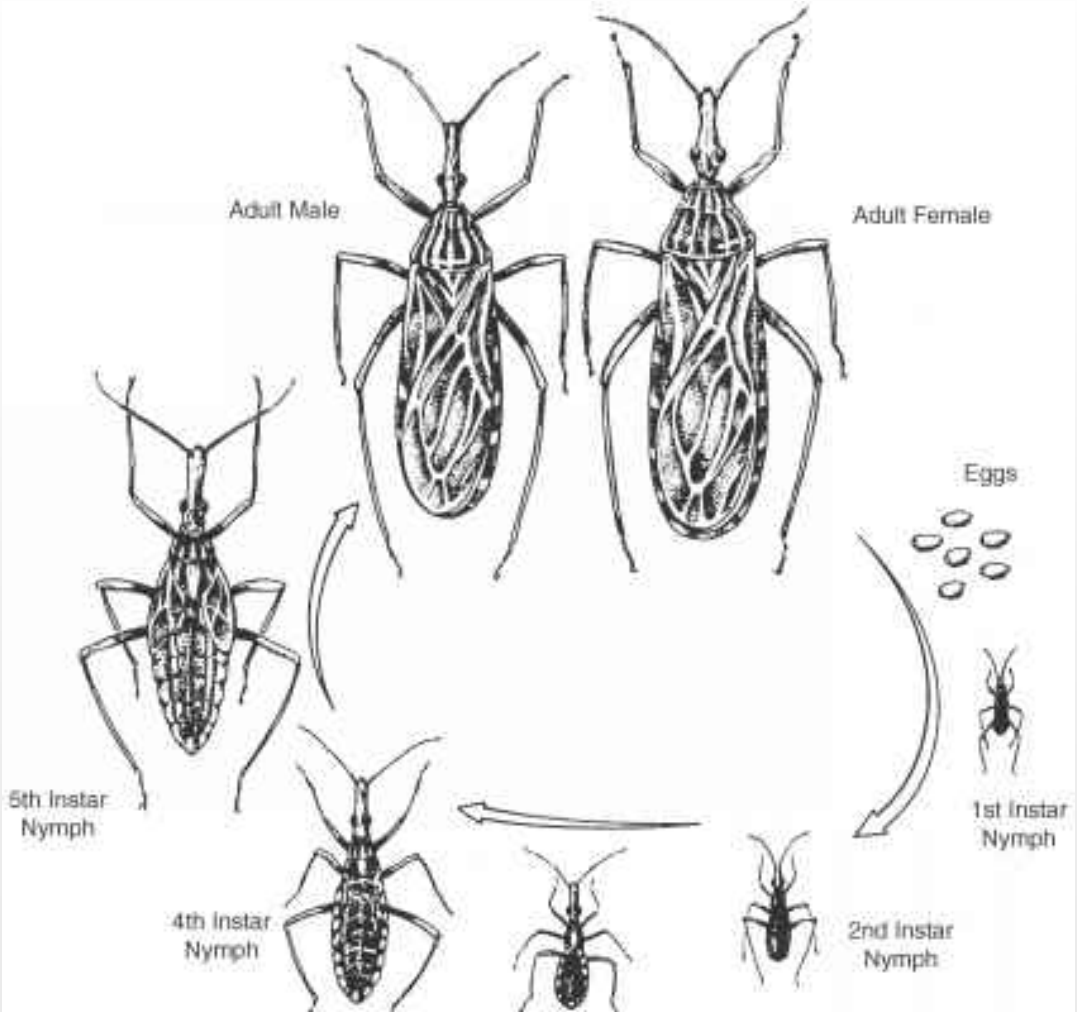
Carriers of plant pathogens

Plant pests

Excrete honeydew

excretion rich in sugar)

Assassin Bug Lifecycle

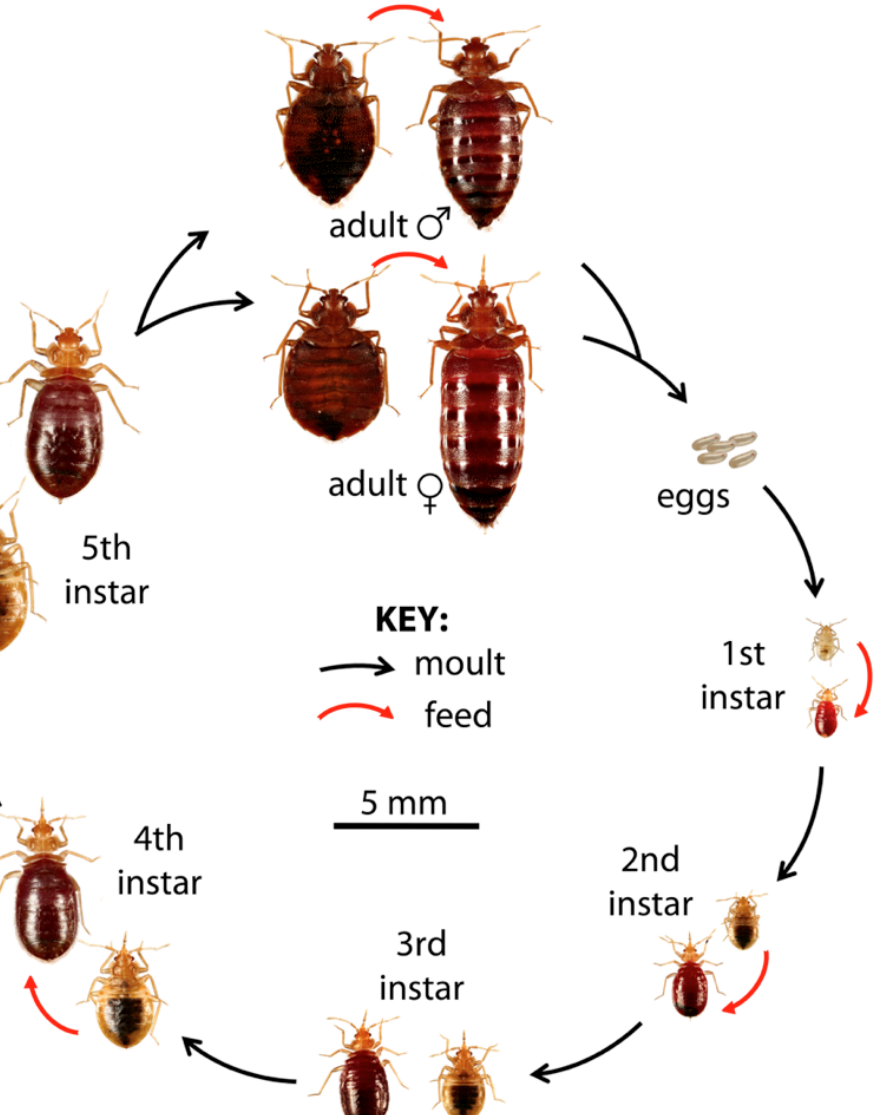


Examples:

Beneficial Examples:

