

# Insects: Biology, Ecology, Identification



4/4/2023

San Diego County Master Gardeners



A top-down view of numerous beetles of various species and colors (black, yellow, orange, green, blue) scattered on a light-colored, textured surface. The beetles are arranged in a way that they appear to be crawling or resting. The background image is used as a backdrop for the text overlays.

# Overview

1. What makes an insect an insect?  
Other important arthropods

2. The role of insects in the ecosystem

3. Learn to identify main orders of insects  
Basic life history and biology

4. Hands-on insect ID and pinning



# My Background

The background of the slide features a close-up photograph of two bird nests made of dry twigs and straw, positioned at the top. Below the nests, three beetles are visible on a light-colored surface. From left to right, there is a large, segmented, brownish beetle, a smaller, dark brown beetle, and a large, dark blue-black beetle with a prominent, curved horn (likely a rhinoceros beetle).

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San Diego, Orange, Los Angeles Counties

Entomologist by training

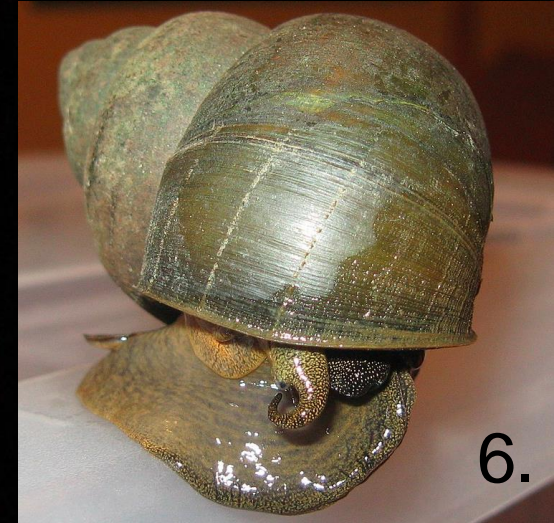
Will also be teaching IPM course shortly



A detailed scientific illustration of various insects, including several species of moths and caterpillars, on a background of foliage and flowers. The illustration is labeled with numbers 1 through 12. A semi-transparent text box is overlaid on the image, containing the text 'makes an insect a'. The moths shown include a large one with brown and green wings (top left), a smaller one with green and yellow wings (top right), a large one with green and brown wings (middle left), a smaller one with green and yellow wings (middle right), a large one with green and brown wings (bottom left), and a large one with green and brown wings (bottom right). The caterpillars include a large one with green and yellow segments (middle left), a smaller one with green and yellow segments (middle right), a large one with green and brown segments (bottom left), and a large one with green and brown segments (bottom right). The background features various plants, including a large white flower (center), a pink flower (bottom left), and a green plant (bottom center).



# Which of these is an insect? Round 1





# Which of these is an insect? Round 2

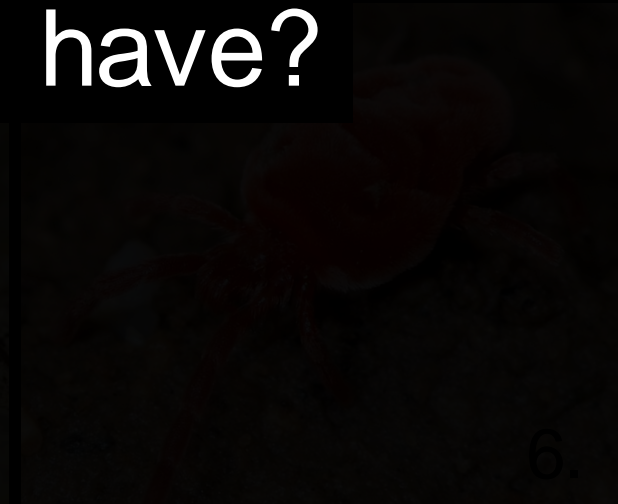
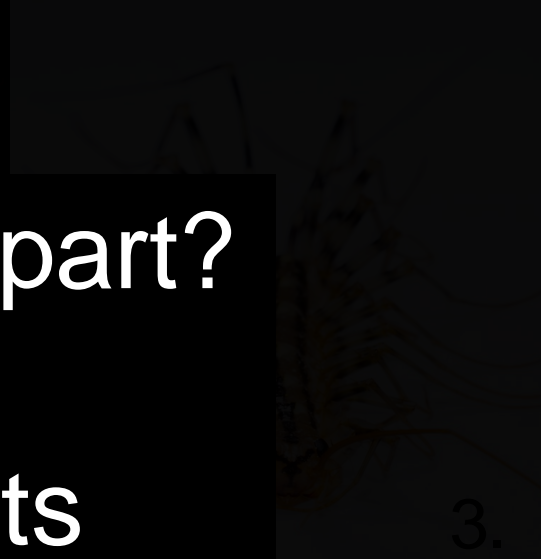
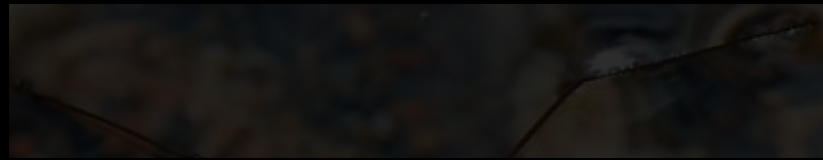
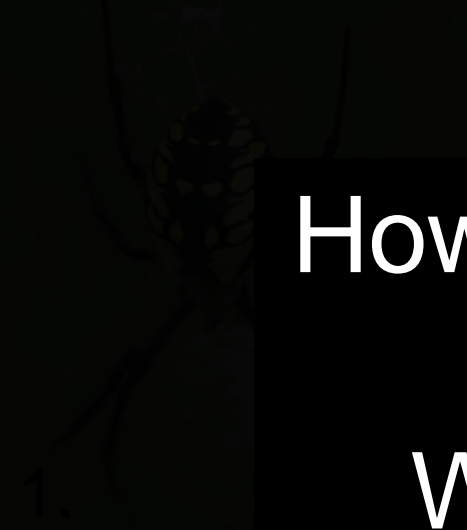




Which of these is an insect? Round 2

How do we tell them apart?

What traits do insects  
and other arthropods have?







# A Good Approach to Arthropods/Insects

The amount of diversity is huge: “rules” get broken frequently

The “rules” often aren’t rules...

...Just rules of thumb

And even that is a rule of thumb  
because there are some actual rules  
that are not broken



# Arthropod Traits

Mites, spiders, millipedes, crustaceans, and insects share these

Exoskeleton

Chitinous structure on outside of body

Molt to grow

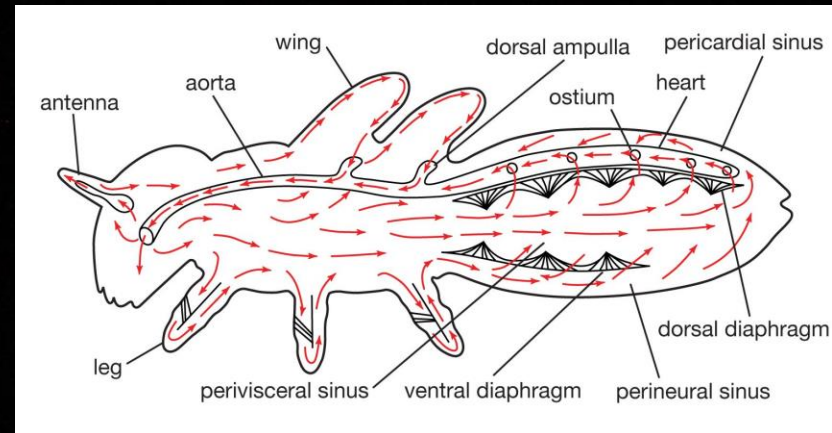
Segmented bodies: varies by group

Open circulatory system

Blood not constrained

Ectotherms (Cold blooded)

