

## Virtual Entomology for Master Naturalists

# 3. The seven largest insect orders

Rivanna Master Naturalists

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# The seven largest orders

| ORDER | # families worldwide | # species in North America | # species worldwide |
|---|---|---|---|
| ODONATA (dragonflies and damselflies) | 29 | 400 | > 5000 |
| ORTHOPTERA (crickets, katydids, grasshoppers) | 28 | 1100 | > 10,000 |
| HEMIPTERA (true bugs) | 133 | 10,000 | > 82,000 |
| **COLEOPTERA (beetles)** | **166** | **24,000** | **> 300,000** |
| **DIPTERA (flies)** | **130** | **17,000** | **> 100,000** |
| **LEPIDOPTERA (butterflies and moths)** | **135** | **11,000** | **> 110,000** |
| **HYMENOPTERA (bees, wasps, ants)** | **90** | **18,000** | **> 100,000** |

PALEOPTERA

EXTERNAL WING DEVELOPMENT

INTERNAL WING DEVELOPMENT

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# ORDER **ODONATA**

**Suborder: Anisoptera (dragonflies)**

**Suborder: Zygoptera (damselflies)**

# ORDER **ODONATA**

Can’t fold wings

External wing development

Aquatic immatures

Aerial adults

Predators at all stages

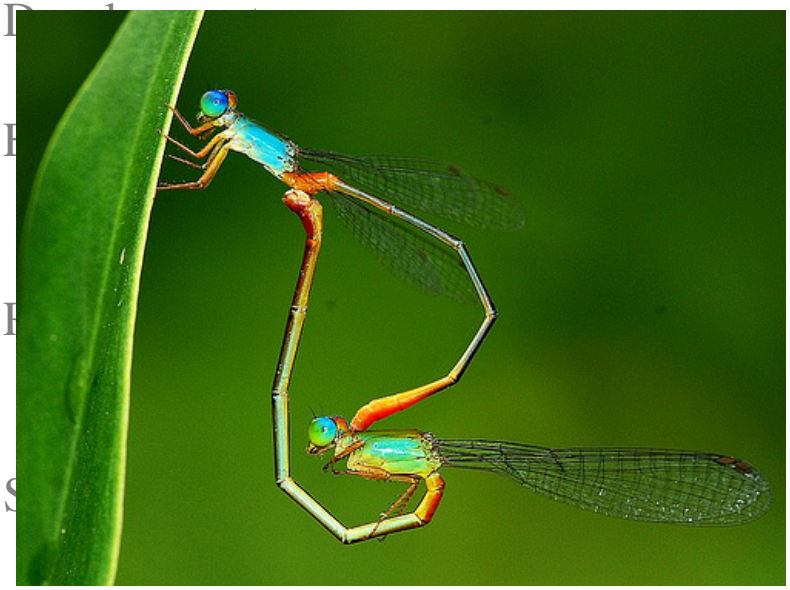
# ORDER **ODONATA**

Aquatic immatures take in oxygen via

Internal rectal gills (dragonflies)

External posterior gills (damselflies)

# ORDER **ODONATA**



## Reproduction

- secondary sexual organs (male)
- ‘wheel position’ & tandem flight
- sperm competition: sperm removal, mate guarding

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# Orthoptera: grasshoppers, katydids, crickets

# Related orthopteroid orders




# ORTHOPTEROID orders

- **CHEWING MOUTHPARTS**
- **external wing development**
- **anal cerci**
- **long, multisegmented antennae**

