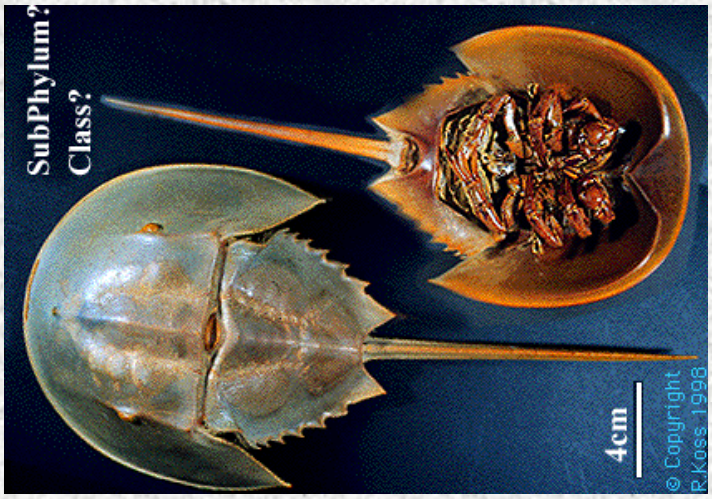
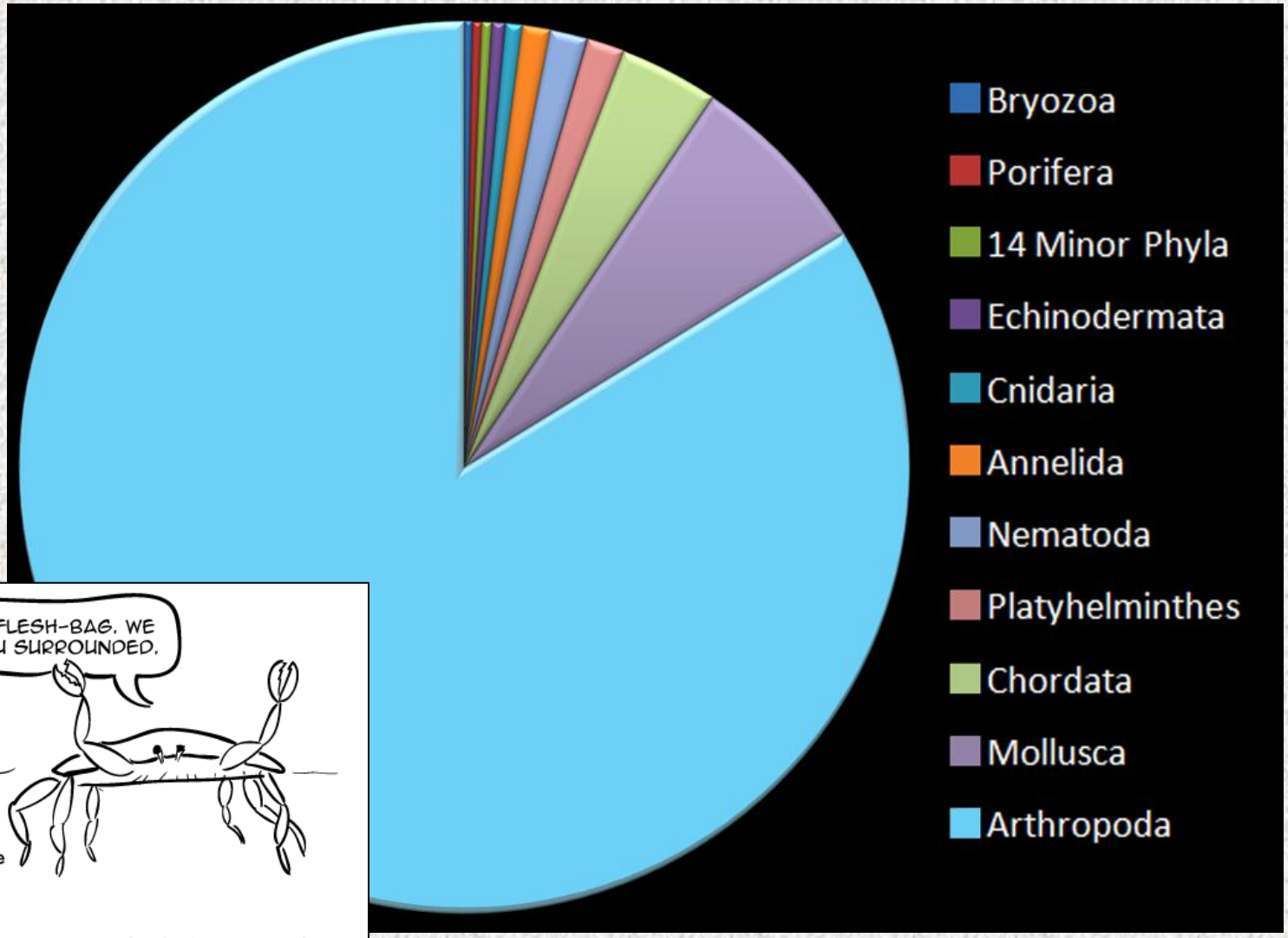
Insect Diversity

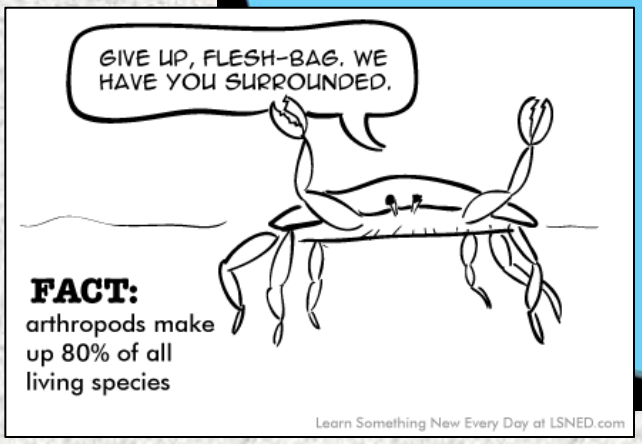
Phylum Arthropoda

- Most successful phylum
  - Ecologically diverse
  - Present in all regions of the earth
    - Adapted to air, land, freshwater, marine, other organisms



The relative number of species contributed to the total by each phylum of animals.
97% invertebrates. Lots of Arthropods! (Molluscs second)