Extremely abundant and important across all ecosystems





# Important Non-Insects

## Crustaceans

Isopods



## Arachnids

Spiders

Scorpions

Mites

Ticks

Opiliones (Harvestmen)



## Myriapods

Centipedes

Millipedes





# Isopods

Terrestrial crustacean

Deep sea varieties also exist

Have gills

Require moisture to breathe/live

Mostly detritivores

Commonly found in gardens

Occasional pests

Feed on young plants, seedlings





# Arachnids: Spiders and Scorpions

Arachnids: 4 pairs of legs

Also have pedipalps

Can act/look like legs

Scorpion pincers=pedipalps

Cephalothorax

Abdomen



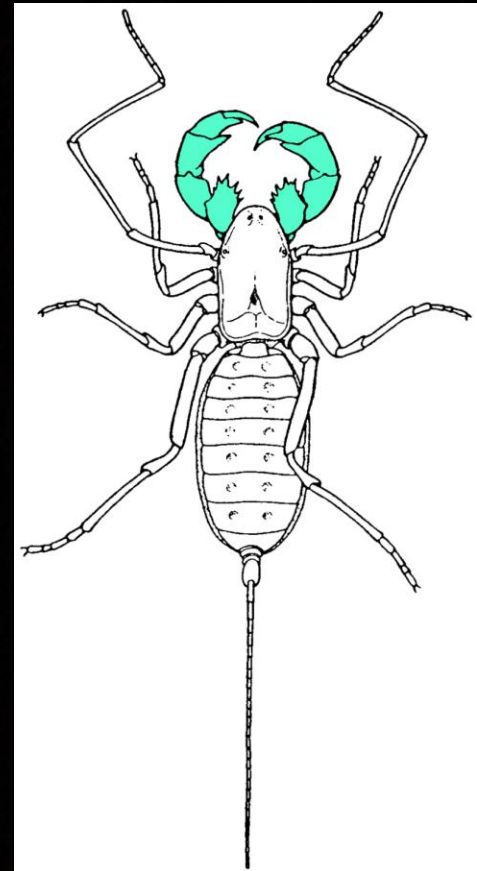
~45,000 spider species. Araneae

~2,000 scorpion species. Scorpiones

Functionally all are predators

Very few pose any threat to people

Those that do rarely harm humans





# Arachnids: Mites and Ticks

## Mites: Order Acari

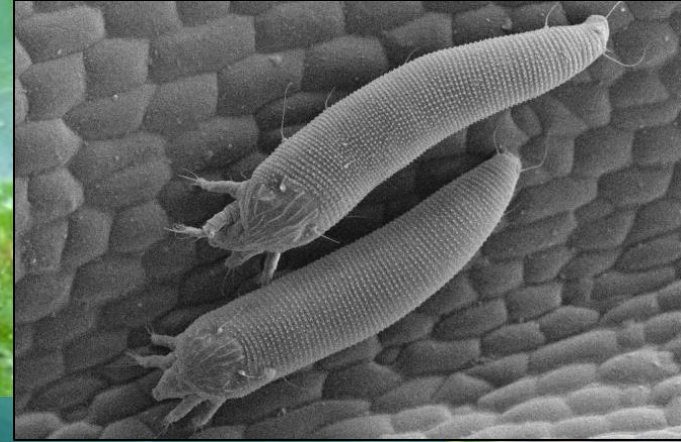
Mites are hugely diverse  
More so than currently known  
~50,000 species

Fill all kinds of niches

Herbivores, predators, detritivores, parasites

Many are important pests

Spider mites and eriophyoid mites



## Ticks: Order Ixodida

We are all aware of ticks

~850 species

Can spread disease



# Arachnids: Opiliones

Order Opiliones. ~6,500 species

Common Names  
Harvestmen  
Harvest Spiders  
Daddy longlegs



Not spiders

Cephalothorax and abdomen usually fused

Abdomen is segmented

Useful predators

Highly venomous, but can't bite?

Myth: Opiliones aren't venomous at all





# Myriapods: Millipedes, Centipedes

“Many legs”

Diplopoda: Millipedes

Often hundreds of legs  
2 pairs of legs per body segment  
Detritivores, can release poison



Chilopoda: Centipedes

Fewer legs, but still 10's of pairs  
1 pair of legs per body segment  
Venomous: front legs = stingers  
Predatory



# Questions About Other Arthropods?

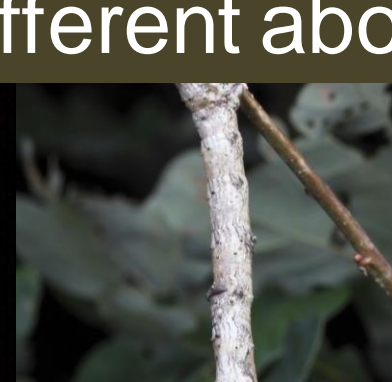




# Moving on to Insects!



What is different about insects?



What makes them unique from other arthropods?





# Insects Are Everywhere

Biologist JBS Haldane on what his studies revealed about the nature of God

Haldane: The creator has “An inordinate fondness for beetles”

Insects found in all environments

Except...