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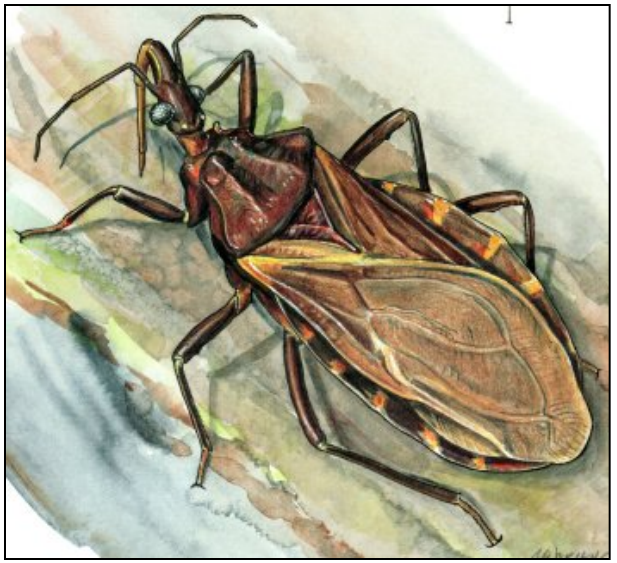
# HEMIPTEROID Orders

- **SUCKING MOUTHPARTS**
- **external wing development**
- **no anal cerci**



# SUCKING MOUTHPARTS

# Spittlebugs

# Aphids

# Aphids

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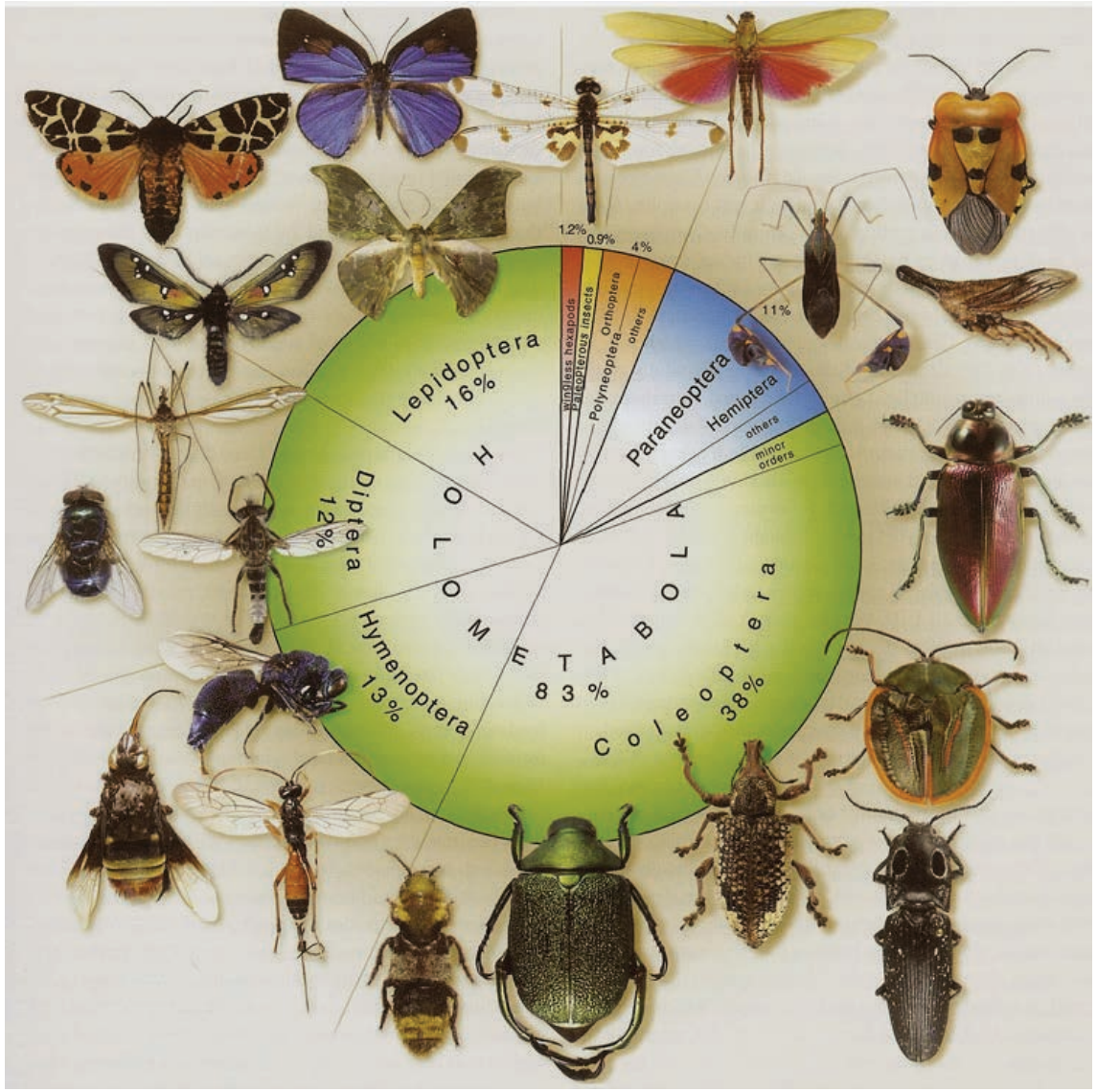
INTERNAL WING DEVELOPMENT