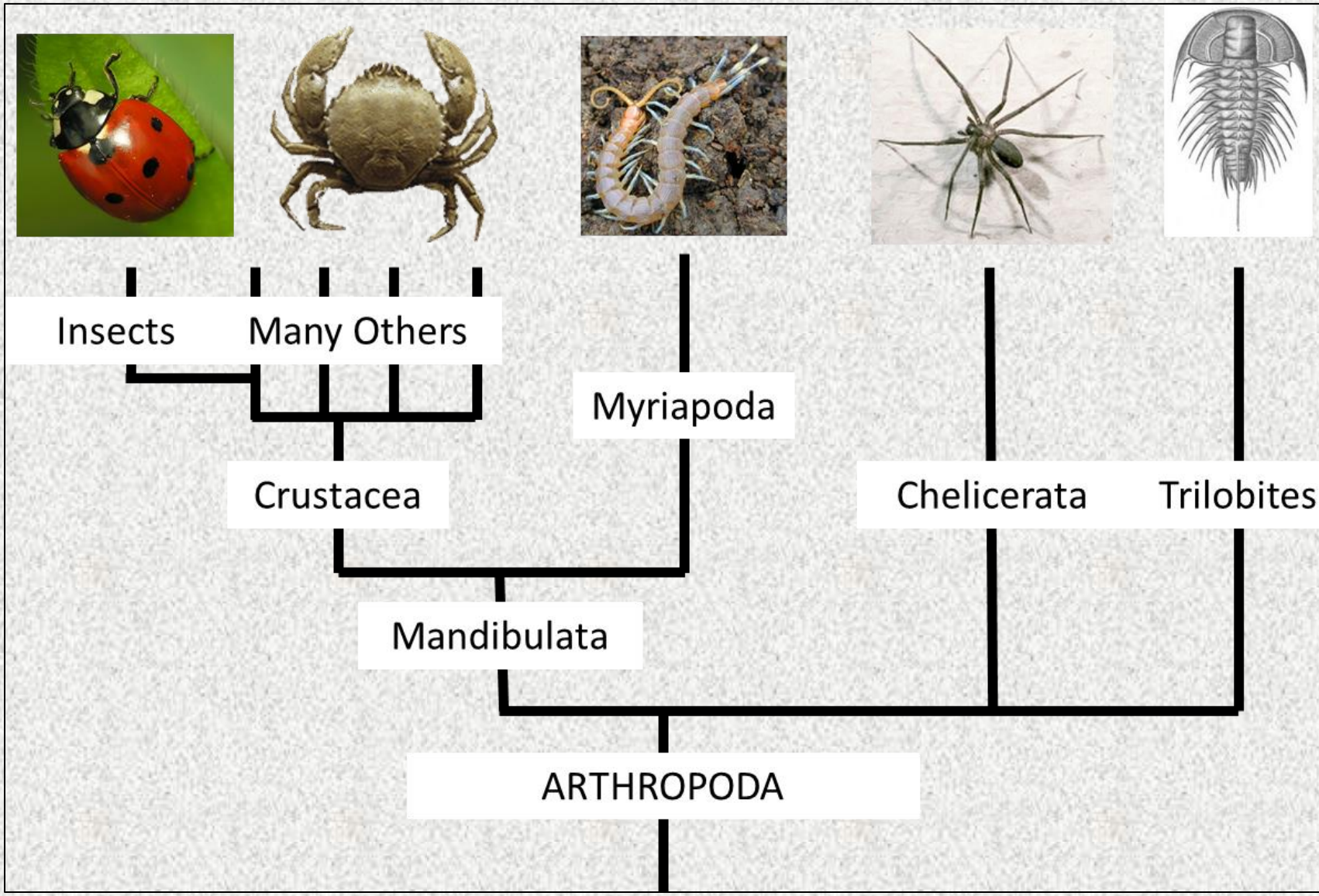




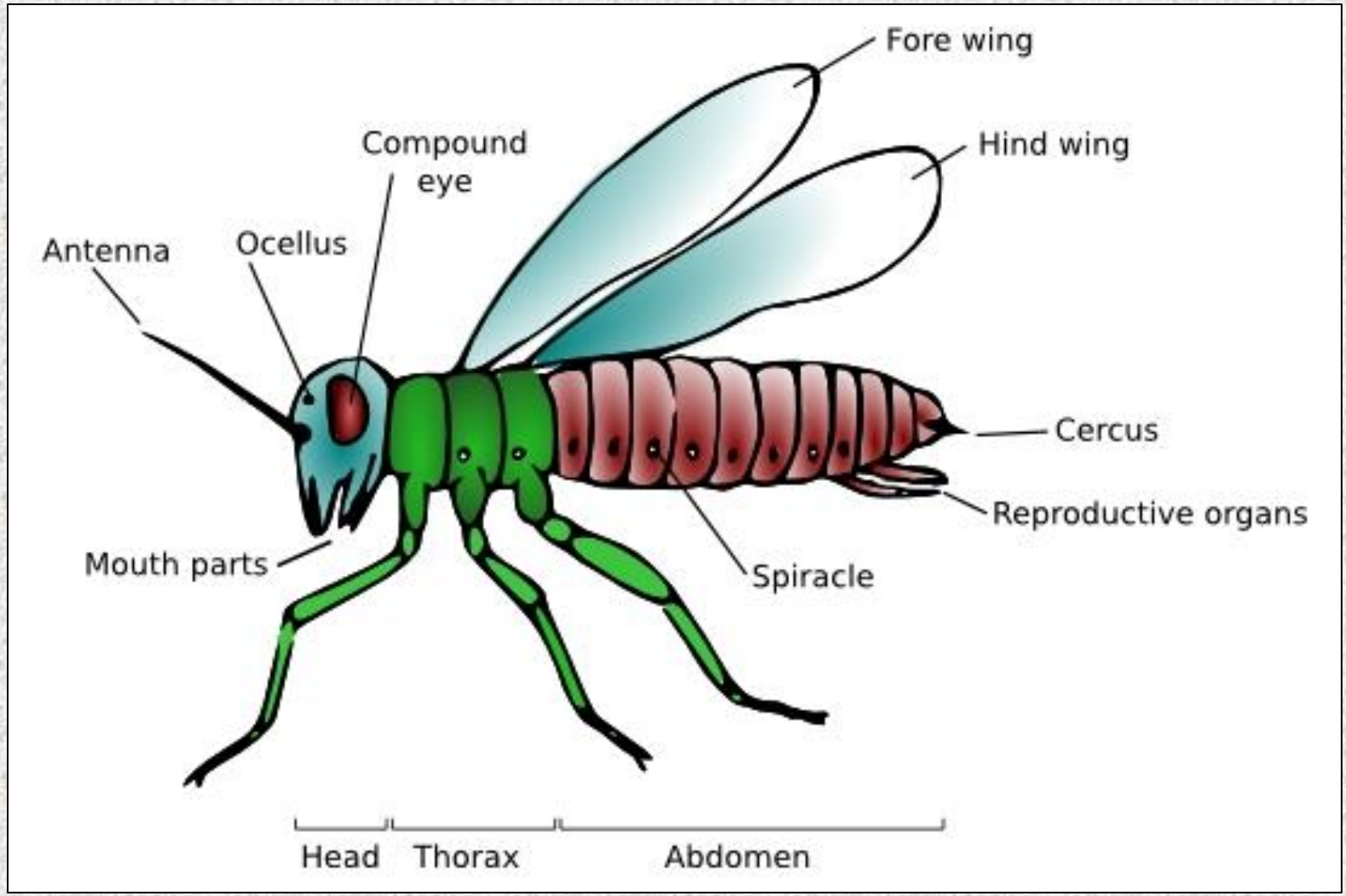
Reasons for success

1. Versatile exoskeleton
2. Efficient locomotion
3. Air piped directly to cells (terrestrial)
4. Highly developed sensory organs
5. Complex behavior
6. Metamorphosis

Molecular evidence places insects WITHIN the Crustacea



Insects


Fore wing
Hind wing
Compound eye
Ocellus
Antenna
Cercus
Reproductive organs
Mouth parts