Bedbugs

Bedbug Lifecycle

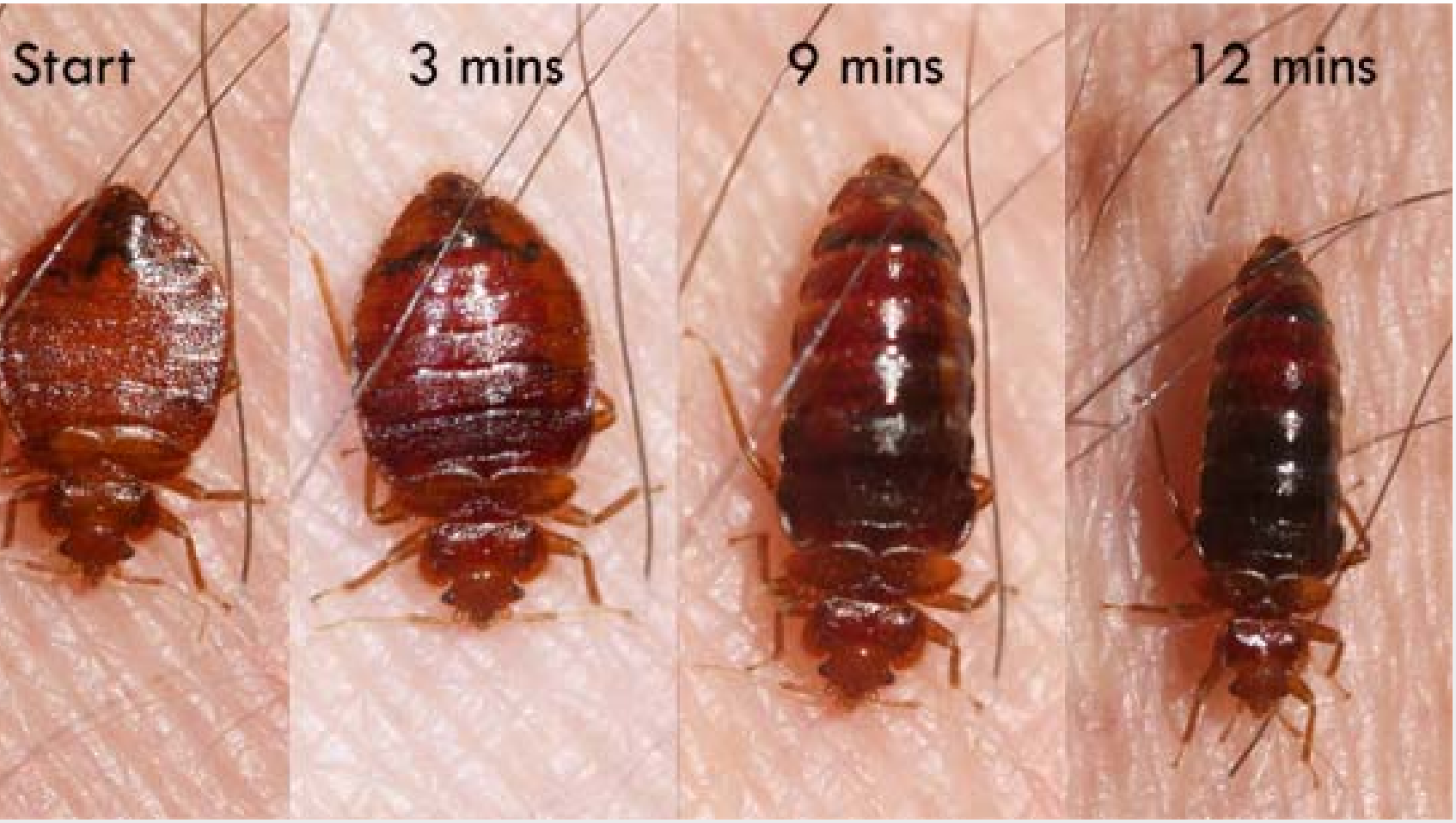


Bedbug Infestation

Bedbug Infestation


FREE

Bedbugs

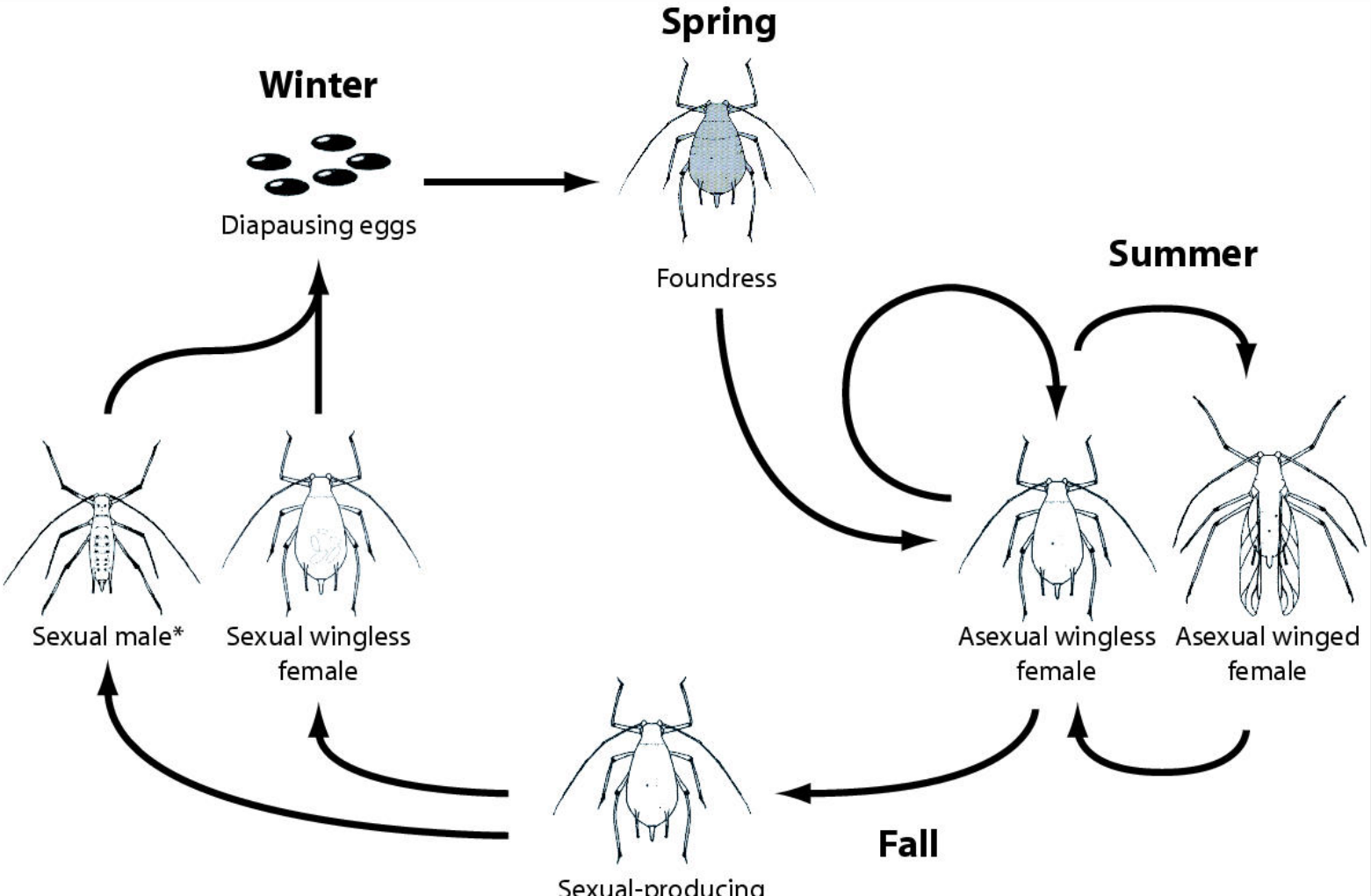


Bedbug Bites

Aphids

- Small soft bodied (2-6 mm)
- Globular in shape
- Cornicles nearly always present near posterior end of the abdomen
- Winged or Wingless
- Piercing sucking mouthparts (honeydew)

Aphid Lifecycle

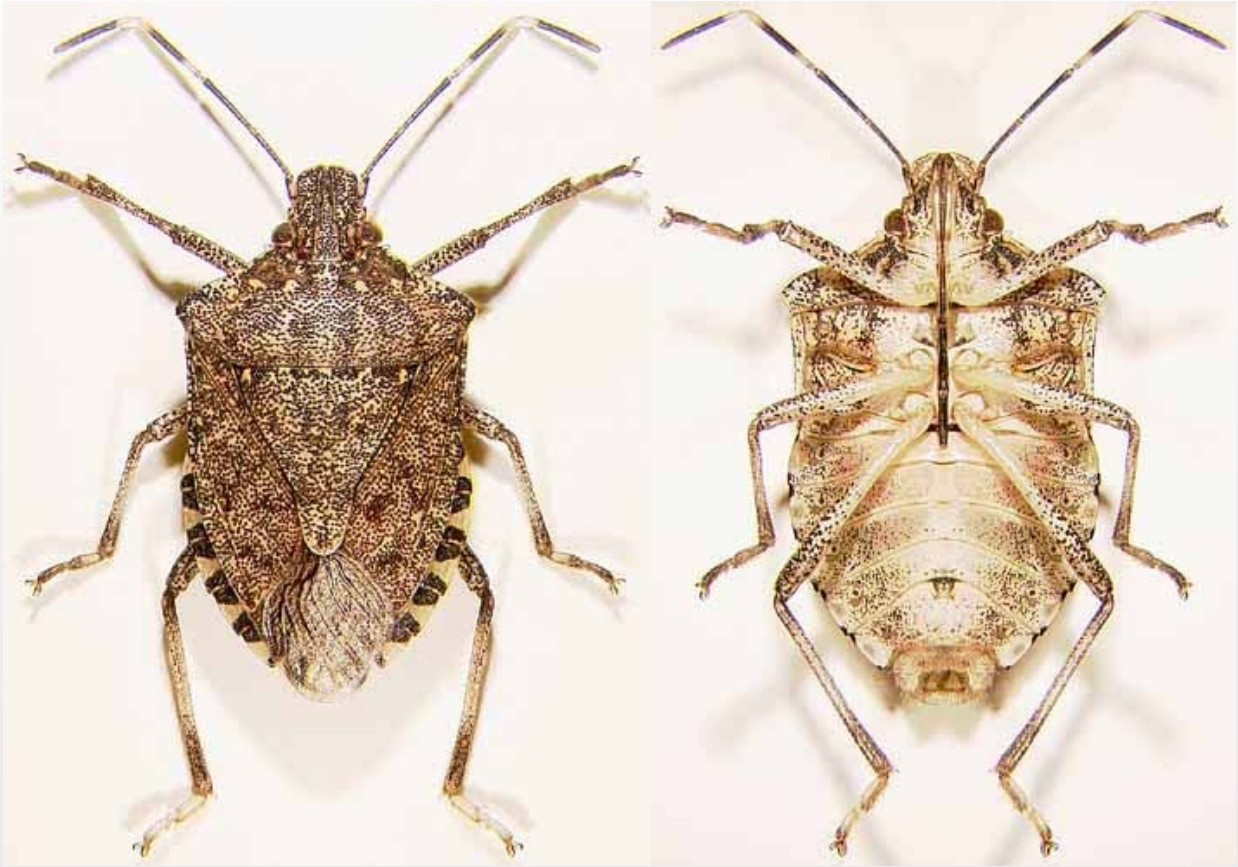


Asexual or Parthenogenetically Reproduction

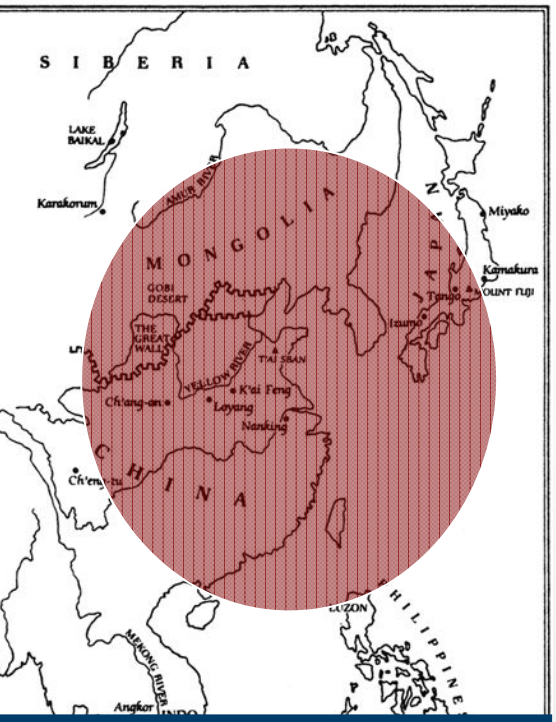

Brian McCornack, University of Minnesota

Symbiotic Relationship

Brown Marmorated Stink Bug



Eggs and Immature Nymphs



- Within Asia, 300 host plant recorded. US surveys identified over 60 hosts including:
- apple, plum, peach, pear, cherry, raspberry, blueberry, grape, pecan, bell pepper, tomato, pole/bush beans, cucumber, sweet/field corn, soybean ornamental trees and shrubs (maple, holly, dogwood, crabapple, hawthorn, elm, sycamore and serviceberry).

Brown Marmorated Stink Bug

Order Hymenoptera (Bees, Wasps, and Ants)

hymeno = god of marriage

- Complete/Complex Metamorphosis
- Chewing mouthparts
- Antennae long with 10 or more segments
- Two pairs of membranous wings (unless wingless)
- Important pollinators!
- Beneficial
- Social
- Ovipositor usually well developed and

Hymenoptera larvae

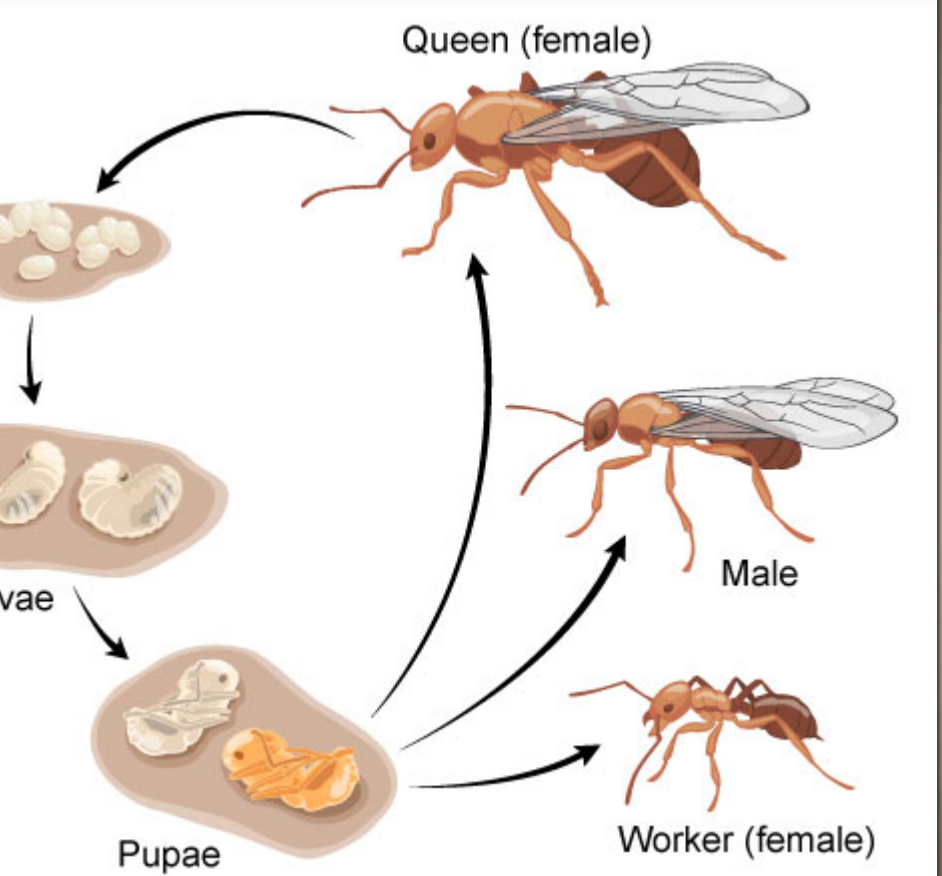
- Larvae have no legs
- However; some sawflies have legs on the thorax and “false” legs with no hooks on the abdomen