# COLEOPTERA: Beetles



# COLEOPTERA: characteristics

Adults **live in concealed, tight spaces**, but maintain ability to fly:

- **Forewings modified into elytra**
  - heavily sclerotized: protection
  - edges meet in tongue-and-groove
  - contribute little to flight
    - reduction in thoracic muscles
    - reduction in mesothorax

- **Hindwings fold** lengthwise and crosswise and are tucked under elytra

# COLEOPTERA: other characteristics

**Larvae and adults:**

- Chewing / biting mouthparts
- Varied diets


**Larvae:**

- Varied in form
- **Usually hidden and usually generalized**
- Little variation in coloration

# Beneficial beetle predators

Ladybird beetles (Coccinellidae, Coleoptera) vs. aphids

# Scarabaeoidea

**Adaptations for burrowing**

Large forecoxae and tibiae

Adult **antennae clubbed or lamellate**


**Major family**

**Scarabaeidae: scarab**

heavy bodies

larvae C-shaped, with obvious legs

- "chafers": agricultural pests (Japanese beetle)
- dung beetles
- goliath, hercules beetles

Japanese beetle

# Elateriformia

Heterogeneous group

Larvae longer-lived than adults

Some adults aposematic and unpalatable

Larval ecology varied: include ectoparasites, aquatic, predaceous, detritivores

**Major families**

**Elateridae: click**

**Lycidae: net-winged**

**Lampyridae: fireflies**

**Cantharidae: soldier**

**Buprestidae: jewel**



# Phytophaga: Cerambycidae

**Long-Horned Beetles**

elongate, cylindrical,
long antennae
eyes usually notched
often brightly colored

most adults feed on flowers
most larvae are wood-boring

some are major tree pests

locust borer on goldenrod

# Phytophaga: Chrysomelidae

**Leaf Beetles**

closely related to the Cerambycidae
shorter antennae
Smaller (usu. <12 mm), rounder

Adults feed on flowers and foliage
- Many are brightly colored

Larvae are phytophagous
- free feeders on foliage
- leaf miners
- stem borers
- seeds
- roots

Many are significant pests of cultivated plants

Colorado potato beetle

spotted cucumber beetle

locust leafminer

# Phytophaga: Curculionoidea

## Weevils or snout beetles

Head prolonged forward into snout
Mouthparts small, mandibles at tip of snout

Plant feeders
Most larvae burrow into twigs, nuts
Larvae C-shaped, legless (vermiform)

Many major agricultural and forest pests

Major families
**Curculionidae: true weevils**
**Brentidae: straight-snouted weevils**

# DIPTERA: True Flies



# DIPTERA: True aeronauts

- **Hind wings modified into halteres**
  - **flight stabilizers**, help insect fly straight
- **Assisted by sensory systems**
  - **sensory structures** on halteres detect distortions during flight
  - **visual system** sends signals from brain to haltere muscles, which send signals to wing muscles