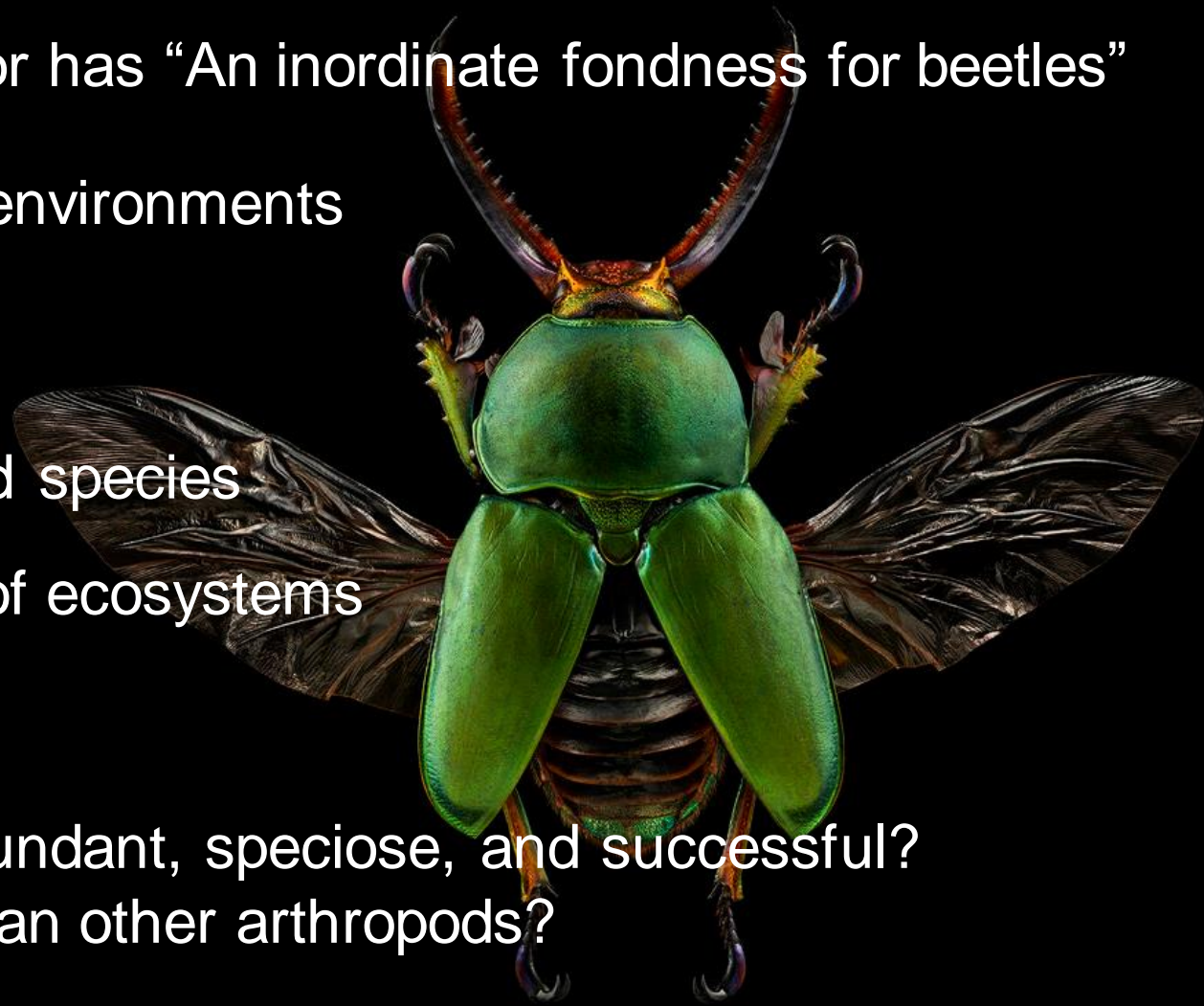
The open ocean

Majority of described species

Integral to all parts of ecosystems

Are super cool

Why are they so abundant, speciose, and successful?  
Even more so than other arthropods?





# What traits do insects have?



1. Segmented body: Head, thorax, abdomen
2. Six legs
3. Wings and 1 pair of antennae
4. Metamorphosis (Usually)

# Segmented Body

Head

Feeding and sensing

Thorax

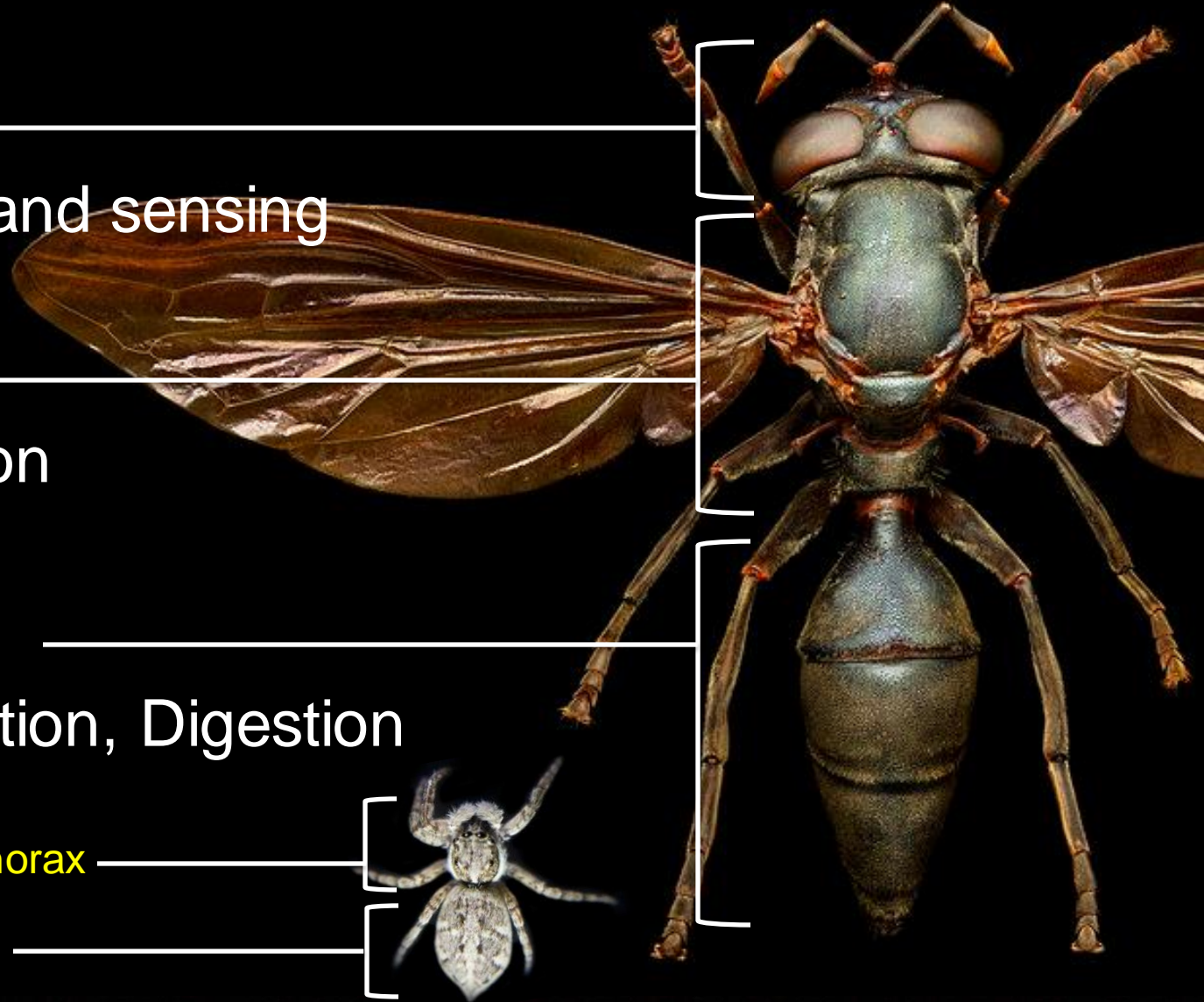
Locomotion

Abdomen

Reproduction, Digestion

Cephalothorax

Abdomen





# Six Legs

Insects all have 6 legs

Although sometimes reduced

Subphylum Hexapoda: Greek for “Six legs”



Compare to other arthropods

Myriapods: 5-375 pairs of legs

Crustaceans: ~5 pairs of legs

Arachnids: 4 pairs of legs



# Wings and Antennae

All insects have 4 wings...

...with 2 exceptions...