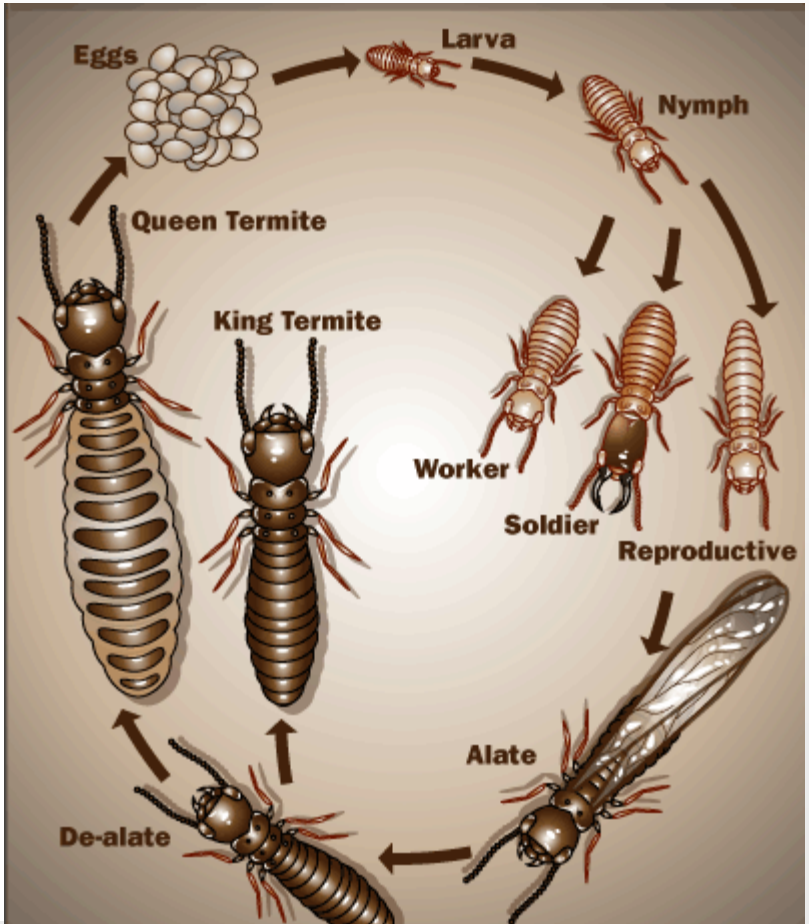
Ants (Formicidae)

- Social insects
- Usually live underground
- Often times considered a nuisance in homes and/or a pest in the garden
- Some ants will eat soft bodied insects

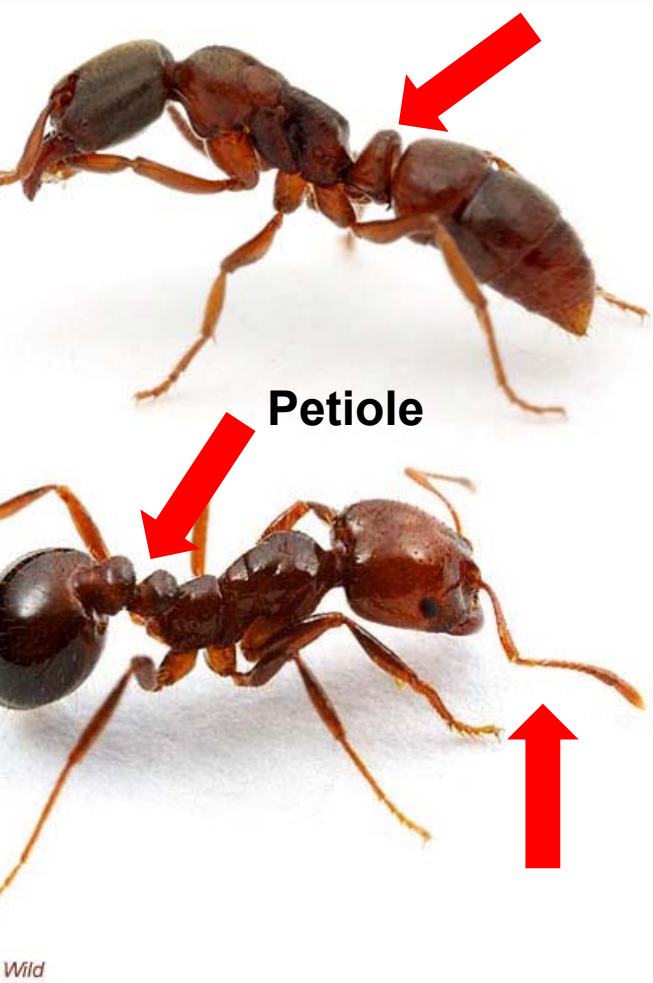
Right: Red imported fire ants (*Solenopsis invicta*) with cerambycid larvae.

Ant Lifecycle





Ants vs. Termites



Hornets, paper wasps
(Vespidae *Polistes*)

Solitary/Hunting Wasps/Paper Wasps

- Adults eat mainly caterpillars and feed their larvae beetles, flies, true bugs, and other wasps
- Adults switch to feed on sugar in late summer
- Yellow and black markings
- Some are more aggressive than others

Other Beneficial Wasps

Parasitic Wasp of White Fly

Important parasite of the greenhouse whitefly

How small can these wasps get?

139µm (micrometers)

1000 µm (microns) in 1 millimeter

Sweat Bees (Hymenoptera: Halictidae)

Mining Bee (Hymenoptera: Andrenidae)

Plasterer Bees (Hymenoptera: Colletidae)

Leafcutter Bee (Hymenoptera: Megachilidae)

Leafcutter Bee Houses

Carpenter Bees (Hymenoptera: Apidae)

Bumble Bees (Hymenoptera: Apidae)

umblebee is
y member of
bee genus
mbus, in the
nily Apidae.
ere are over
0 known
ecies.

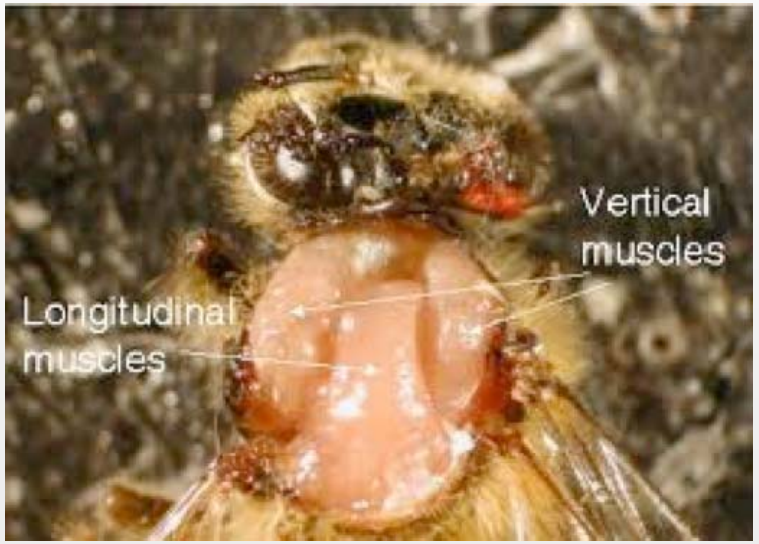
Honey Bee (Hymenoptera: Apidae)

Honeybees Like to Dance


.honey

Did Your Know the Honeybee is the Ultimate Frequent Flier…

To make a pound of honey, a bee flies around 55,000 miles, equivalent to twice around the world, visiting 10,000 flowers on more than 500 foraging trips.



"*As Busy As a Bee*!"

A single productive hive can produce 1000g of honey every day in a good year. This honey represents the sweetness of about 20 million blossoms.

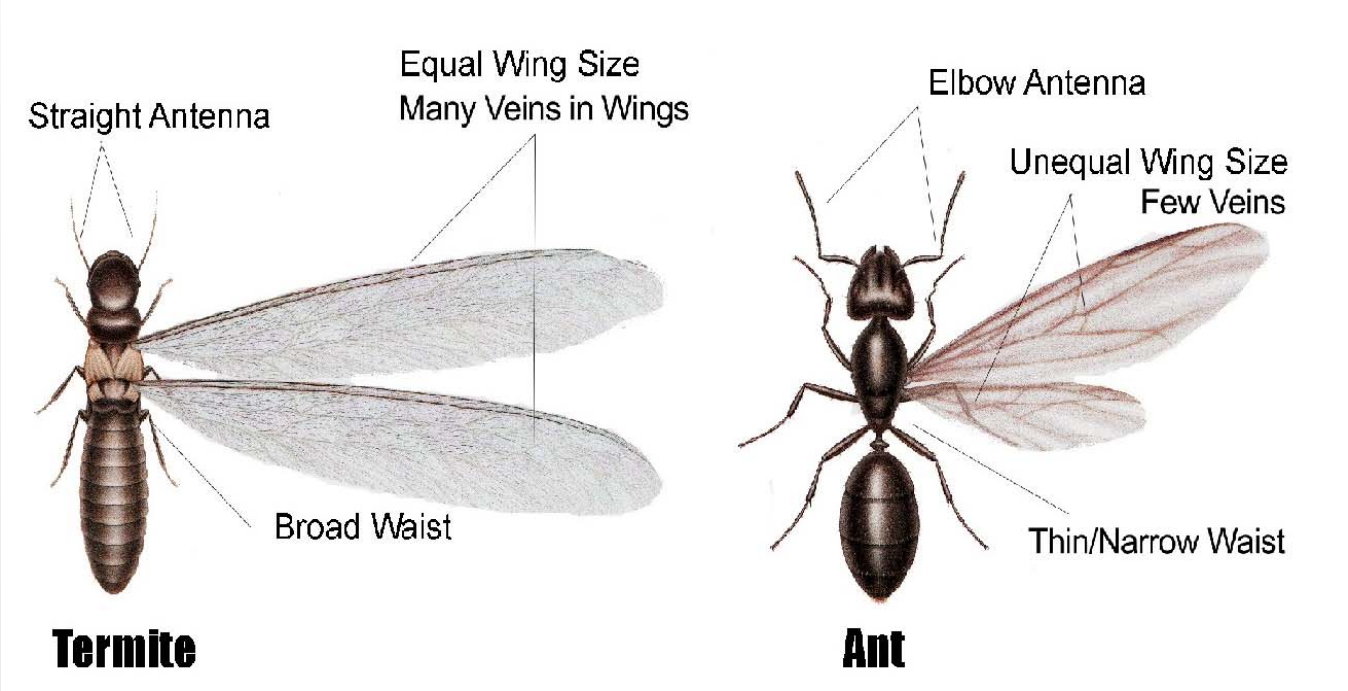
Food

- Of the 100 crops that provide 90 percent of the world's food, over 70 are pollinated by bees. Honey bees account for a third of the $3 trillion worth of