Spiracle
Head
Thorax
Abdomen

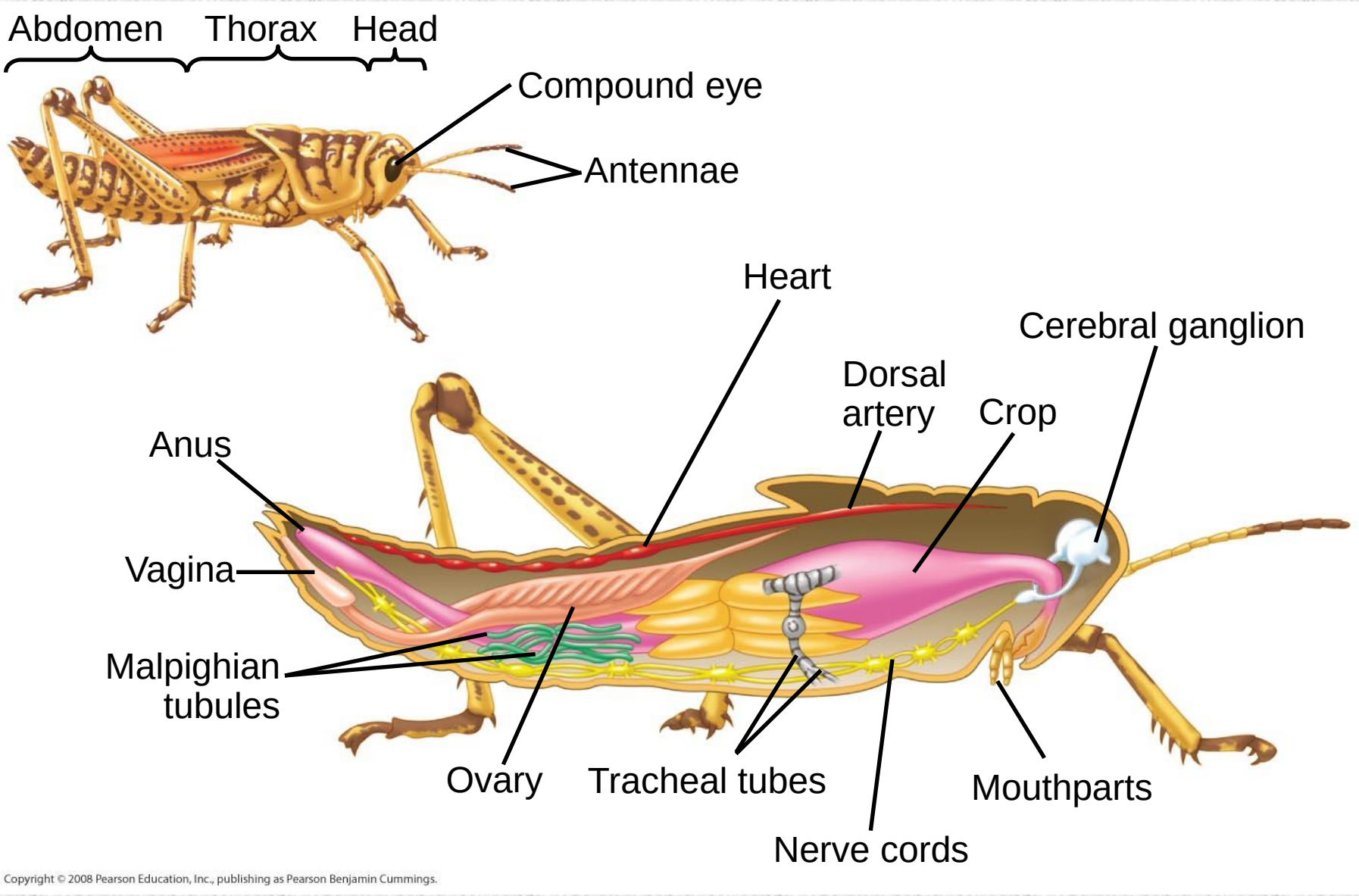
Subphylum Hexapoda - Insects

- More species than all other forms of life combined
- Almost every terrestrial habitat and in fresh water
- Complex organ systems
- Most insects live on land
- Early colonizer of land
- Diversified several times:
  - evolution of flight,
  - adaptation to feeding on gymnosperms, and the
  - expansion of angiosperms