...or if secondarily lost/modified

This happens a lot, on large and small scales

If it has wings and is an invertebrate, it is an insect

1 pair of antennae (2 antennae total)





# Metamorphosis

Complete and Incomplete metamorphosis

Hemimetabolous: Incomplete

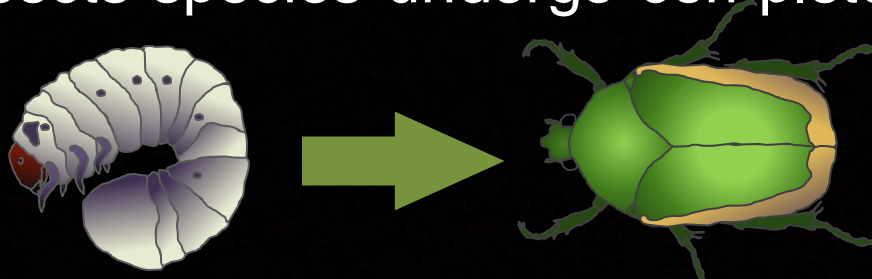
Holometabolous: Complete



Involves changing body, almost always adds wings

Can be relatively minor, or completely transformative

Majority of insects species undergo complete metamorphosis



# Why Are Insects So Successful?

Not fully understood, but much is explained by their unique traits

## Versatility

### Exoskeleton and Size

Body durable, small size allows access, large populations

### Wings

Extreme versatility, mobility



### Metamorphosis

Ability to exploit different niches during different life stages





# Segmented Body

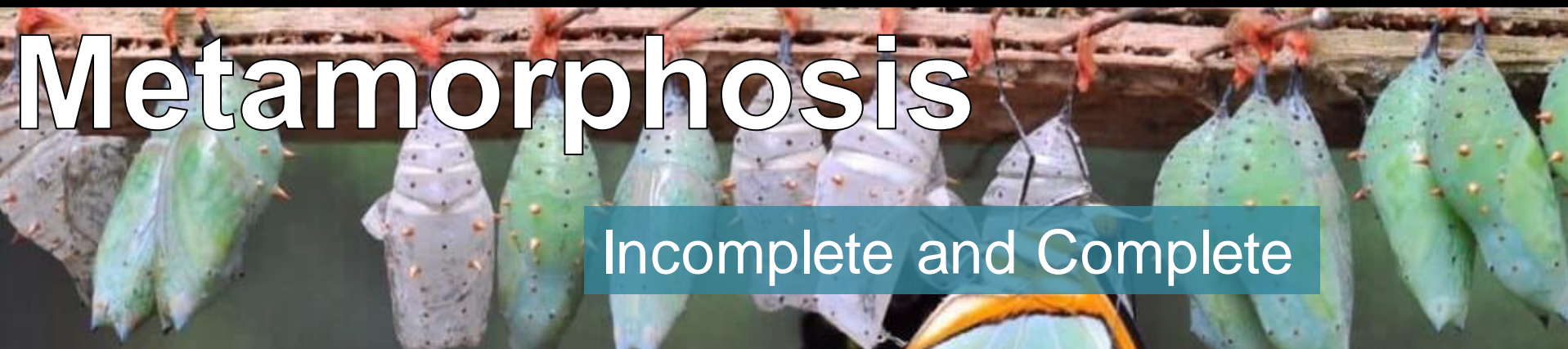
Head  
Thorax  
Abdomen



# Six Legs

# Wings and Antennae

2 antennae, almost all have wings



# Metamorphosis

Incomplete and Complete



# Which of these is an insect? Round 3





# Questions about insect traits?



# The Roles of Insects

Natural Enemies

Predators

Parasitoids

Parasites

Herbivores

Pollinators

Detritivores

Pests





# Natural Enemies: Predators

Many different species are predatory

Kill and eat others for food

Must kill many individuals over lifetime



## Generalists

Consume wide range of prey

Can be omnivorous

Ex: Lacewings, mantids, most ladybeetles



## Specialists

Consume narrow range of prey

Sometimes only eat 1 species

Ex: Two spotted stink bug



# Natural Enemies: Parasitoids

Parasitoid: Lives in close association with host, eventually kills it

Need host for lifecycle, must kill host

Usually consumes host from inside out

Majority are wasps (Hymenoptera)

Also occurs in beetles, flies

Tend to be highly specialized

Very important for pest control

More impactful than predators





# Parasites

Parasite: Lives on or in another organism, causing it harm, and is structurally adapted to this life

“Predators that eat prey in units of less than one”  
—E.O. Wilson

Do not kill host (usually)

Common in insects, extremely common within all life



Strepsiptera (Male)



# Parasites



Huge diversity: most organisms have a parasite





# Herbivores

Massive niche that insects fill

Feed on all different parts of all plants

Consume leaves, sap, wood, roots, pollen

Leaves: Caterpillars, beetles, ants

Sap: Aphids, mealybugs, cicadas

Wood: Termites, bark beetles, borers

Roots: Grubs, mealybugs, maggots

Pollen: Bees, ladybeetles, flies

Not just detrimental

Tamarisk leaf beetle



# Pollinators

Vital for much of plant reproduction

Bees are best known

~20,000 species worldwide

Other taxa also pollinate

Wasps, ants, beetles, flies, lepidoptera

Non insects: bats, birds



Generalists

Visit and utilize wide range of flowers

Honeybees classic example of generalist

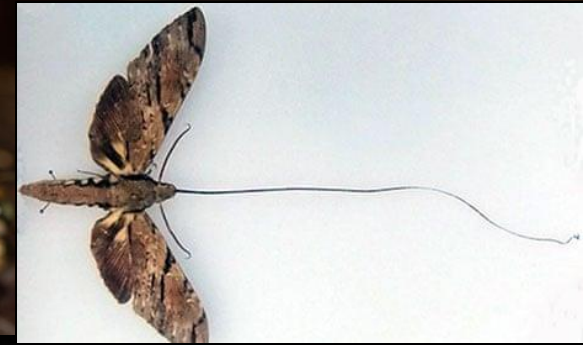


Specialists

Visit and utilize select species

Squash bees, Darwin's moth

Represent majority of insect pollinators





# Detritivores

Often unnoticed, completely necessary  
Break down dead and decaying matter

Ecosystems cannot function without them

Dung beetles

Burying beetles

Fly larvae of many different kinds

Collembola

Forensic entomology...





# Pests

Hugely broad category

A “pest” is anything doing something you don’t like

Pests can...