# DIPTERA: True aeronauts

**Agile flight** (ex: hovering, landing upside down, flying backwards, rapid wing beats)


# DIPTERA: True Flies

**Mobile head**, large compound eyes

**Liquid feeders with haustellate mouthparts** (biting/sucking or licking/sponging)

# DIPTERA: True Flies

**Larvae legless, wormlike**


# DIPTERA: True Flies

## Ecological and economic importance

- pollination
- biological control (predators, parasitoids)
- decomposition

- plant pests
  - ex: apple maggot, Hessian fly (wheat)
- disease vectors
  - ex: malaria, yellow fever, leishmaniasis, west nile virus

# Order Diptera

## Suborder Nematocera
("long horned")

ex: mosquitoes
long-legged, fragile-looking
long antennae

## Suborder Brachycera
("short horned")

ex: housefly
short-legged
short antennae
stockier body

# Nematocera: **Tipulidae** (crane flies)


- large fly family (>1500 sp NA)
- larvae aquatic or semi-aquatic
- adults short-lived, do not bite
- common and abundant

# Nematocera: Cecidomyiidae (gall midges)

- 1-5mm
- most species make plant galls
- economically-important agricultural pests



# Brachycera: **Tabanidae**

(horse fly, deer fly)

common

size medium to large

large **eyes** often bright colors, **iridescent**

**females**

- **suck blood**
- livestock and human pests
- eyes separated

**males**

- **eat pollen and nectar**
- found at flowers
- eyes touch

# Brachycera: **Tachinidae** (tachinid flies)

## •Important parasitoids

•Diverse insect hosts
Lepidoptera, Coleoptera, Orthoptera, Hemiptera, Hymenoptera, Diptera

•Attack in many ways. Female may:
- •lay eggs on host
- •insert eggs into host
- •deposit eggs on plants, eggs eaten by host
- •produce hatching eggs, larvae burrow into host

# What is a parasitoid?

An insect whose immature stages develop within, or attached to the outside of, a single insect host, and ultimately kill the host


Adults emerging out of butterfly eggs

Laying eggs in a caterpillar

Parasitized beetle larva

# Brachycera: **Syrphidae** (flower flies, hover flies)

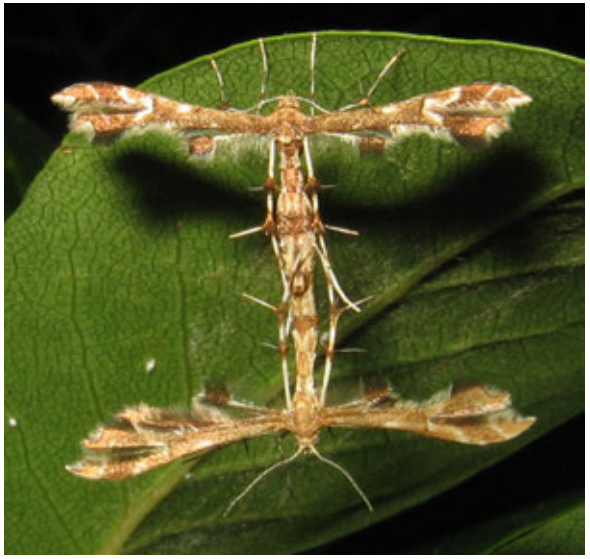
diverse, abundant flies

**adults** common at flowers
**bee and wasp mimics**

**larvae**
ecologically diverse, include:
- predators on aphids
- in social insect nests
- in polluted water
- in rotting wood