Order Isoptera (Termites)
iso = similar, ptera = wing

- Small to medium-sized
- Simple or gradual metamorphosis
- Social
- Having chewing mouthparts
- Digest cellulose with the aid of microbes in their digestive tract (pest of wood)
- Variety of habitats: some live in moist subterranean situations, while others live in dry situations above ground

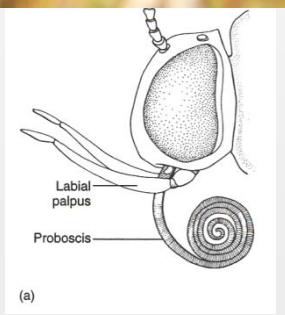
- Oftentimes confused with ants
  - No petiole, thin, straight antenna
  - Reproductive forms have 2 pairs of wings of equal size vs ants that are unequal



Order Lepidoptera (Moths and Butterflies)

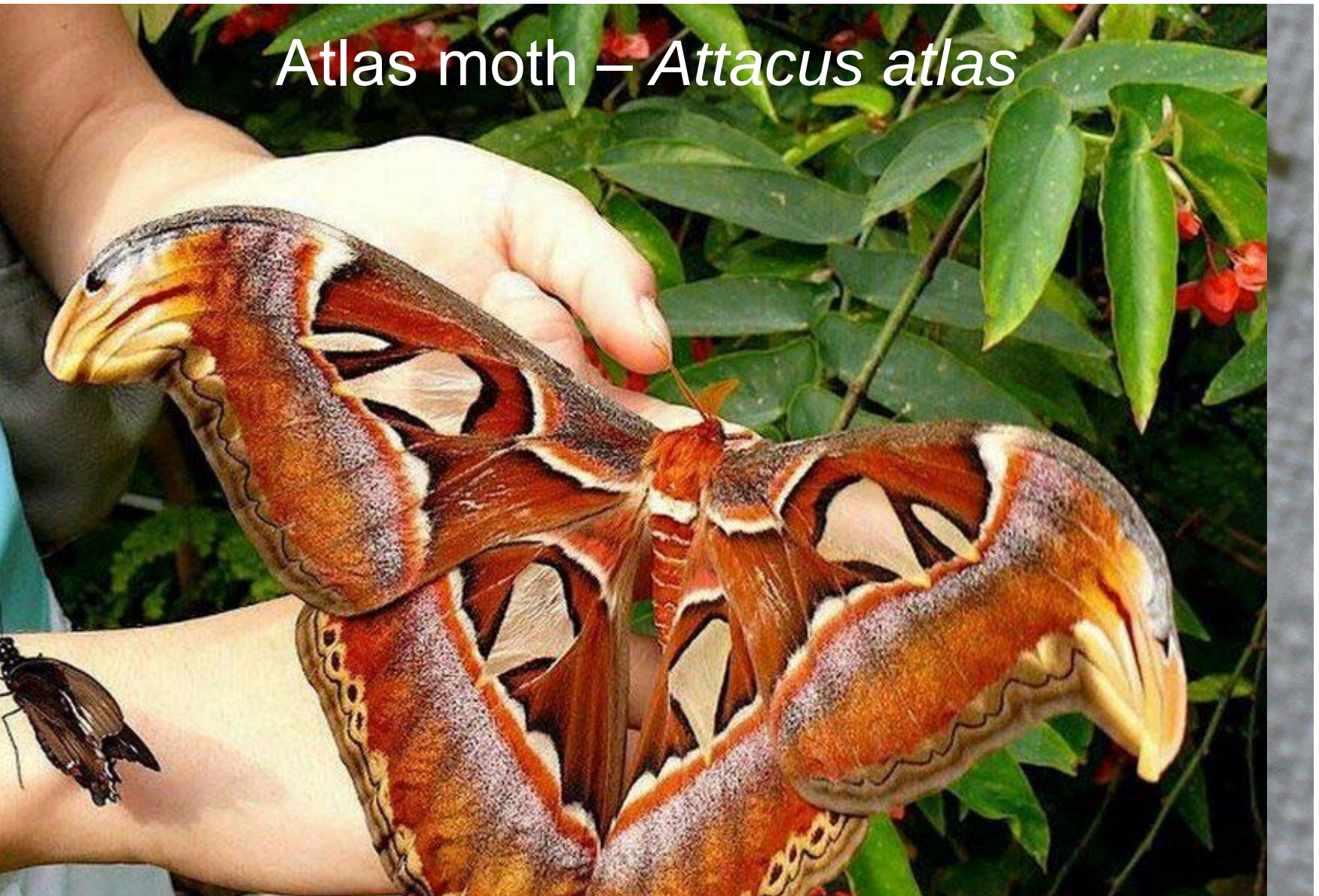
lepido = scale, ptera = wing

- mall to Large
- omplex or Complete Metamorphosis
- Vings almost always covered with scales
- Vings relatively large compared to body
- ront wings larger than hind wings
- outhparts sucking; proboscis almost always orming a coiled tube (in adults)



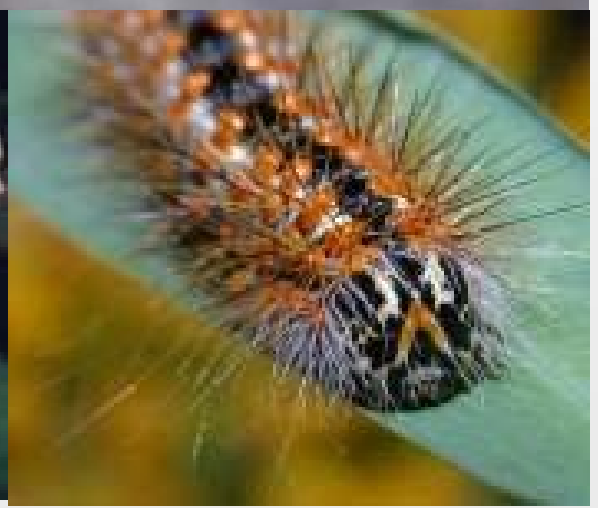
- roduce natural silk
- ajor pollinators

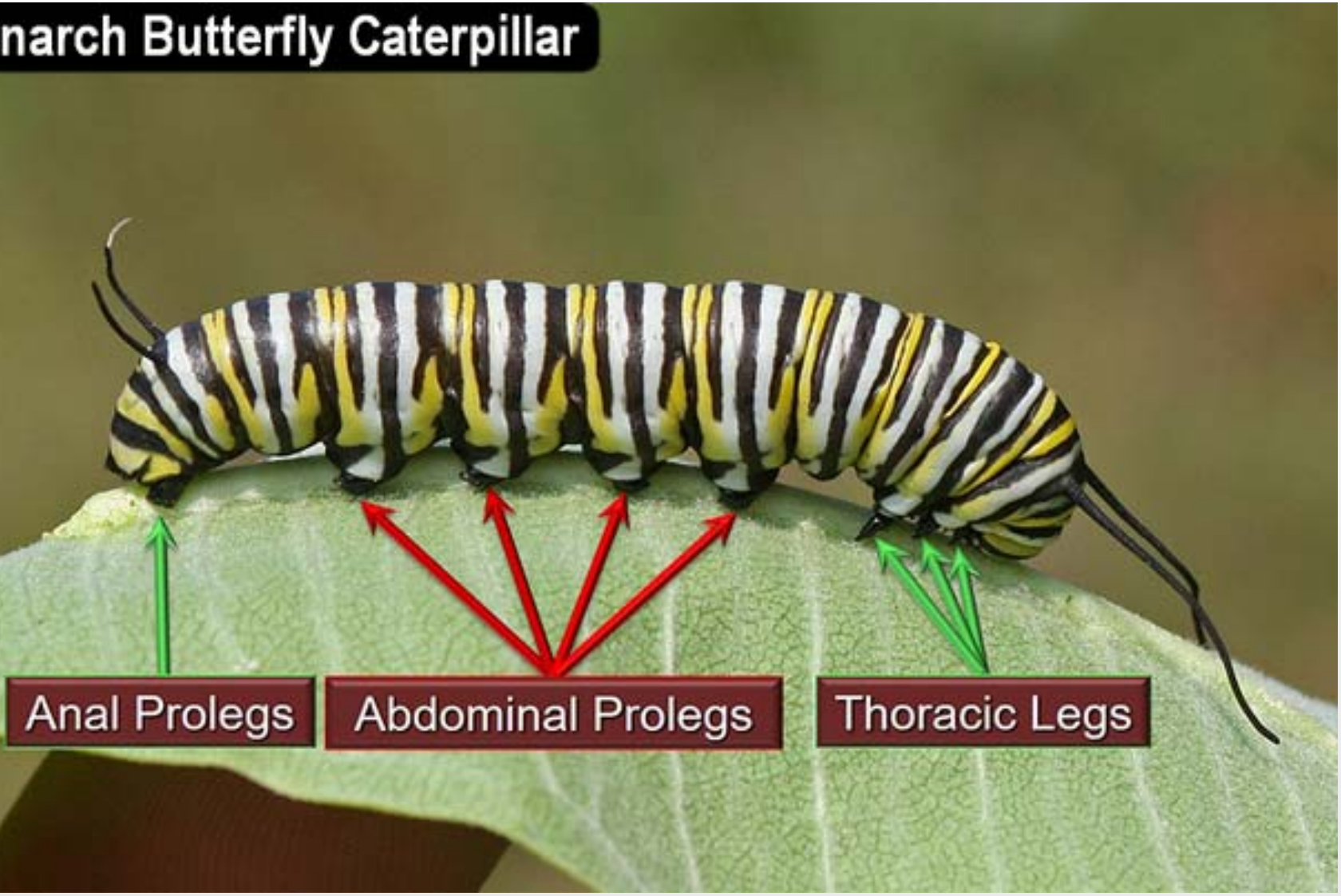
- arvae (Caterpillars) have chewing mouthparts