- Damage crops

- Damage structures

- Feed on stored products

- Harm people

- Be annoying



In the right circumstance, any insect can be a pest

Good way to manage pests: stop considering them pests

We’ll discuss more in IPM section



# Questions on the role of insects?

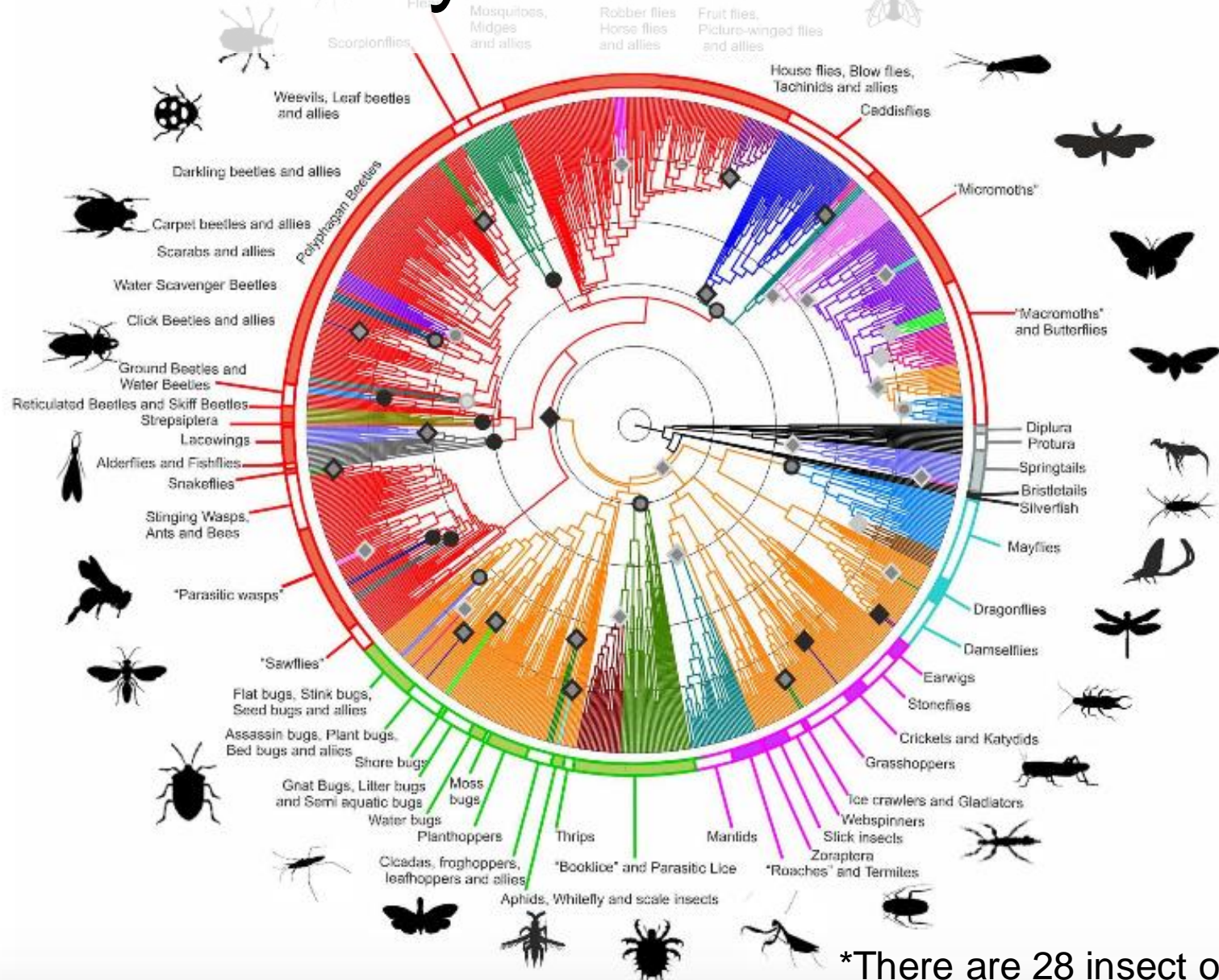


Break!

Learning Main Insect Orders Next



# 2. Primary Orders of Insects\*



\*There are 28 insect orders total



Orthoptera: Grasshoppers/crickets



Hymenoptera: Bees/wasps



Hemiptera: Bugs

## Main Orders



Diptera: Flies



Coleoptera: Beetles



Lepidoptera: Butterflies/moths



## Other Orders



Odonata:  
Dragonflies/Damselflies



Neuroptera:  
Lacewings and others

# Traits to Look For

**Mouthparts:** Piercing/sucking, chewing, sponging, proboscis

**Wings:** Number, modifications, transparency

**Hard vs. Soft bodied**

**Metamorphosis:** Incomplete (Hemimetabolous) vs. Complete (Holometabolous)

**Overall Appearance** (Gestalt)





# Orthoptera: Grasshoppers/Crickets

~20,000 Species

Mostly herbivores, can be agricultural pests

Name Means “Straight Wing”



Mostly hard bodied

4 wings, held back over body

Chewing mouthparts

Incomplete Metamorphosis

Enlarged hind femur (for jumping).



# Common Orthoptera

European House Cricket



Gray Bird Grasshopper



Chaparral Katydid



Jerusalem Cricket





# Hemiptera: Bugs

50,000- 80,000 Species

Mostly herbivores, some predators

Name means “Half Wing”



Usually soft bodied  
(occasionally hard)

Incomplete  
metamorphosis

Piercing/Sucking  
Mouthparts

4 Wings:  
Half hardened,  
Half membrane



# Hemiptera: More than bugs...



Cicada

Wax scale



Aphid

Mealybug





# Common Hemiptera



Citrus Mealybug



Green Peach Aphid



Bugrada Bug



California Red Scale



Glassy Winged Sharpshooter



Box Elder Bug



Whitefly

# Coleoptera: Beetles

~400,000 Species

Predators, herbivores, detritivores

Name means “Sheath Wing”

2 Wings: Hind wings  
Membranous

Forewings hardened  
into sheath (elytra)