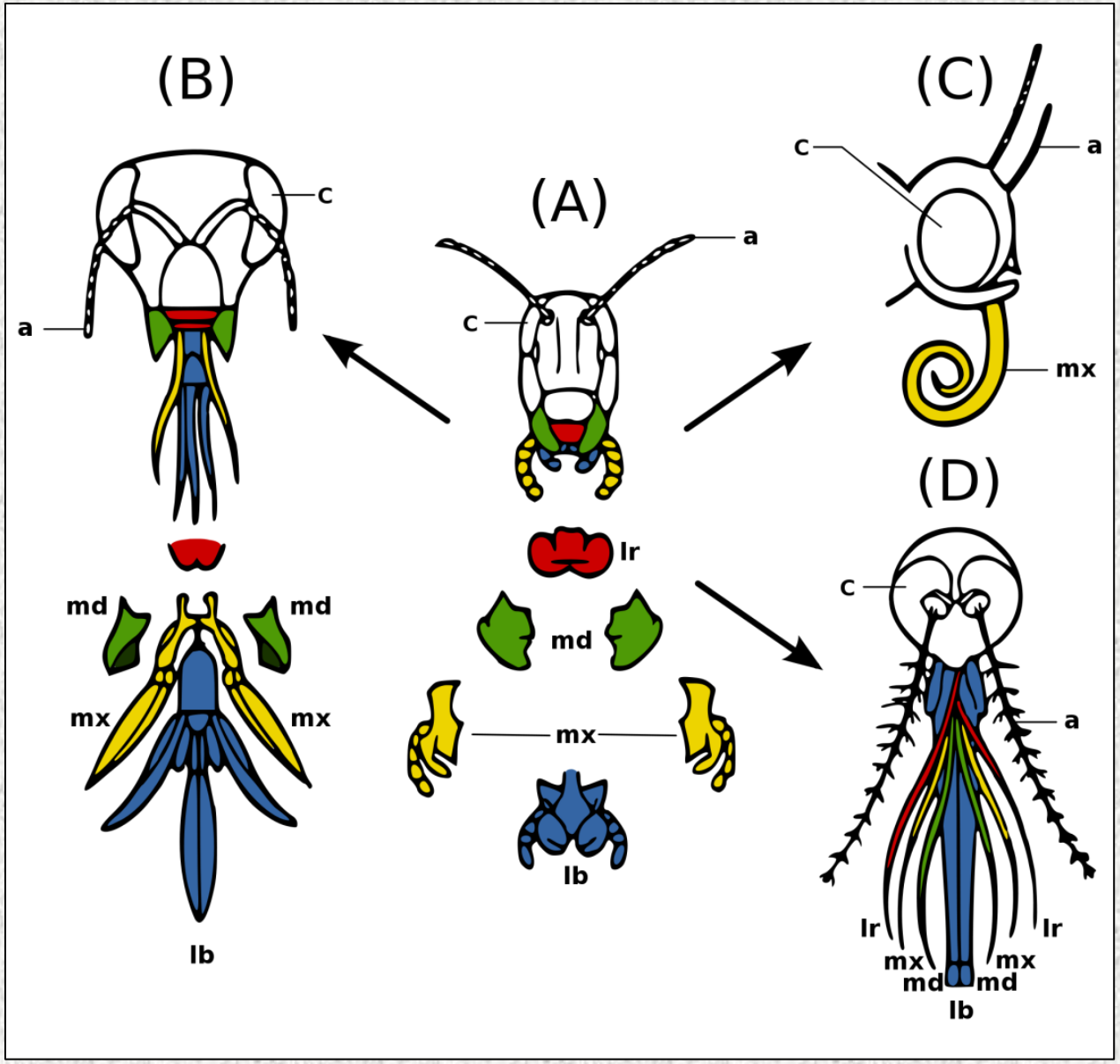
Insect Morphology

- Body segments
  - Head bears sense organs and mouthparts.
  - Thorax bears three pairs of legs and sometimes one or two pairs of wings.
  - Abdomen contains most internal organs.
- The insect head usually bears:
  - A pair of sensory antennae
  - A pair of eyes
- Mouthparts are adapted for particular kinds of eating.
- Flight is one key to the great success of insects.