Atlas moth – *Attacus atlas*

Butterflies – Most Recognized Insect Group


8/31/2003 Bennett Place
Durham County NC
photo Patrick Coin

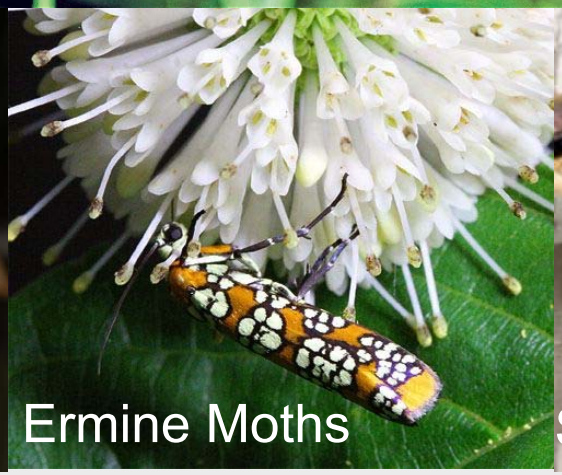




rvae are unique in that they have pseudolegs or prolegs

Moths

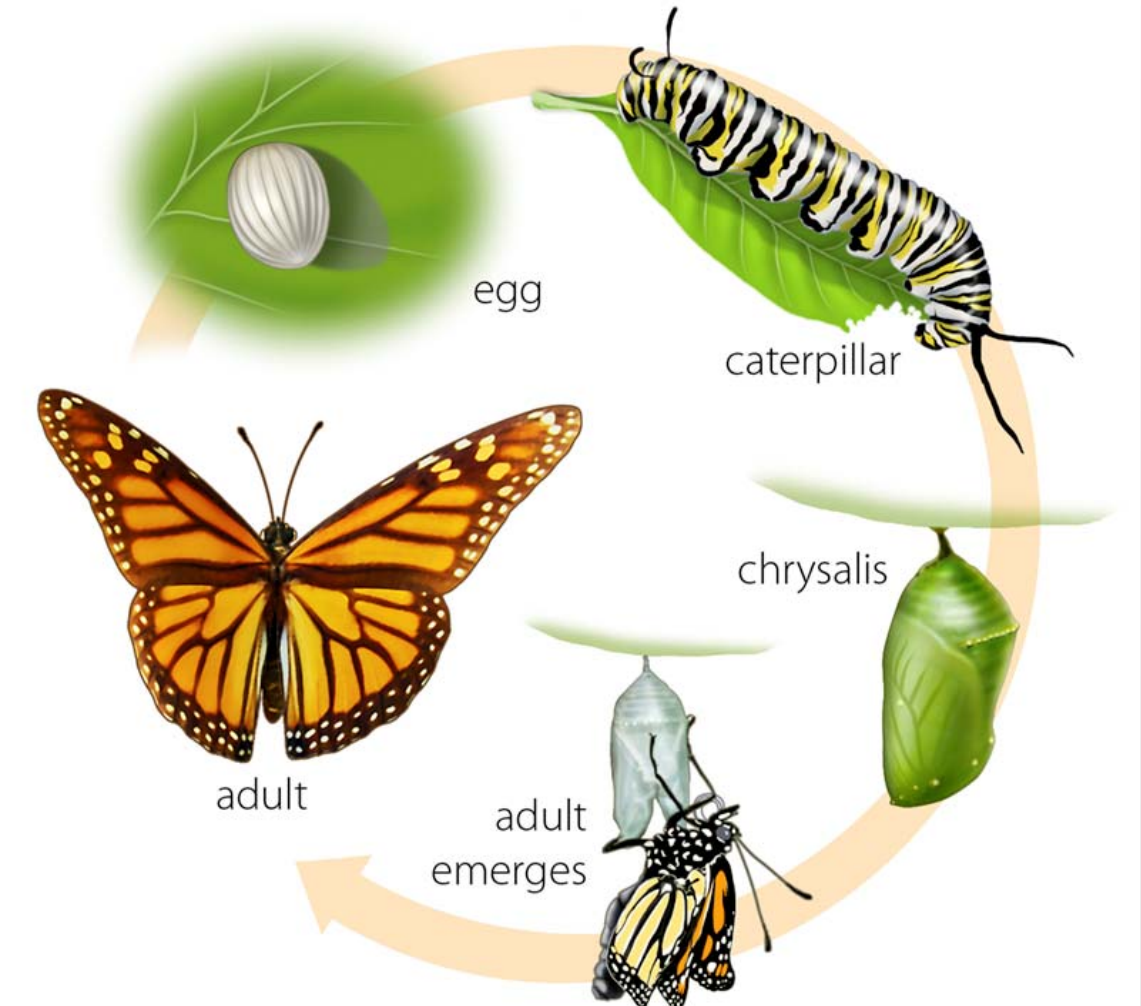
(2-3 mm up to 9.8 inches)



Difference Between Butterflies and Moths

parison chart	Butterfly	Moth
ber	825 species	About 12,000
ity period	Active mostly during the day	Active mostly at night
nnae	Long and thin, swell at end	Short and feathery
ng posture	Usually with wings closed	Wings usually open
g Selection	Use sight to select mates	Use scent to select mates
	Small to Large	Smaller (Micro) / Larger
Temperature Regulation	Uses the sun to warm up.	Moves wings to warm up
	Makes a chrysalis hanging from a branch or other support	Makes a cocoon underground or on the ground
	Usually bright	Usually less bright than butterflies

Butterfly – Life Cycle



Butterfly - Pupa

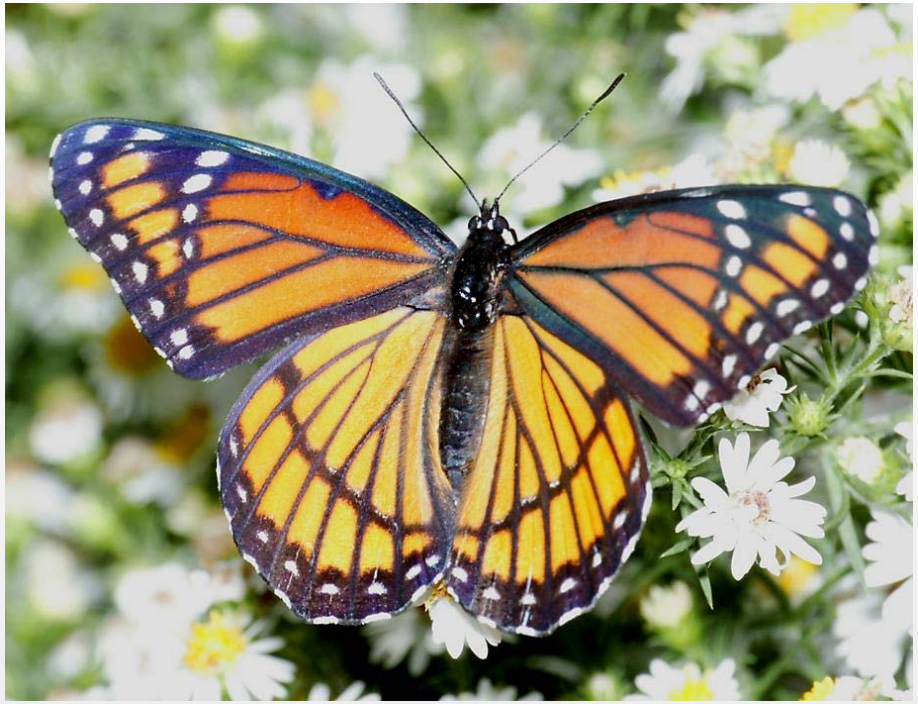
- The larva transforms into a pupa (or chrysalis) by anchoring itself to a substrate and molting for the last time.

Newly Emerged Adult

- A newly emerged butterfly needs to spend some time inflating its wings with blood (hemolymph) and letting them dry, during which time it is extremely vulnerable to predators

Swallowtail

Monarch

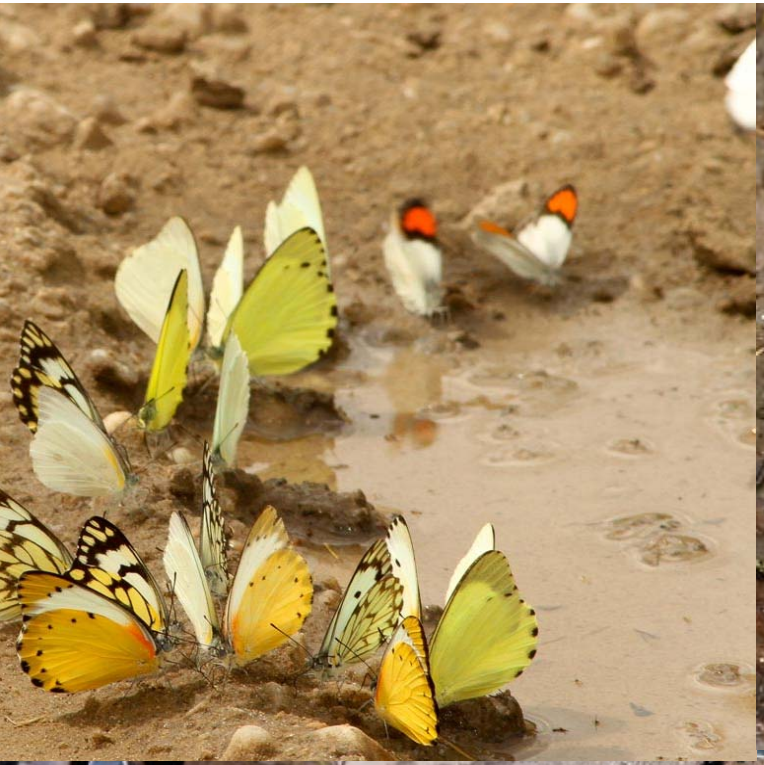


Milkweed Beetle

How to Appreciate/Study Butterflies

How to Appreciate/Study Butterflies

Observe Them on Flowers/Native Plants!



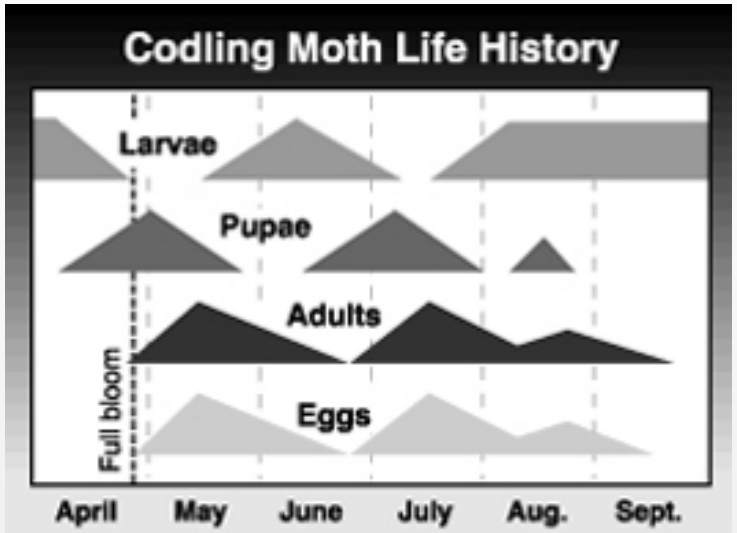
Tomato Hornworm

Egg

Larva

Adult tomato hornworm

Codling Moth



Codling moth usually develops through two generations a year in the Northwest. In warm years, a partial third generation may be produced. Timings are based on observations on Red Delicious apples in Washington.