Hard Bodied

Complete Metamorphosis

Comprise ~25% of all animal species



Chewing  
Mouthparts





# Coleoptera: Immatures

Lots of variability

Chewing mouthparts

Predatory larvae

Resemble small alligators

Ex: ladybeetles



Grubs

Whitish, dark head capsule, soft

Detritivores, pests



Armored worms

Hardened body, clear head and legs

Mealworms, wireworms

Detritivores, soil pests, some predators





# Common Coleoptera



Convergent Ladybeetle



Green Fruit Beetle



Predaceous Ground Beetle

UC Statewide IPM Project  
© 2000 Regents, University of California



Egyptian Alfalfa Weevil



# Hymenoptera: Bees/Wasps\*

~150,000 Species

Bees: Herbivores/pollinators

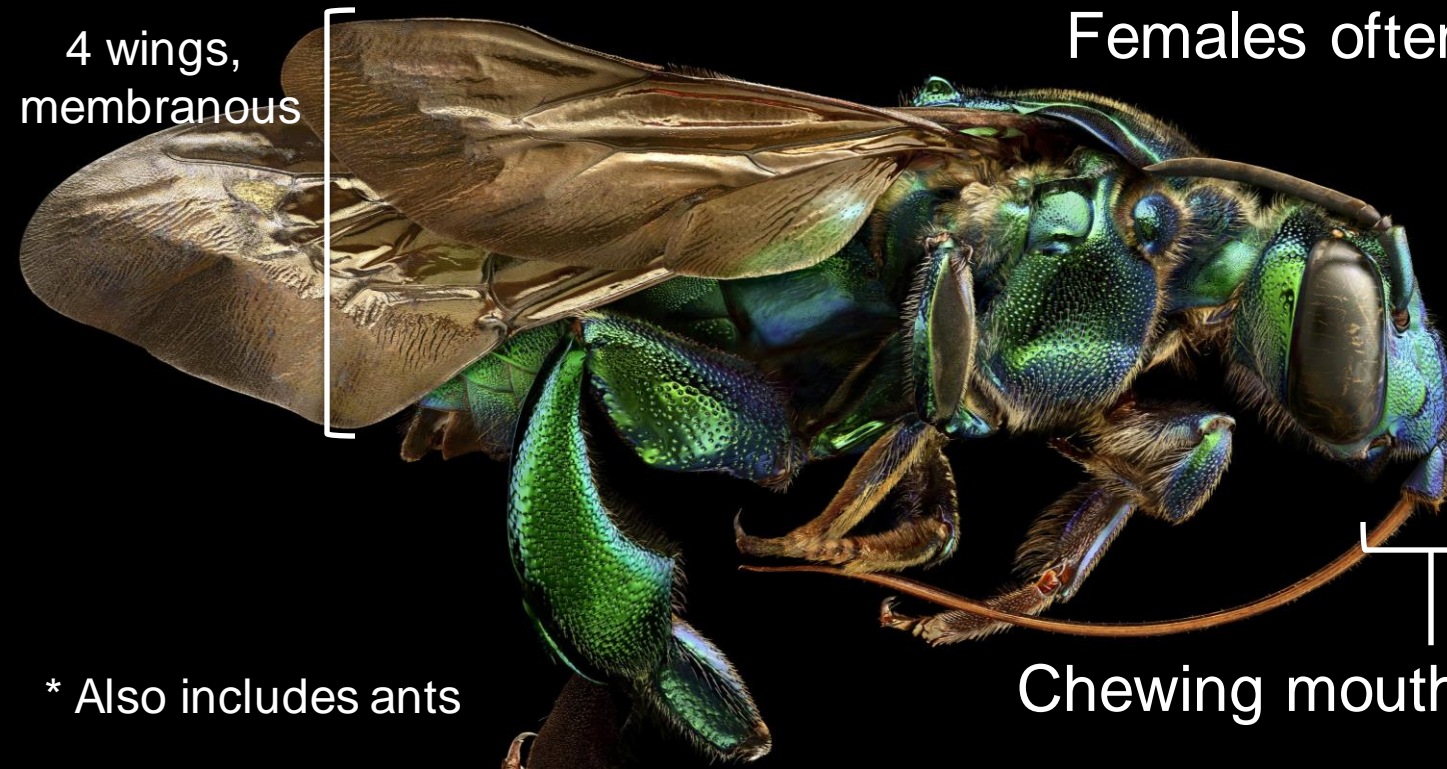
Wasps: Predators

Hard Bodied

Complete Metamorphosis

Name means “Membrane Wing” Many social species

Females often have stingers



\* Also includes ants

Chewing mouthparts



# Hymenoptera: Immatures

Small grubs, usually lack legs

Usually have visible head, but not distinctive (like beetles)

Can also look like clear pill capsules

Mouthparts often chewing

Rarely seen

If seen, often alongside adults

Hidden in burrows, wood, colonies

Sometimes inside other insects

Parasitoid larvae important natural enemies





# Common Hymenoptera



Honeybee



Yellowjacket



Valley Carpenter Bee



Argentine Ant



Tamarixia radiata



Green Sweat Bee

# Diptera: Flies

~125,000 Species

Many detritivores

Name means “Two Wings”

Hind wings reduced to stabilizers (halteres)

Forewings membranous

Soft bodied

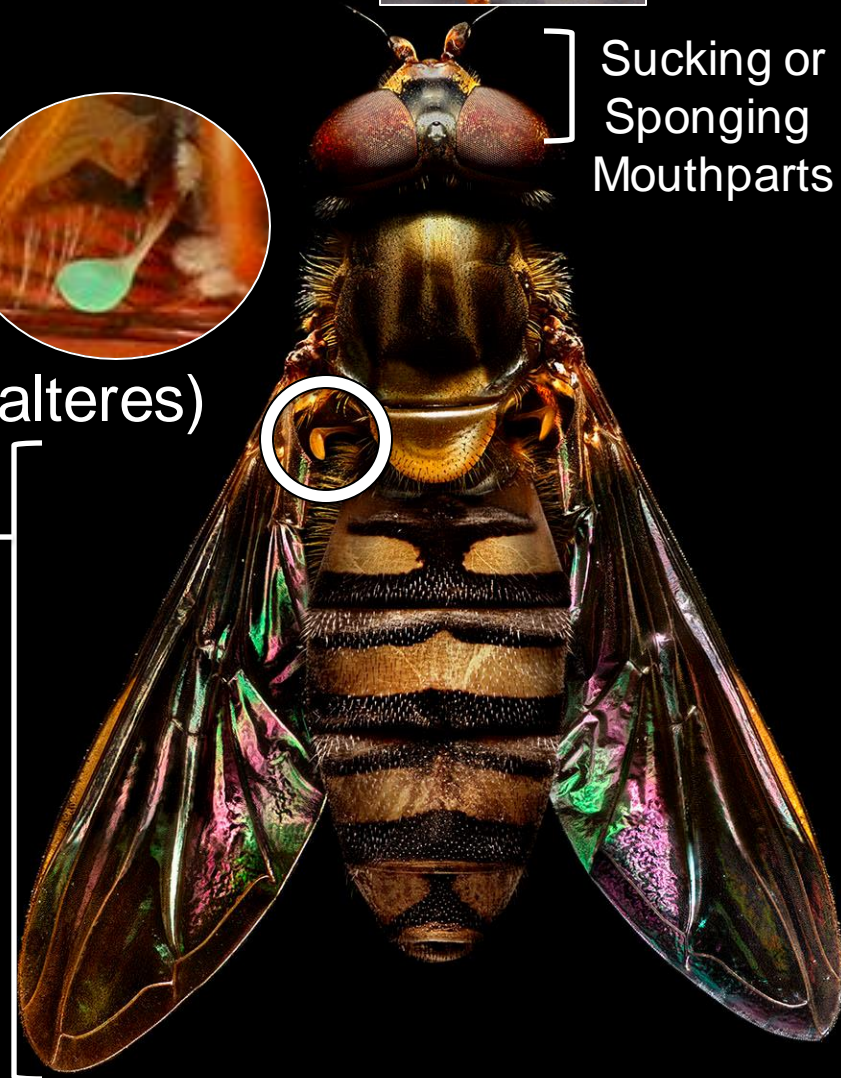
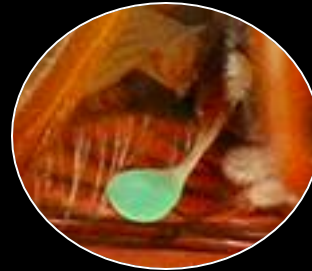
Complete metamorphosis

Antennae often short,

Body with bristles



Sucking or  
Sponging  
Mouthparts





# Diptera: Immatures

Maggots

No legs, no real “head”

Often piercing/sucking mouth

Some chewing

Narrow towards one end

Where mouth is

Important detritivores

Some are predators

Some are pests





# Common Diptera

Hoverfly



(Oblique Streaktail)



House Fly

Mosquitoes



Robber Fly





# Lepidoptera: Butterflies/Moths

~180,000 Species

Name means “Scale Wing”