*Eristalis*, rat-tailed maggot

# LEPIDOPTERA: Butterflies and moths

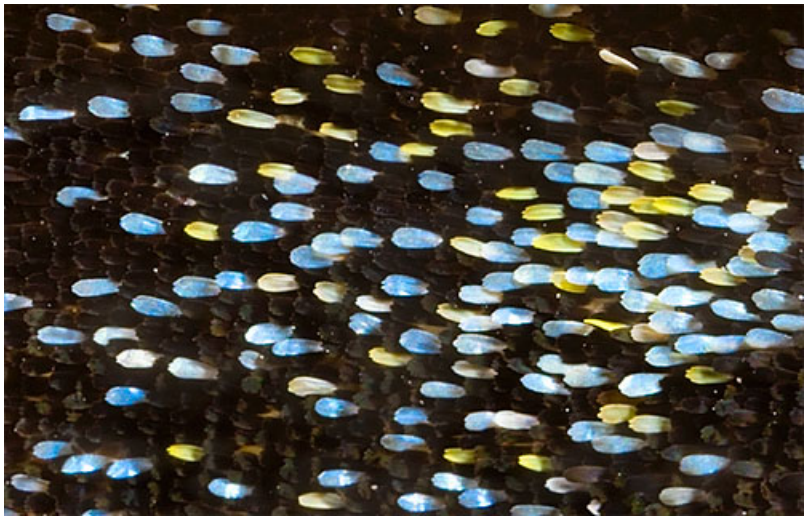


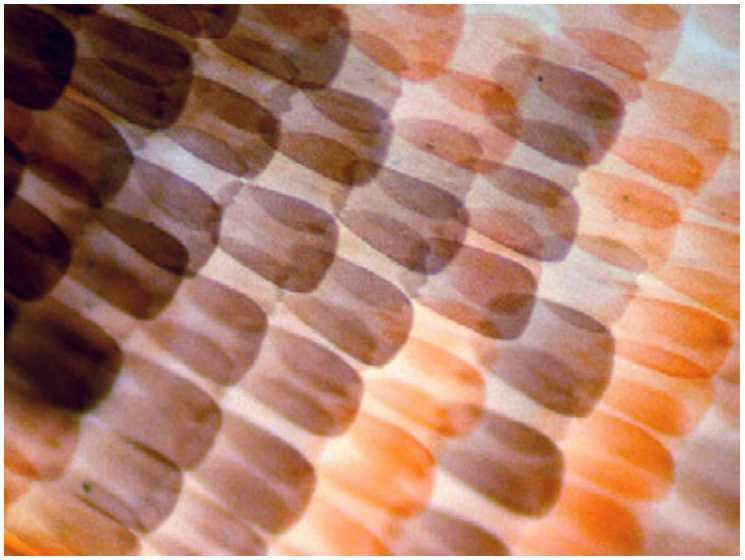
# Lepidoptera adults

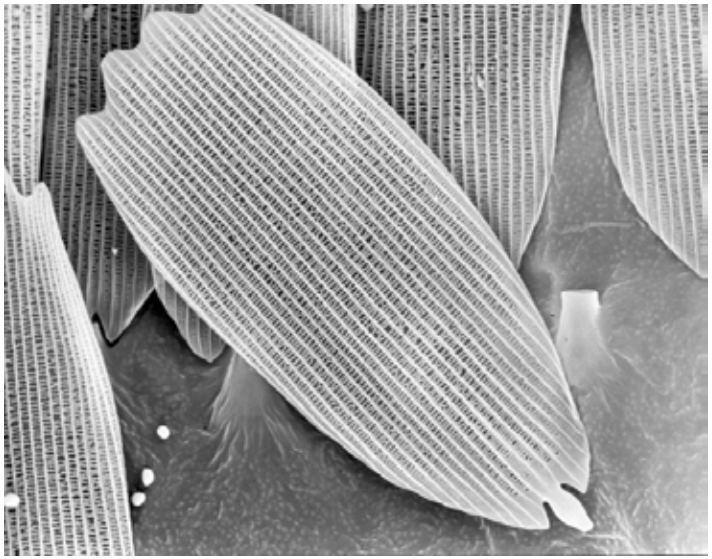
## Adults

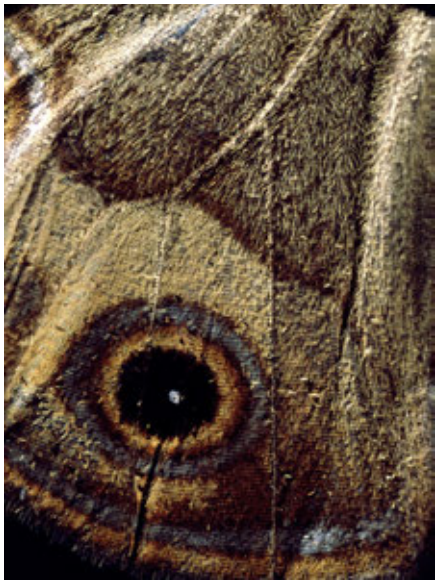
- wing **scales** are flattened setae with complex microstructure
- **proboscis**