Order Orthoptera
(Grasshoppers, Crickets and Katydids)
ortho = straight; ptera = wing

lults medium to large sized

mple or Gradual Metamorphosis

hewing mouthparts

stiferous – damage plants

ually 2 pairs of wings

rewings elongate, narrow and hardened

embranous hindwing “fan” shaped

nd legs are enlarged for jumping

Grasshoppers

Crickets

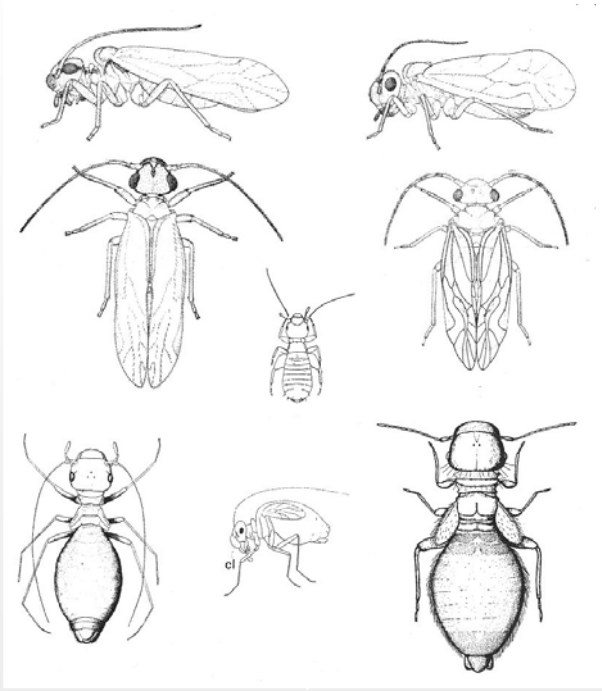
Vs.

- The main difference between a **grasshopper** and a **cricket** is that crickets tend to have long antennae, grasshoppers have short antennae. Crickets stridulate ("sing") by rubbing their wings together, while grasshoppers stridulate by rubbing their long hind legs against their wings

Psocoptera (Book or Bark Lice)

psoco = rub small; ptera = wing

- Very tiny insects
- Chewing mouthparts
- Long Slender antennae
- Winged or wing-less
- Simple or Gradual Metamorphosis
- Feed on dry organic matter, algae, fungi or mold
- Pests in buildings/homes; damage books, feed on flour or sugar



Order Siphonaptera (Fleas)
siphon=tube, a=without, ptera=wing

- Small, laterally compressed insects
- Complex Metamorphosis
- Piercing-sucking mouthparts as adults and chewing mouthparts as larvae, larvae feed on organic debris, especially adult flea feces
- No wings
- Powerful hind legs for jumping
- Ectoparasites; mammals and birds

(Borror

Flea Bites

Order Thysanoptera (Thrips)
thysan = bristle; ptera = wing

iny, slender insects

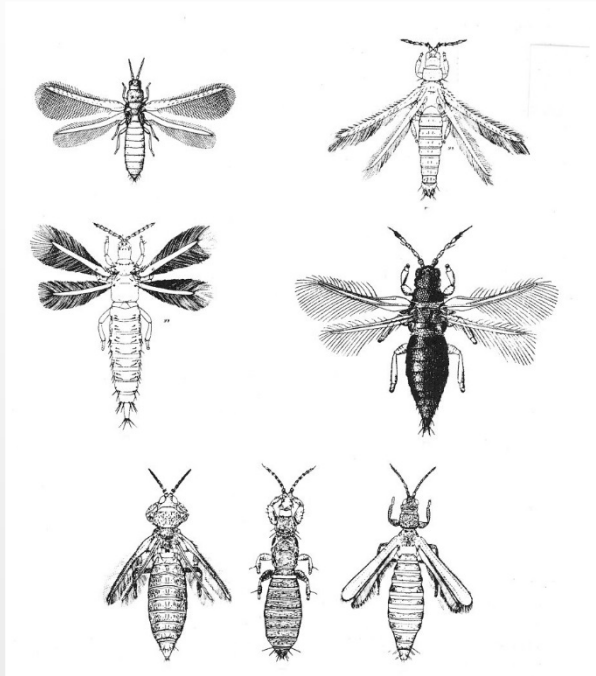
/ings (2) fringed with tiny hairs if resent; few veins or absent

ong narrow cylindrical bodies; bdomen narrowing posteriorly

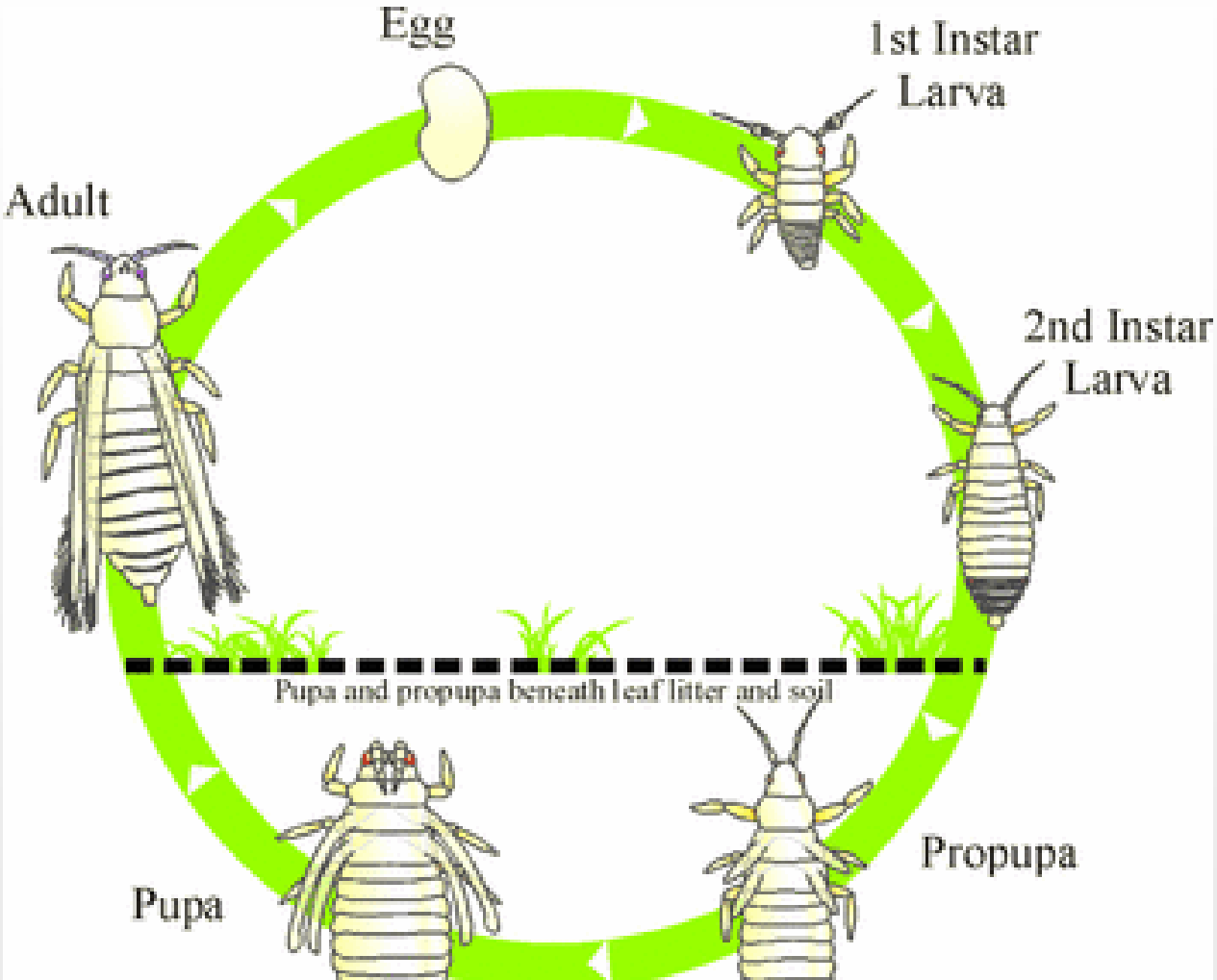
one shaped mouthparts arising osteriorly on head; adapted for craping and sucking

imple/Complex Metamorphosis

lants feeders, some predacious and ome fungal feeders



Thrips Lifecycle



Thrips Damage

Order Thysanura (Silverfish and Firebrats)
thysan = bristle: ura = tail

f-inch long, covered with
e scales (not hunched back
e Jumping Bristletails)

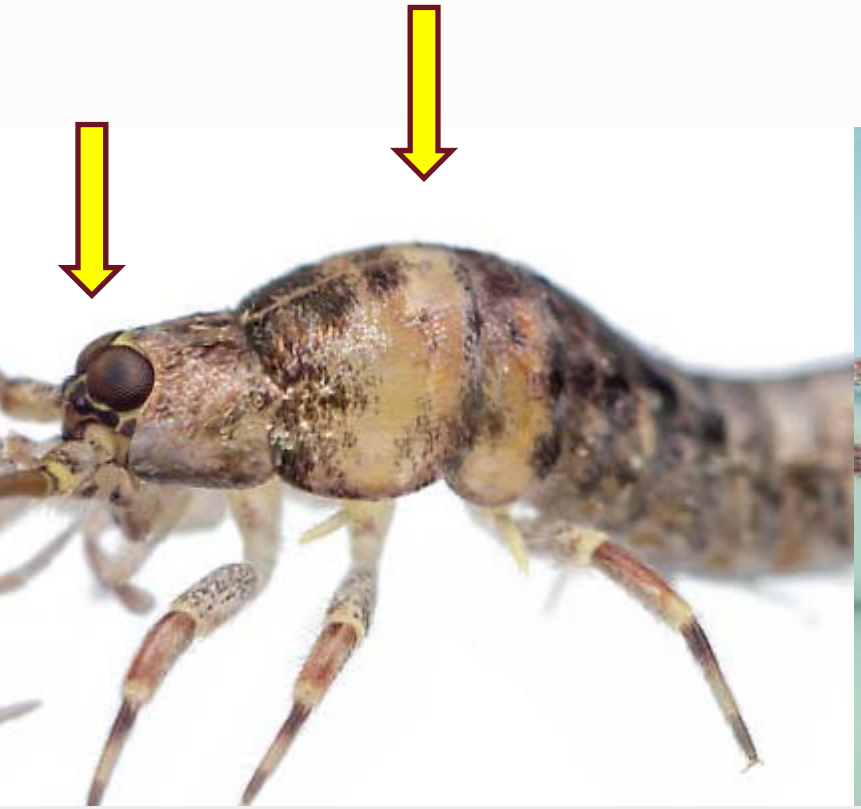
ewing Mouthparts, small
s that are widely separated

ng antenna and 3 **Caudal**
aments (2 cerci + median
dal filament)

mitively wingless and has no-
tamorphosis

d on algae, lichens, moss,
ers feed on paper products

Jumping Bristle tail vs. Silverfish



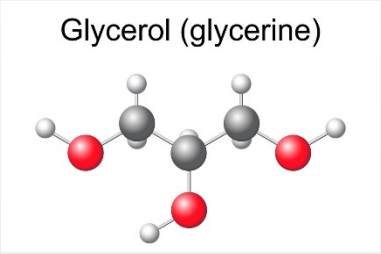
Insect Diversity and Natural History

- The Insect Success Story
- Social Organization/Communication
- Mimicry


SUCCESS

Why are INSECTS so successful?