Herbivores/pollinators

4 wings,  
covered with scales

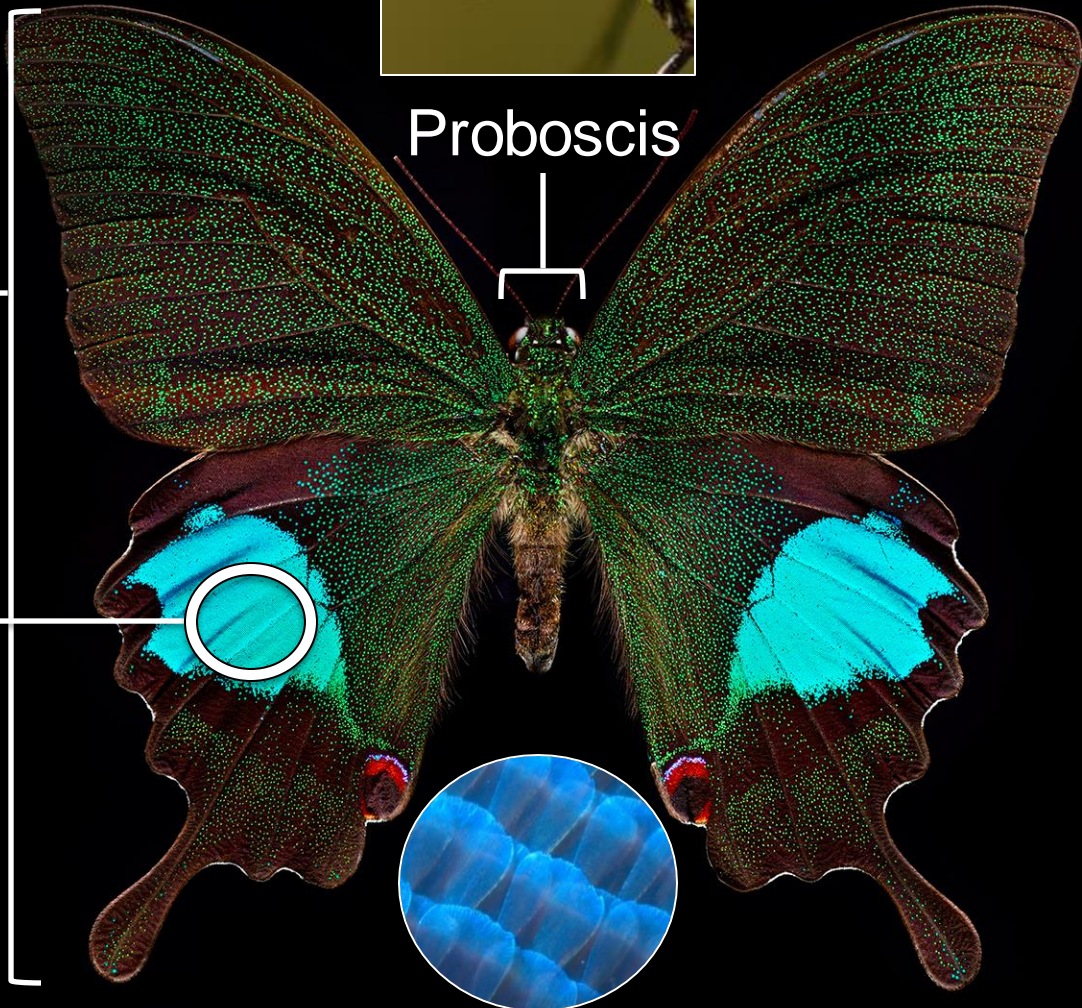
Soft Bodied

Complete Metamorphosis

Many pests as caterpillars



Proboscis



# Lepidoptera: Immatures

Caterpillars

Chewing mouthparts

Different than adults

Have prolegs

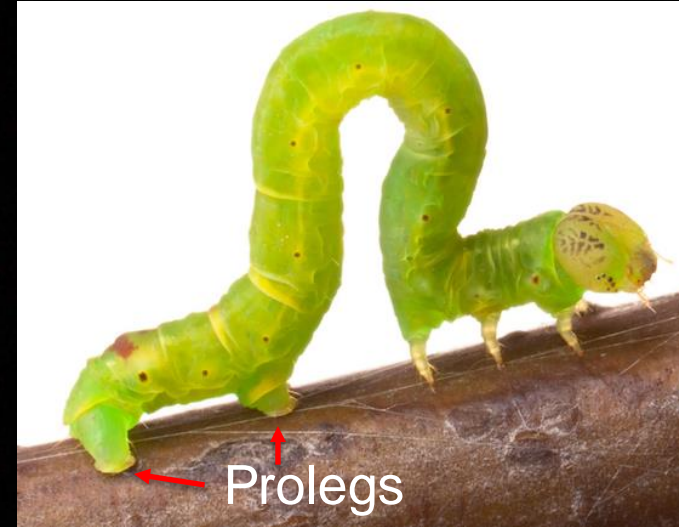
Soft grasping legs lower on body

Not hardened like true legs

Distinctive hardened head

Frequently colorful

Often pests: very different than adults





# Common Lepidoptera

Gulf Fritillary



Cabbage White



Beet Armyworm



Monarch



# Neuroptera: Lacewings and others

~6,000 Species

Name means “Nerve Wing”

Important predators as larvae



4 wings,  
Obvious veins

Chewing  
Mouthparts

Long, thin antennae  
common

Wings tented over body

Complete Metamorphosis

Soft Bodied



# Neuroptera: Immatures

Important Predators

Resemble small alligators

Large, sucking  
pincers

Soft Bodied



Dustywings lack obvious pincers



# Common Neuroptera

Green Lacewing



Dustywings



Antlion



Brown Lacewing





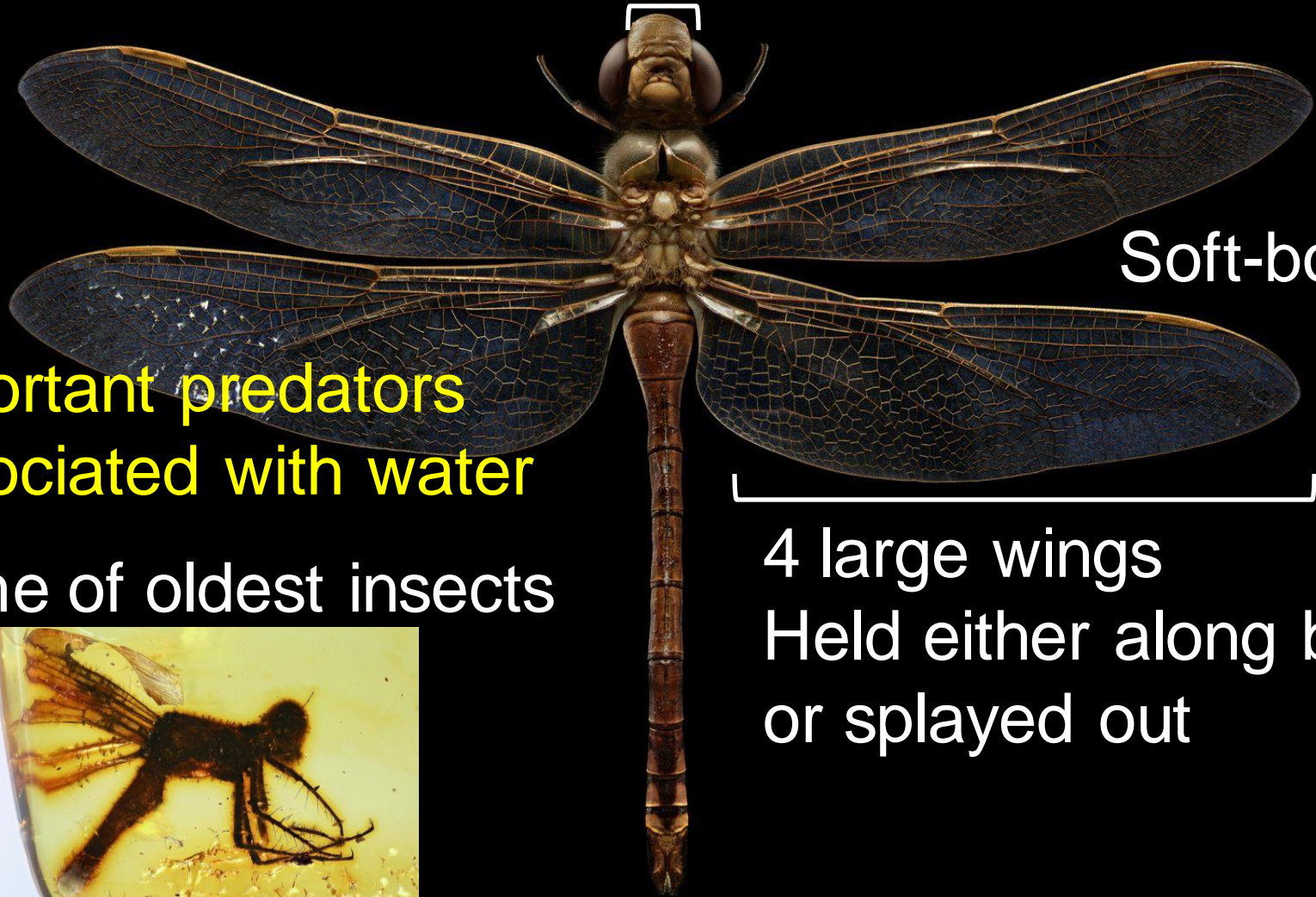
# Odonata: Dragonflies and Damselflies

~5,000 Species

Name means “Tooth”