# Lepidoptera wing scales









# Lepidoptera larvae and pupae

## Larvae

- muscular **prolegs** on abdomen
- **crochets** on prolegs

## Pupae

- obtect (appendages fused to body)

# Lepidoptera larvae

# Caterpillars use silk from labial glands

uses: ballooning and droplines; shelters, leaf roll;, webs and tents; girdles, buttons and cocoons

# Lepidoptera and plants

Largest lineage of plant-feeding animals

The evolution of the Lepidoptera is linked with the evolution of flowering plants (angiosperms)

Many Lepidoptera have specific hostplant associations

# Milkweed Butterflies

Subfamily Danainae

Family Nymphalidae

Hostplants: milkweeds (Asclepiadaceae) and dogbanes (Apocynaceae)

# Pieridae (“Whites” and “Sulfurs”)

subf. **Pierinae (“whites”)**

hostplants: **mustard family**

(ex: cabbage white butterfly)

subf. **Coliadinae (“sulfurs”)**

hostplants: **legumes**

# Hymenoptera: Bees, wasps, ants


# Hymenoptera: Bees, wasps, ants

- **Membranous wings**
  - **not many veins**
  - hind wings small
- **Chewing mouthparts**
- **Ovipositor well developed**
- **Most have a “wasp waist”**

# Bees, wasps, ants: why have a “wasp waist”?

constriction = petiole


# Why have a wasp waist? Maneuverability.


# Bees, wasps, ants: diversity of diet

**Nectar and pollen feeders**

**Parasitoids**

**Predators**

**Gall formers**

# PARASITOID EXAMPLE: Braconidae

- Hosts: Lepidoptera
- Diversity: ~2000 spp N.A.
- Endoparasites and ectoparasites
- Solitary and gregarious
- Stages attacked: any


# Gall formers

An insect that stimulates a plant into producing a home within which the insect can feed and develop.