- Devonian period (about 400 million years)
- Small size and structure
- Small food requirements
- Rapid and prolific reproduction
- Physical ability to respond to change quickly and their adaptability



- Growth my molting
- Life stages feed on different substrate
- Ability to fly
- Sheer numbers

ocial Organization and Communication

You take him, he's been "bugging" me all day…

What is different between nsect societies and swarms of locusts, fish or birds?

is huge’: Locust swarms in Africa are worst in decades

The social insects have royalty!

- Social Hymenoptera (ants, wasps, bees) have a queen
- Social Isoptera (termites) have a king & queen
- The queens (and kings) are typically long lived (15 years in termites, 4 years in honeybees)
- Their sole task is often reproduction (while other individuals are often sterile and don't reproduce)

Western drywood

Honeybee queen

Size of insect societies

- In honeybees, one queen and up to 40,000 workers
- In bumblebees, one queen and 20-500 workers
- In wasps, 1 to 1000s of queens and 1000s to millions of workers
- In ants, 1 to over a million queens; up to many million workers
- One Japanese red wood ant colony contains 307 million ants, including some 306 million workers and about 1.1 million queens.
- *In Hymenoptera, the workers are invariably female; the males are good only for one thing: sex. Termites also have male workers*

olution of eusociality in different taxa

Insect order	common names	frequency of evolution of eusociality
Hymenoptera	Ants, wasps, bees, sawflies	11
Isoptera	Termites	1
Homoptera	Gall-forming aphids	1
Coleoptera	Bark-nesting weavils	1
Thysanoptera	Gall-forming thrips	1
Non-insects	Snapping shrimps and naked mole rats	2

Social Insects

Social insects are often defined by 3 characteristics:

1. reproductive division of labor (some individuals reproduce while other do not)
2. cooperative care of the young
3. overlapping generations (the young do not leave the nest when they mature)

Ants, wasps, bees, and termites make up the major groups of these animals.

Members of the colony

social insect colony is made up of several different classes of individuals

1. Queens: they lay the eggs
2. Workers: they do all the work
3. Larva: the immature young
4. Males: they just hangout until mating time

Queen/worker Dimorphism

bus terrestris

Apis mellifera

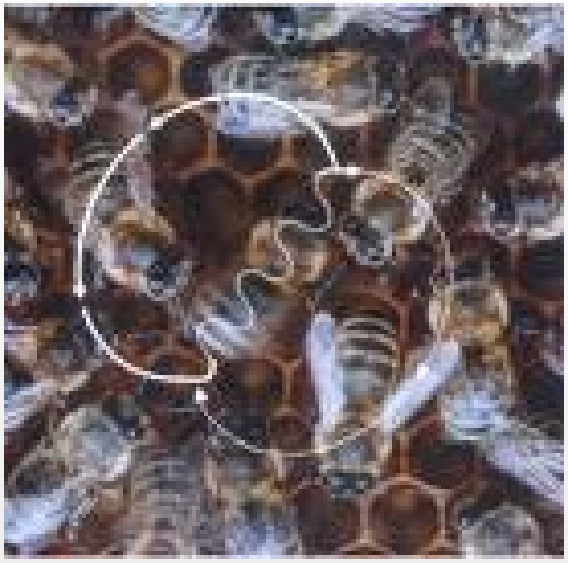
Nannotrigona melanocera

hy are Social Insects so Interesting?

- Ecological dominance
  - Up to 70% of all the animal biomass in some tropical forests like the Amazon are composed of these creatures

    - Think about it. In your everyday life, the animals you most often see are ants, bees, and wasps. They're everywhere!

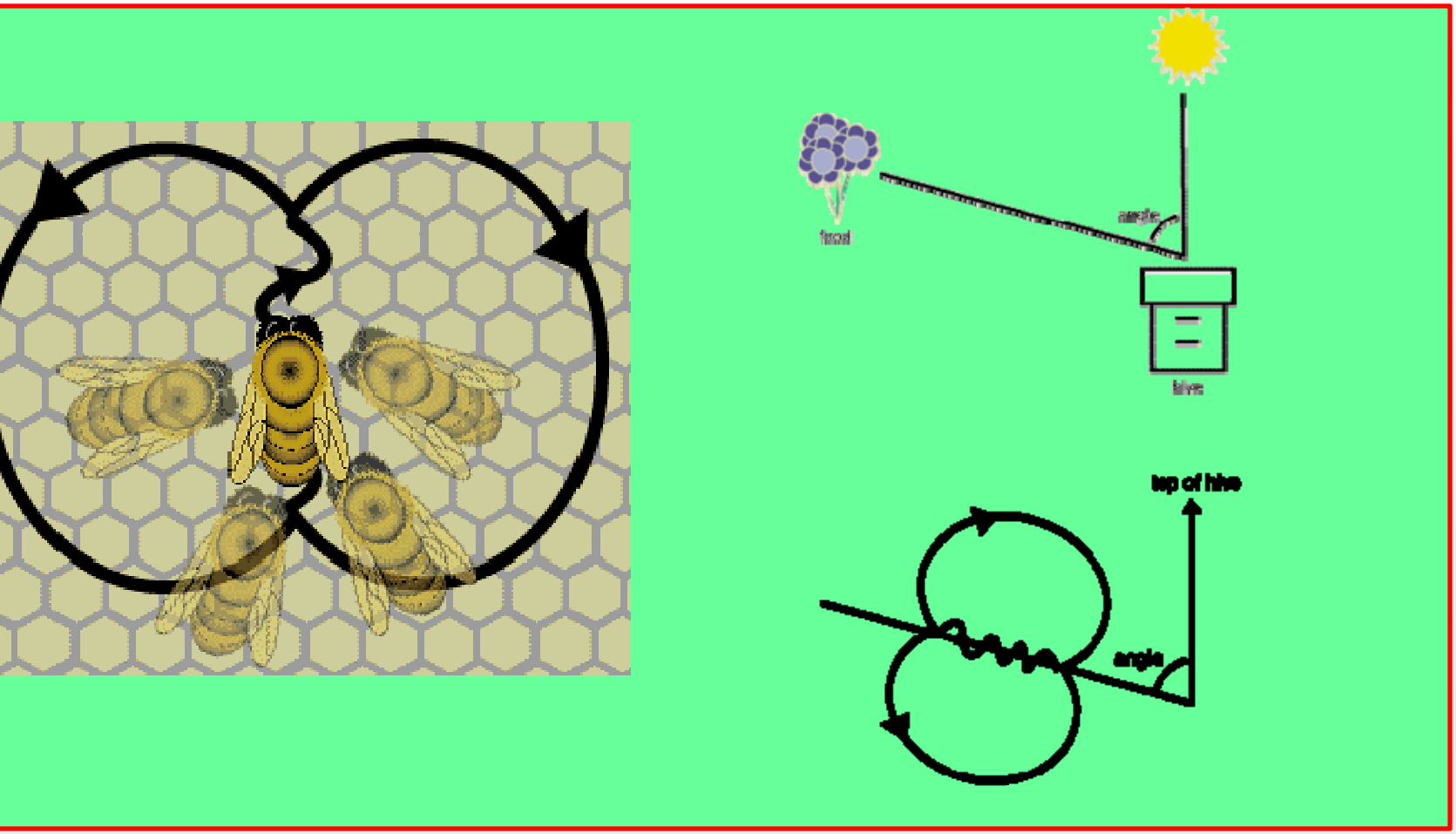
Why so Interesting cont.…



Although workers are tiny, they can make huge structures like the termite mound above. Some workers, like those of the honey bee, can even talk to each other with their own waggle dance language of buzzes and runs (shown on the right).

Honey bee “Waggle Dance”

Honey bee “Waggle Dance”



Insect Behavior and Communication

Insect pheromones are volatile organic molecules of low molecular weight that elicit a behavioral response from individuals of the same species and can be used to communicate between members of the same or the opposite sex

Types of Pheromones

Aggregation – bark beetles

Alarm – bees and wasps

Oviposition or marking – Rose Hip fly

Trail – ants

Sex – several

Pest Management

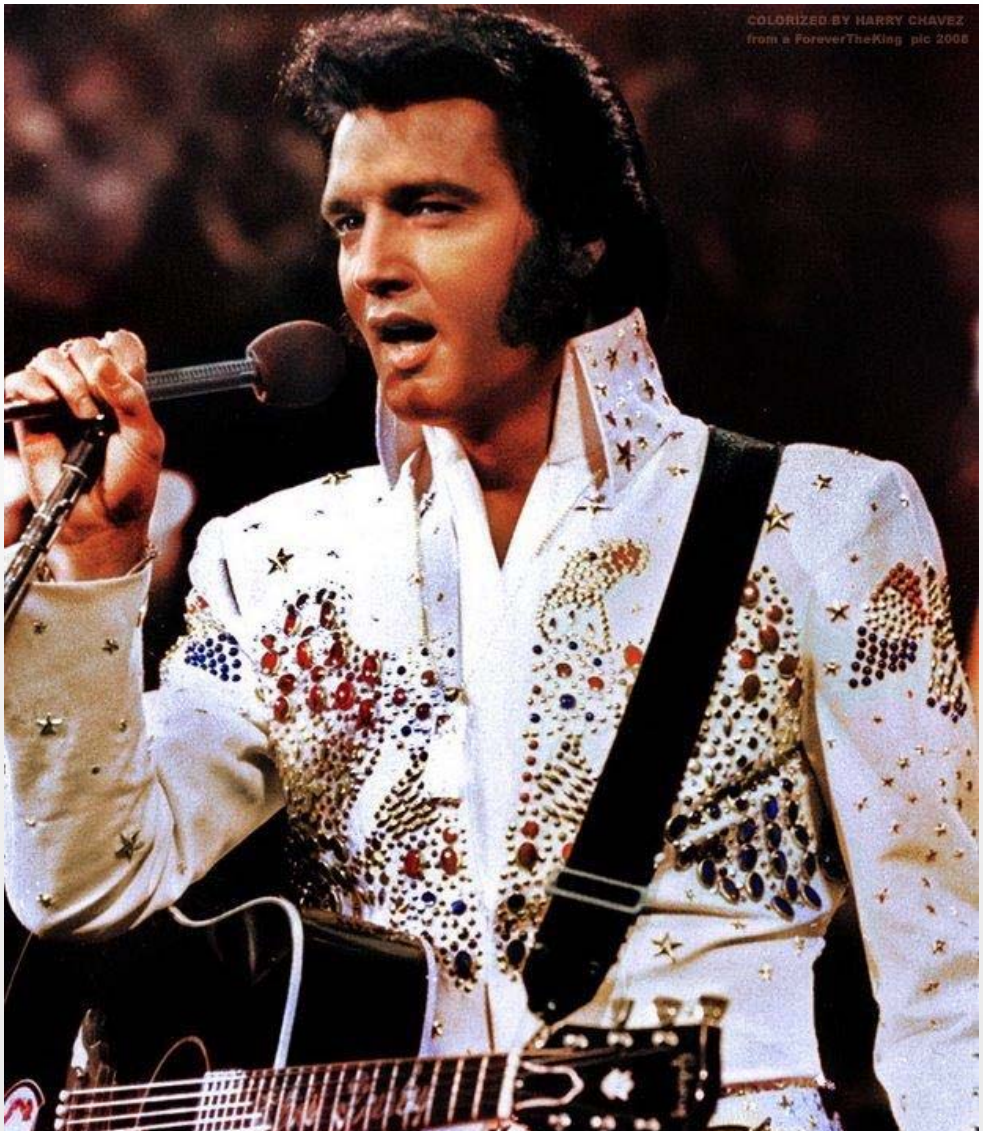
Trail – ants

Sex – several; mating disruption

MIMICRY

‘mimic’