Insect Morphology

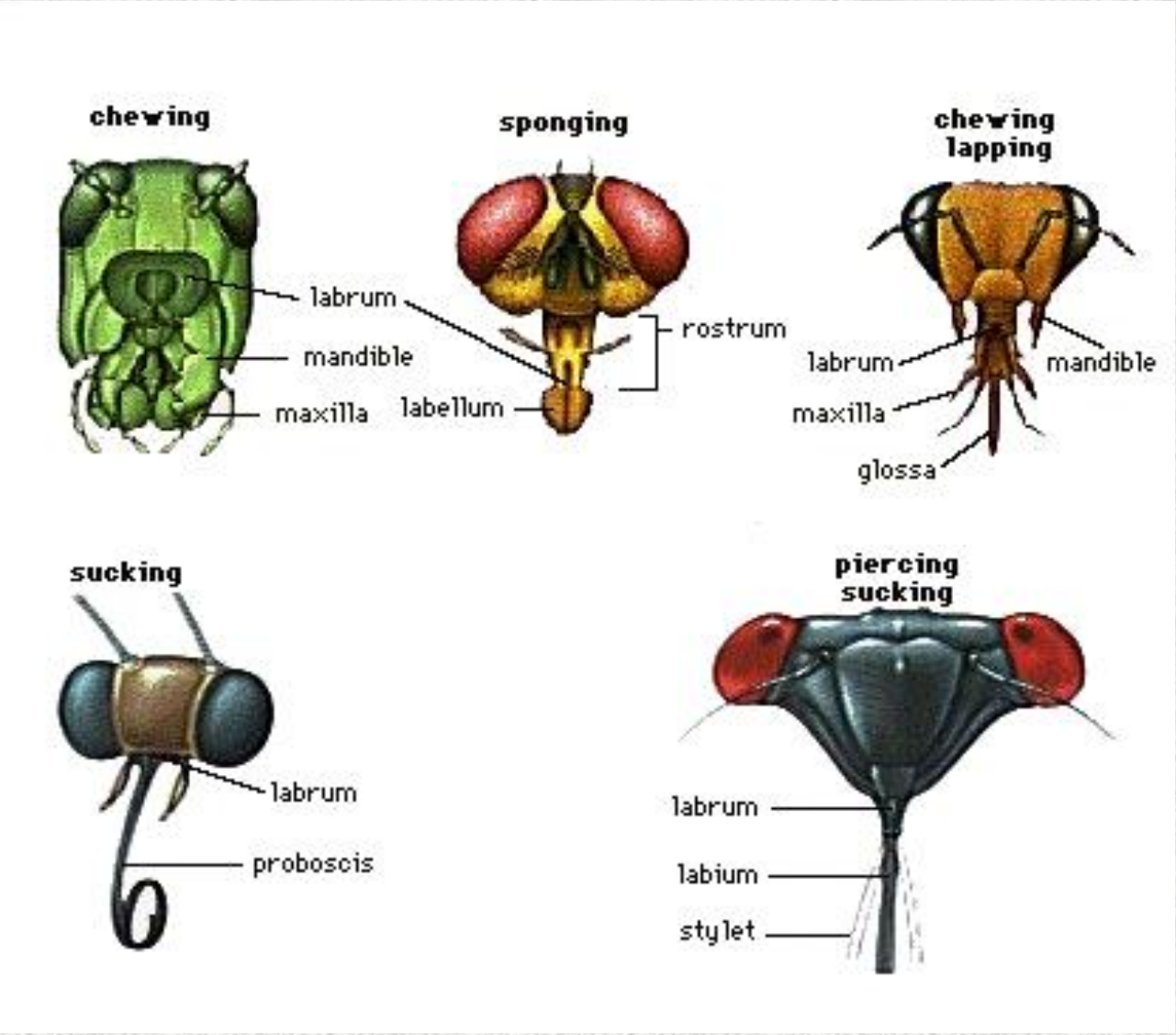


Feeding / Mouthparts

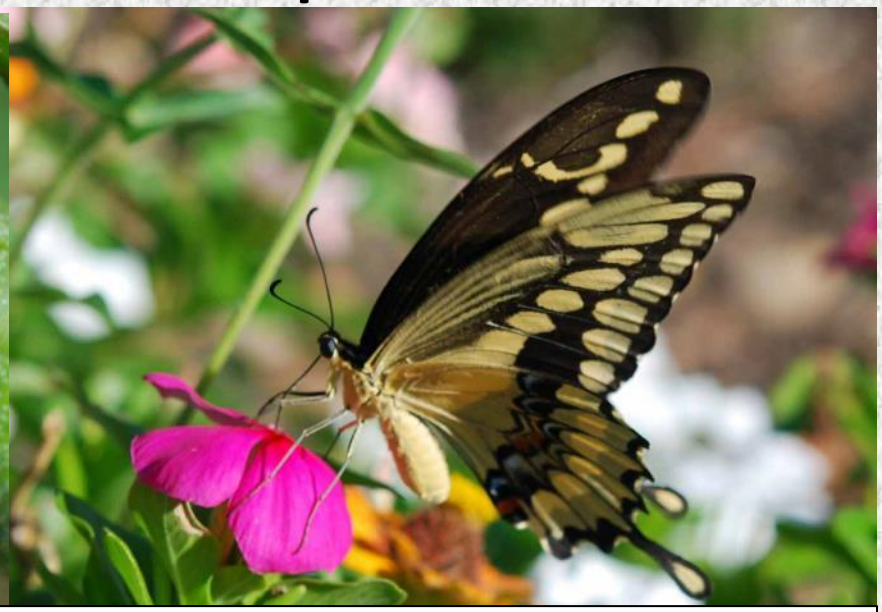


Feeding / Mouthparts

- Insects usually have specialized jaws/mouthparts suited to their ecological niche