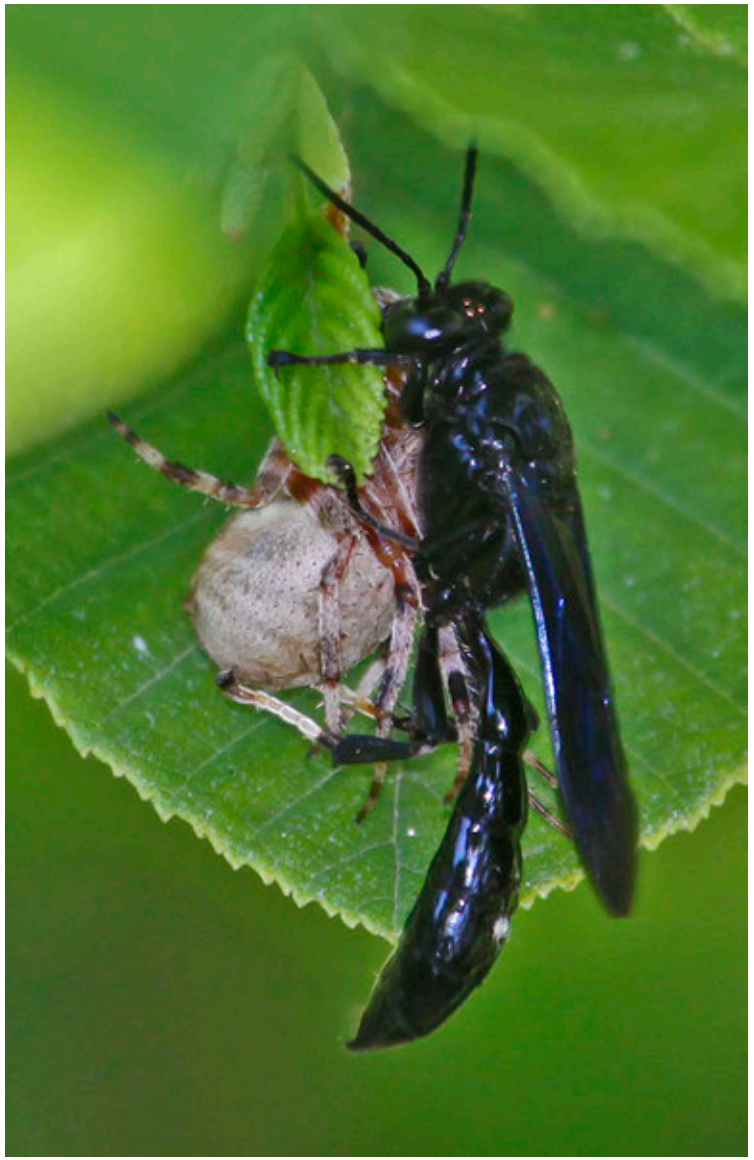
**Many hymenoptera**

- protect young in nests
- supply young with food

# Example: Sphecid wasps

**The Pipe Organ Mud Dauber**

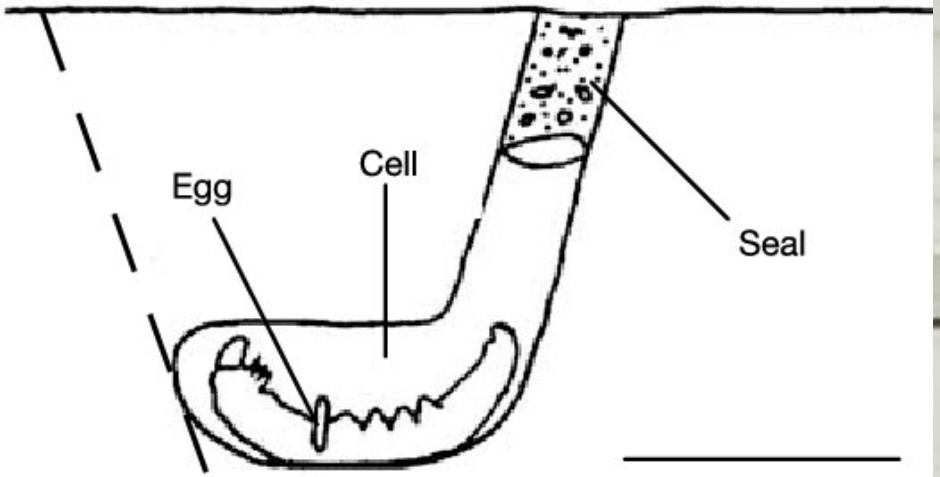
**The female catches spiders, paralyzes them, puts them in a cell, and lays an egg.**



Her larva eats the spiders.