‘model’

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ELVIS

yptic mimicry: - "**crypsis"** is the ability of an organism to avoid
rvation or detection by other organisms. It may be either a predation strategy
n antipredator adaptation, and methods include camouflage, nocturnality,
erranean lifestyle, transparency, and mimicry.

ry/Crypsis by predators to GET a meal:

cry/Crypsis by predators to GET a meal:

ry for predator avoidance:

sian mimicry: a palatable mimic looks like an unpalatable model, and so protection

Monarch Viceroy

ry for predator avoidance:

sian mimicry: a palatable mimic looks like an unpalatable model, and so protection

ee
erent,
alatable
cies

cry for predator avoidance:

esian mimicry: a palatable mimic looks like an unpalatable model, and so gains ction

ee
erent,
alatable
cies

Three female morphs of a single **palatable** species; each mimics an unpalatable species in its range.

sian mimicry: a palatable mimic looks like an unpalatable model, and so protection, i.e. the model is dangerous, but the mimic is not…

Honey bee

sian mimicry:

Hornet moth

esian mimicry

This is a katydid, NOT an ant…

esian mimicry

This is a true bug, NOT an ant…

esian mimicry

Ants are unpalatable to most birds and are avoided, selecting for mimicry in many other insects

Fly

True bug

Beetle

esian mimicry:

sian mimicry

Snake-head caterpillars (different species)

Batesian vs. Mullerian mimicry

- Batesian mimicry: unharmful species mimics a harmful one

- Mullerian mimicry: 2 harmful species mimic eachother

(a) Cuckoo bee

larian mimicry: Ant-mimic spiders

WASHINGTON STATE UNIVERSITY EXTENSION

Plant Health Care & IPM

Dale Whaley

Assistant Professor – Regional Extension Specialist

Plant Health Care (PHC)

- Plant health care:
  - emphasizes plant health over pest management,
  - it takes an ecosystems approach that emphasizes working with nature instead of fighting nature;
  - it sees proper culture as the foundation of a healthy landscape

When we promote total plant health ("preventive medicine"), we avoid many problems. Cultural and environmental problems are minimized, and healthy plants are better able to withstand insect, disease, and weather-related damage.

Plant Health Care (PHC)

Components of Plant Health Care:

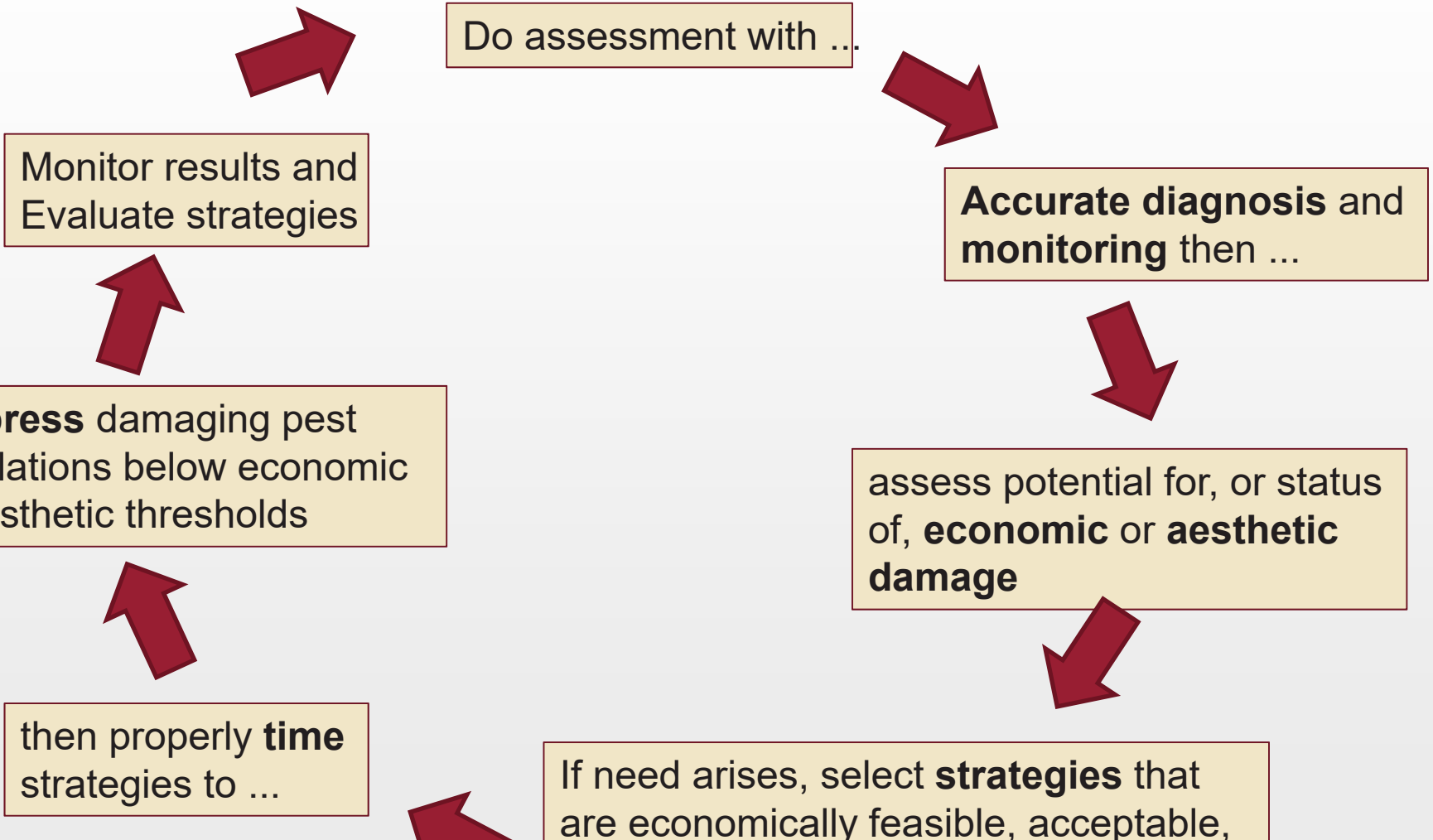
- *Know your plants*
- *Determine key problems: biotic and abiotic*
- *Study the landscape or garden's ecosystem*
- *Optimize overall plant and garden health*
- *Employ integrated pest management techniques*

Integrated Pest Management (IPM)

- Integrated Pest Management (IPM) is an environmentally friendly and common-sense approach to managing insects, diseases, weeds and other pests of landscapes and gardens by using all the various tools available to gardeners, starting with their skills of observation.

ecision-making process that uses regular nonitoring to decide if and/or when treatments re needed to control a pest, then uses a variety f tactics to keep pest numbers low….

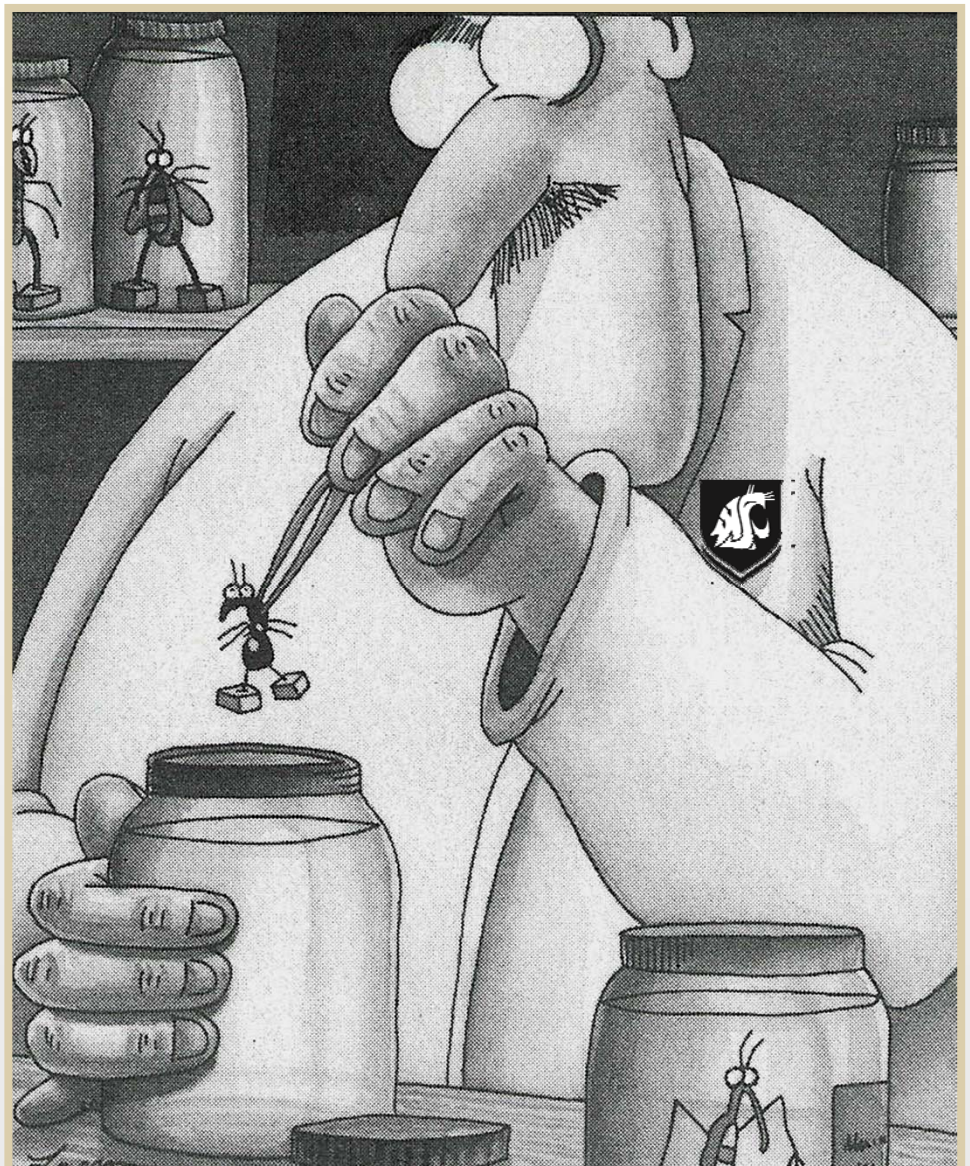
IPM Decision-Making Process



hank You

Nymphalidae: *Caligo eurilochus* (Owl Butterflies)

The End



Helping You Put Knowledge to Work!

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