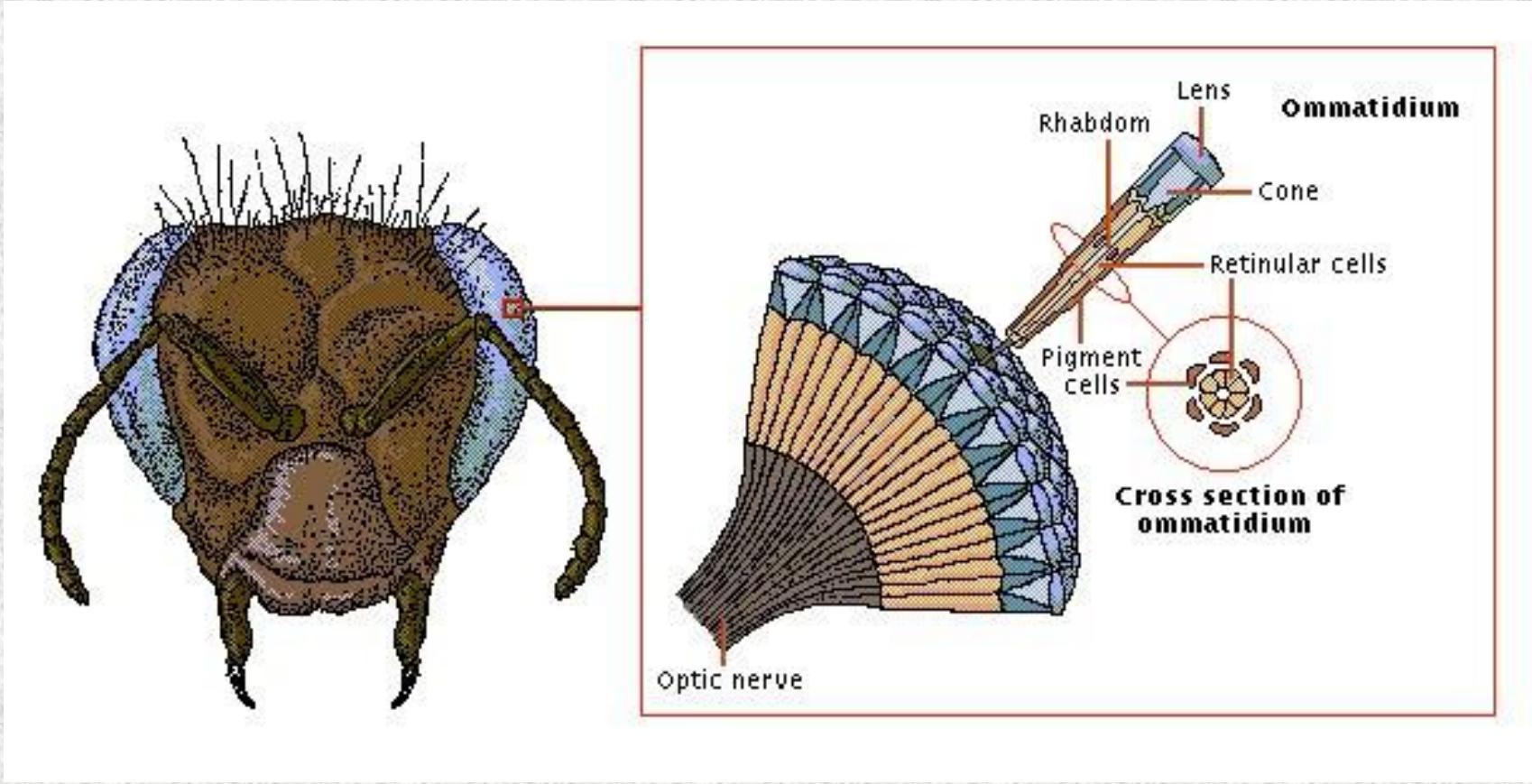


Feeding / Mouthparts

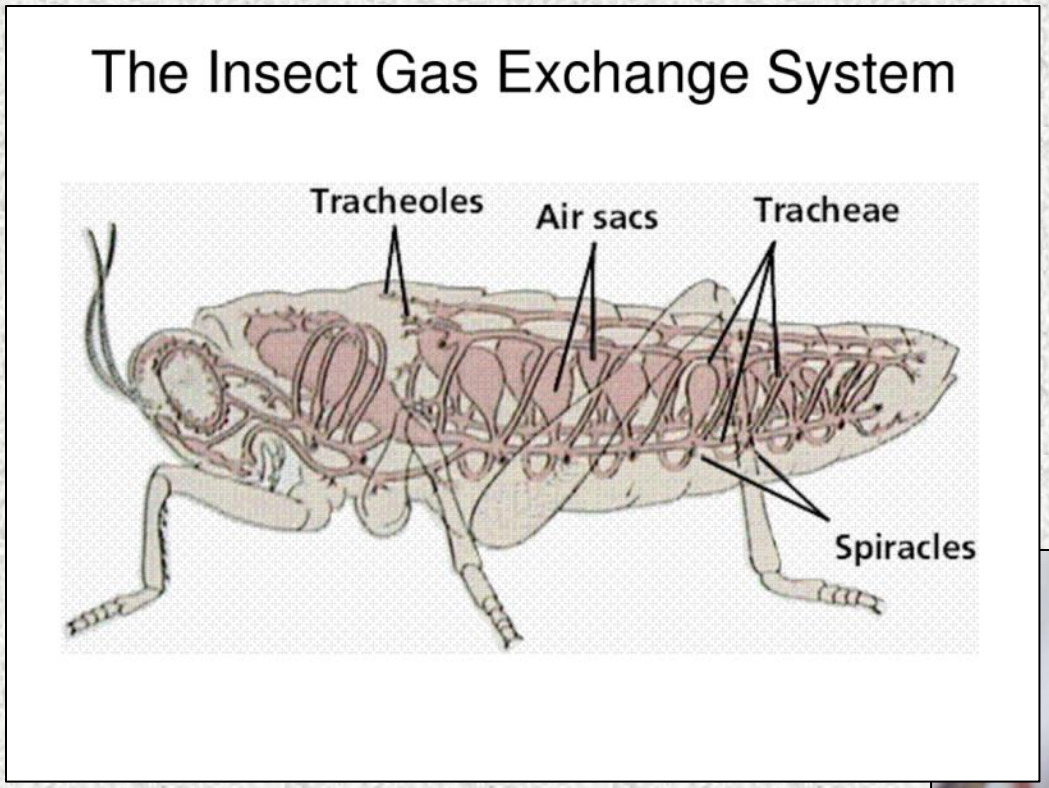


Vision

- Have complex <u>compound eye</u> which is usually extremely sensitive to motion and allows 360^0 vision
- Most insects see well into the UV spectrum



- Insects live on land and breathe by **tracheae.**



Insect Diversity

- Insects outnumber all other forms of life combined.
- Insects live in:
  - Almost every terrestrial habitat
  - Freshwater
  - The air
- Many insects undergo **metamorphosis** in their development.
- Young insects may:
  - Appear to be smaller forms of the adult or
  - Change from a larval form to something much different as an adult

Complete Metamorphosis

egg

larva

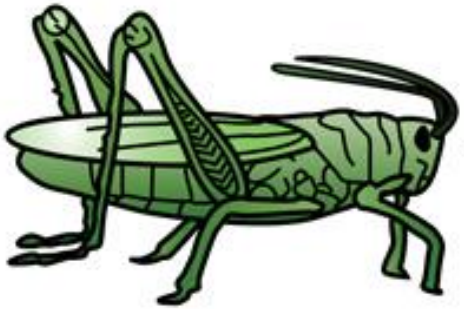
pupa

adult

Incomplete Metamorphosis

egg

nymph



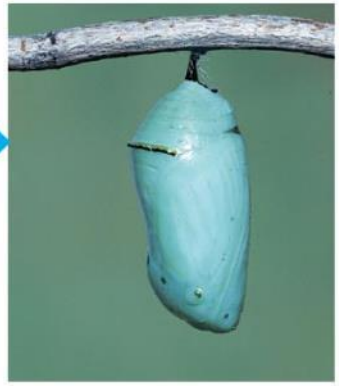
adult

Many insects undergo *complete metamorphosis.*

Body parts are completely reorganized.

The larva (caterpillar) spends its time eating and growing, molting as it grows.

After several molts, the larva becomes a pupa encased in a cocoon.