Chewing mouthparts

Not helpful



Soft-bodied

Important predators  
Associated with water

Some of oldest insects

4 large wings  
Held either along body  
or splayed out



# Odonata: Immatures

Aquatic in fresh water

Helps explain Odonata association with water

Body similar to adults

Big eyes, shorter abdomen

Large

Chewing mouthparts

Extendable mouthparts

Voracious aquatic predators





# Common Odonata



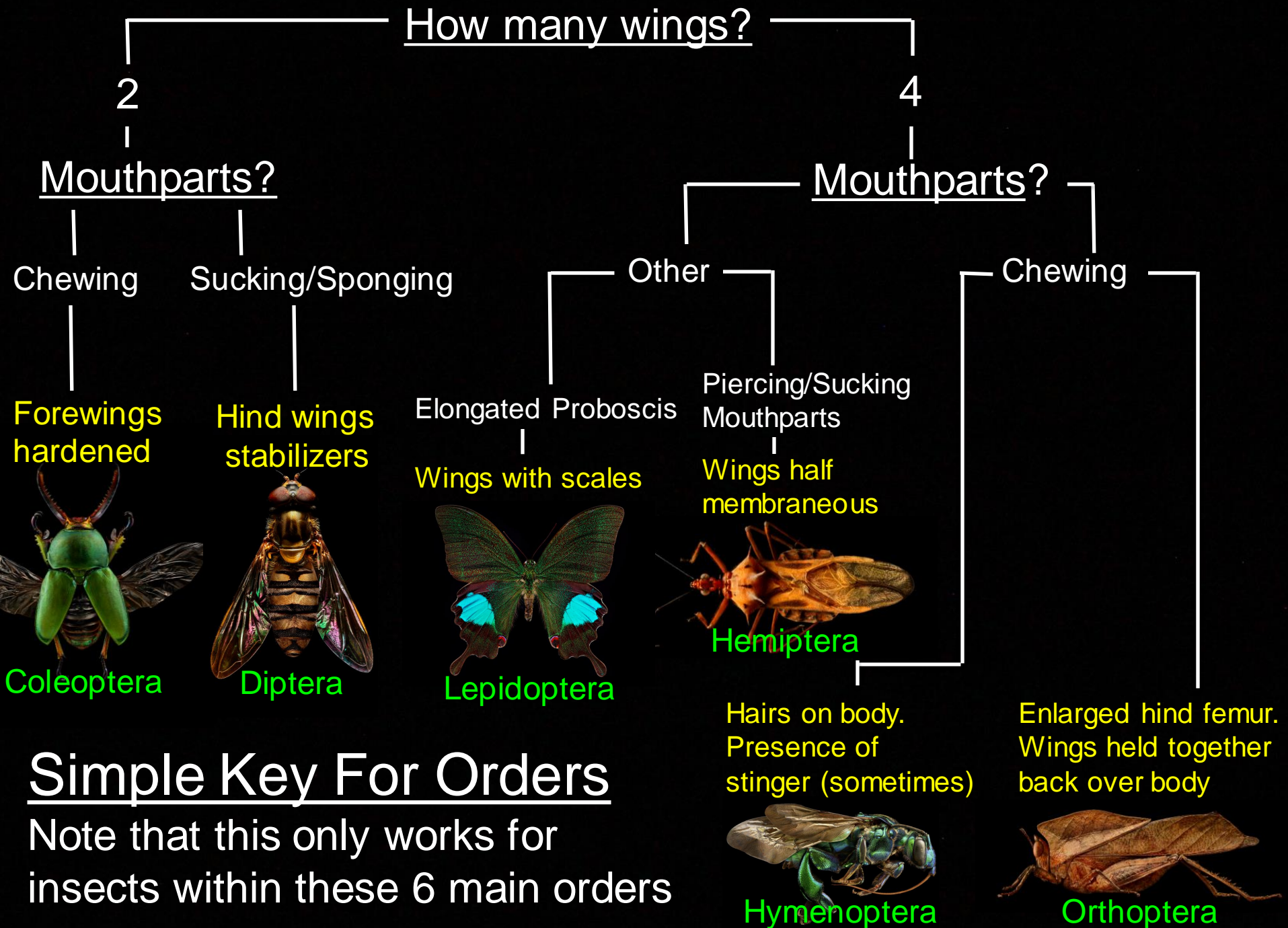
Multicolored  
Darner



Red Tinged  
Skimmer



Violet Dancer





## Orthoptera

4 wings over back  
Chewing mouthparts  
Enlarged hind femur



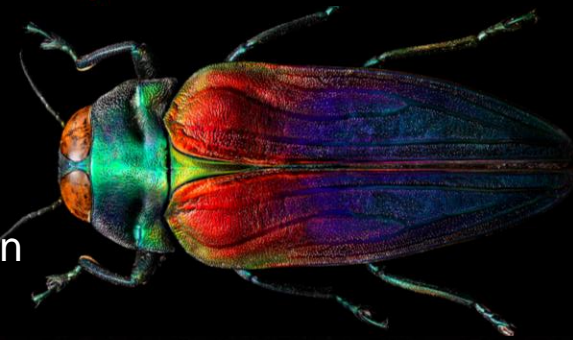
## Hemiptera

4 wings: half membranous,  
half hardened  
Piercing/sucking mouthparts



## Coleoptera

2 wings: Forewings  
Hardened into elytra  
Chewing mouthparts  
Elytra cover abdomen



## Odonata

4 wings, extended/over back  
Chewing mouthparts  
Found near water



## Hymenoptera

4 wings, membranous,  
Chewing mouthparts  
Often social, with stinger



## Diptera

2 wings, others halteres  
Sponging/sucking  
mouthparts  
Often bristly



## Lepidoptera

4 wings, all with  
tiny scales  
Proboscis



## Neuroptera

4 veined, tent-like wings  
Chewing mouthparts  
Usually long antennae





## Orthoptera



Look like adults  
Lack wings

## Hemiptera



Look like adults  
Lack wings

## Coleoptera



Small alligators  
Grubs: distinct head, whitish  
Armored worms  
Chewing mouthparts



## Hymenoptera

Rarely seen  
Often have head  
Lack legs, features

## Diptera

Maggots  
No head, no legs



## Lepidoptera

Caterpillars  
Distinct head  
Prolegs present  
Chewing Mouthparts



## Odonata



Found in water  
Look similar to adults



## Neuroptera

Small alligators  
Big sickle jaws



# Insect ID Questions?

Insect ID is difficult and takes times

Practice needed to be any good



**Diversity equals success.**

Just ask a beetle.

Become a Member

Nearly one-fourth of all classified species are beetles, more than 100 lineages that can be traced back to a common ancestor. Zoologists say there's a reason for this: given beetles an evolutionary leg up. <sup>1</sup>

Hemiptera





# Questions?



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