# Other sphecid wasps capture other prey


# and make their nests in different places


# Many bees and wasps, and all ants, are highly social ("eusocial")

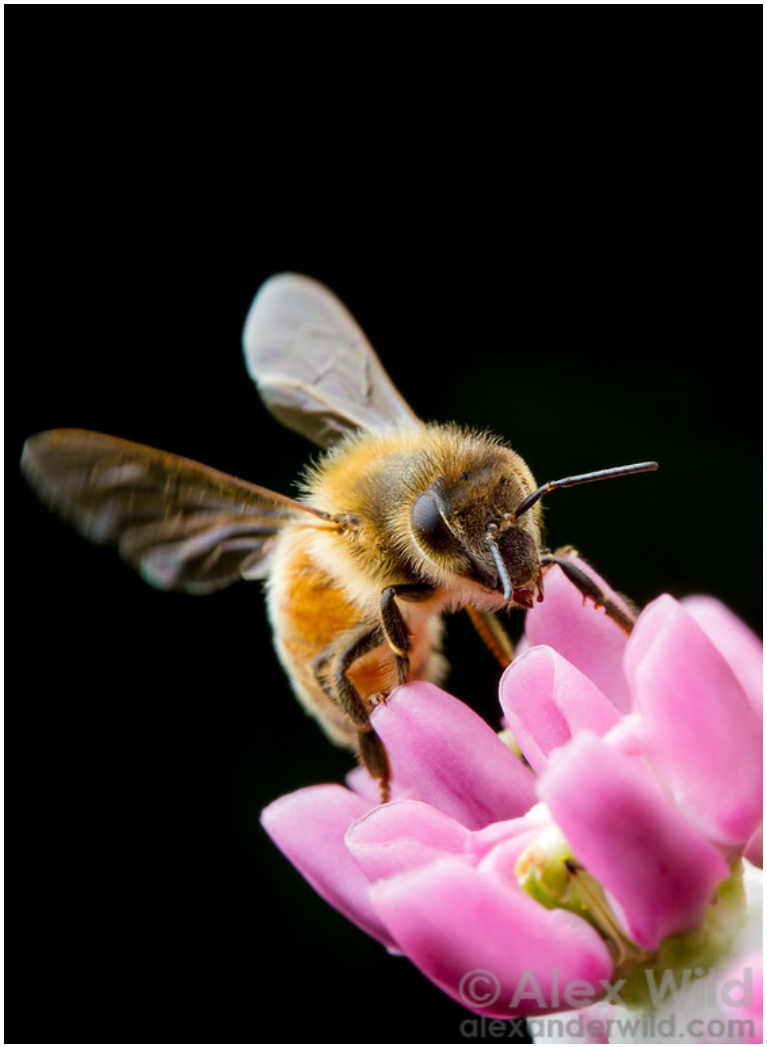
- They live together in a colony
- They have a division of labor
  - different groups (castes) have different jobs
  - many workers never reproduce (sterile)
- They cooperate in caring for offspring

# Example of a eusocial insect: The Honey Bee

# European Honey Bees, *Apis mellifera*

# Characteristics of honey bee colonies


**Nest**
wax comb in an enclosed, protected space (hollow tree, wooden hive)




**Food**
nectar and pollen

# Honey bee castes

## Workers

- unmated females
- do everything for the colony
- > 10,000

## Queen

- mated female
- lays eggs (up to 200,000 per year)
  - fertilized = females
  - unfertilized = males
- controls colony with chemical communication
- 1 per colony

## Drones

- males
- do zero work in the colony
- fly out looking for virgin queens
- if lucky, mate once and die
- if unlucky, never mate and die
- 100's to 1000's, ~15% of colony

# Honey Bees, *Apis mellifera*

# What were our goals for Insect Day?

## Understand

1. features that characterize arthropods in general, insects specifically
2. how much variation there is in all aspects of insect biology
3. ecological importance of insects

## Feel prepared to

4. participate in insect projects as Master Naturalists
    - children's and school programs
    - pollinator and foodplant gardening
    - monitor native insect populations, stream health, exotic insects
    - measure biodiversity (e.g. bioblitz, NABA butterfly count)
    - citizen science (e.g. Journey North, Monarch Watch)
5. learn more about insects

# Insect natural history

**What is interesting to observe?**

- **Diversity**
- Phenology
- **Interactions**
- Invasive species
- Population dynamics
- **Community ecology**

**Who pollinates your herbs?**

# Insect natural history

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**When do swallowtail butterflies appear?**

# Insect natural history

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**What are brown marmorated stink bugs feeding on?**

# Insect natural history

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- Diversity
- **Phenology**
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- Invasive species
- **Population dynamics**
- Community ecology

**Which insects are scarce this year? common? early? late? missing?**

# There is always more to discover

# There is always more to discover

Here are some things I've learned this year

- Aphids and their relatives host a lot of symbiotic bacteria .... and we don't know what most of them do.
- Emerald ash borers are ruthless.
- New molecular tools are going to make it possible to eliminate the mosquitoes that transmit malaria.
- Virgin honey bees travel miles to drone aggregation sites. Some of these sites have been in use for more than 50 years.

# There is always more to discover

Let me know about your discoveries!