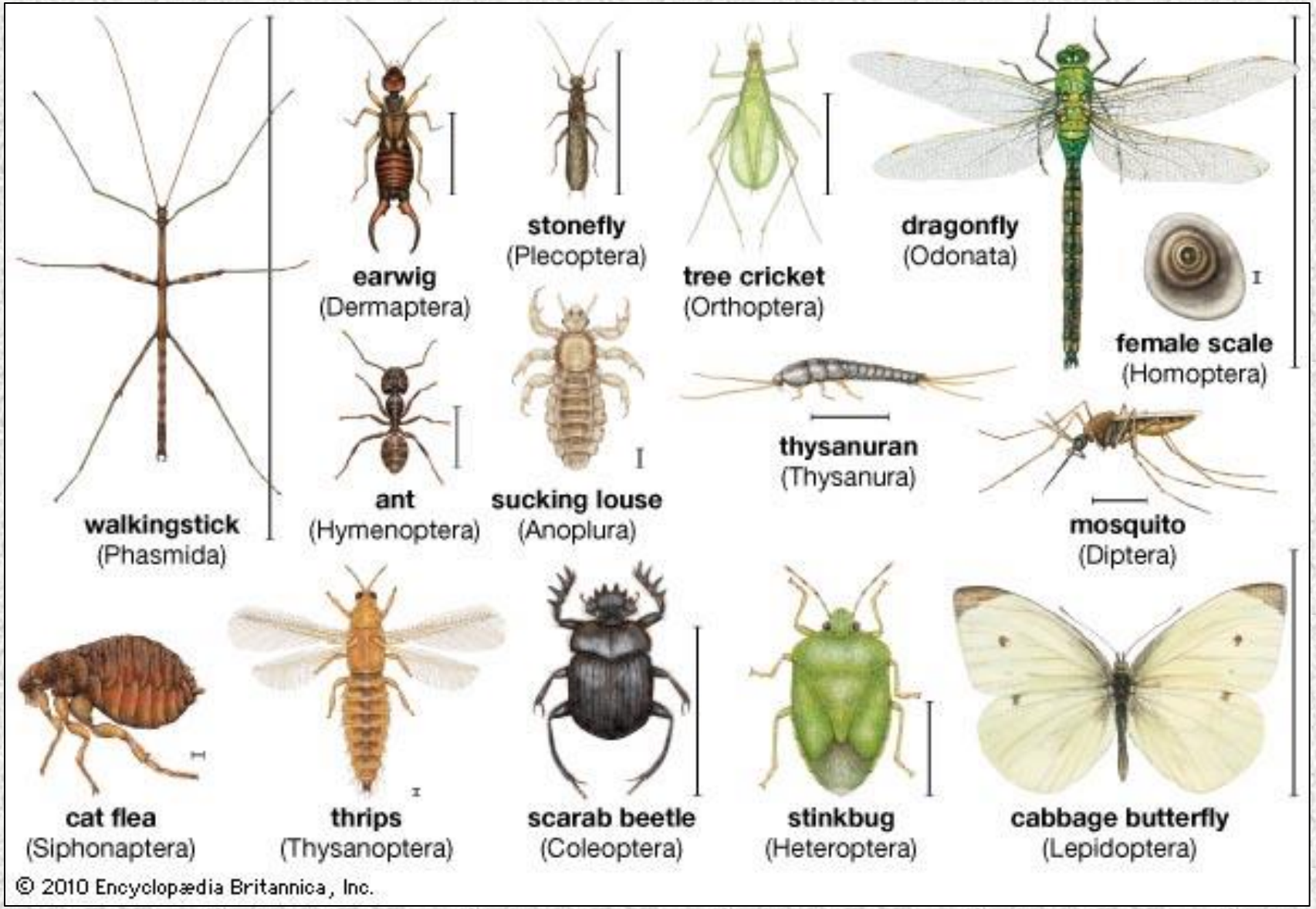


Within the pupa, the larval organs break down and adult organs develop from cells that were dormant in the larva.

Finally, the adult emerges from the cocoon.

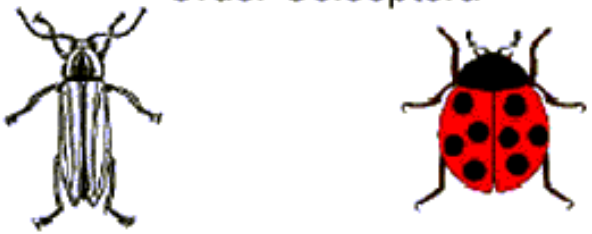
The butterfly flies off and reproduces, nourished mainly by calories stored when it was a caterpillar.

Insect Diversity

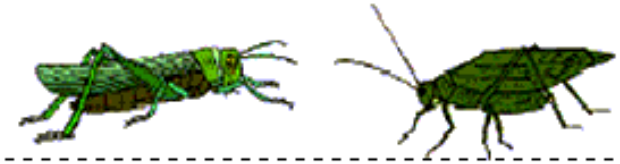


Dragonflies and Damselflies
Order Odonata

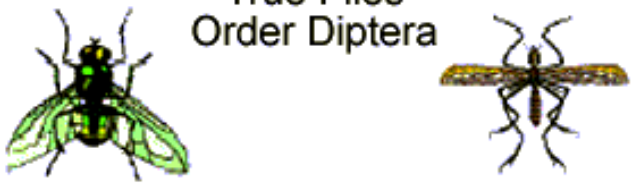
Beetles
Order Coleoptera



Grasshoppers and Crickets
Order Orthoptera



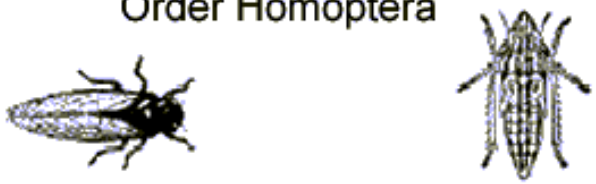
True Flies
Order Diptera



True Bugs
Order Hemiptera

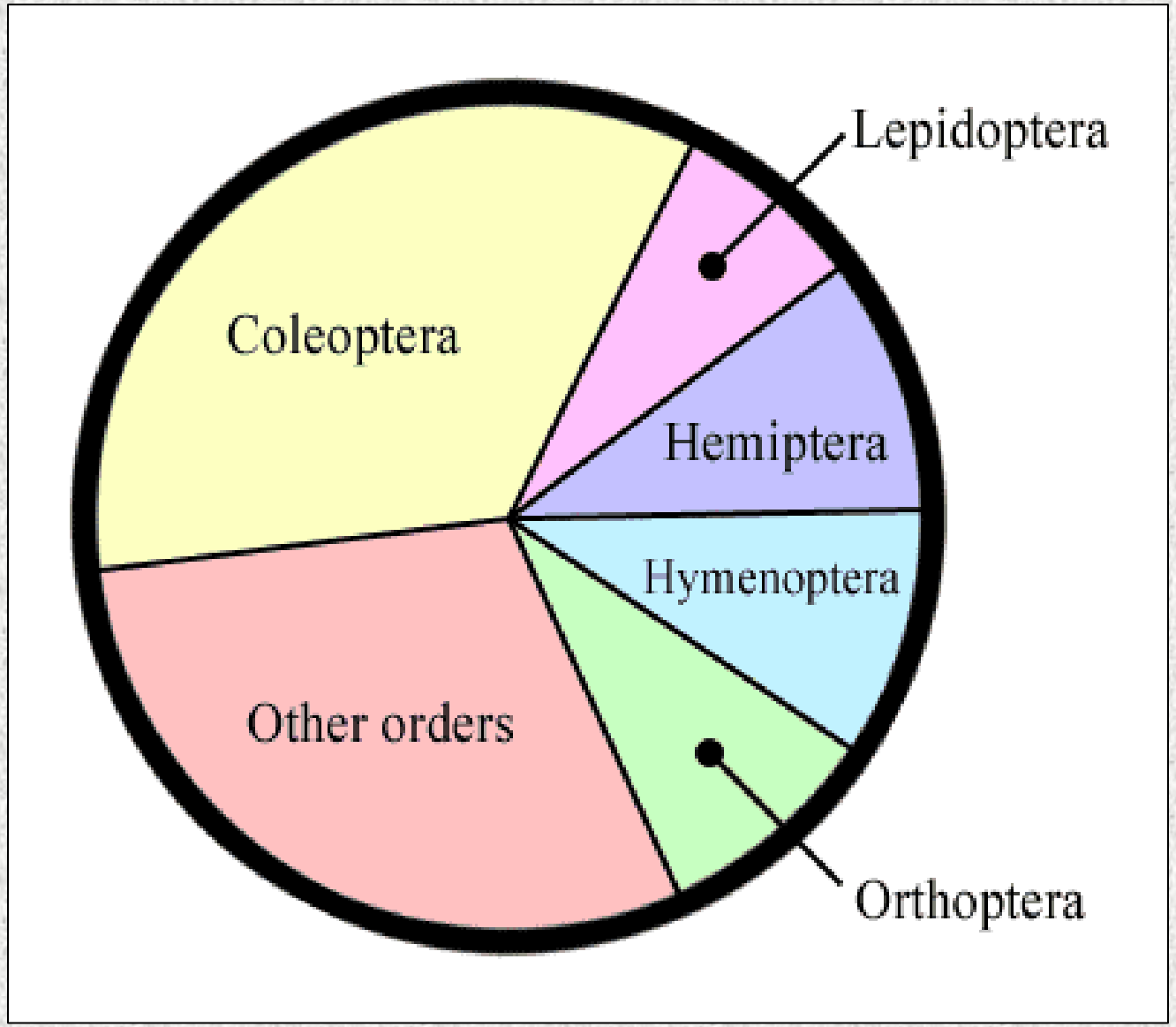
Butterflies and Moths
Order Lepidoptera

Cicadas and Leafhoppers
Order Homoptera



Wasps, Bees, and Ants
Order Hymertoptera

Insect Orders

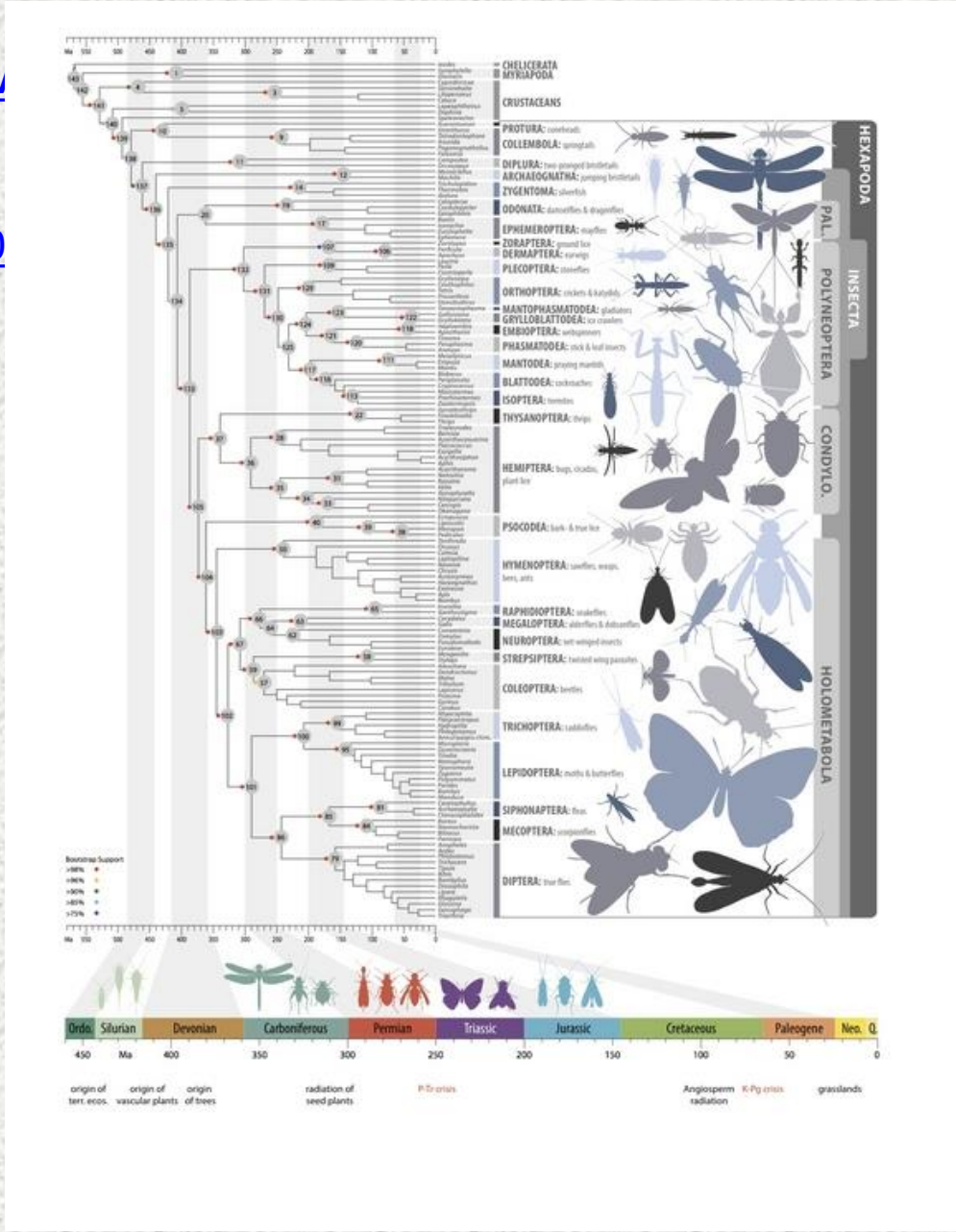


EIGHT ORDERS OF INSECTS

https://www.youtube.com/watch?v=4lDnxV

Learn Insect Orders in Just 4 Minutes

https://www.youtube.com/watch?v=AH0Nx0



Insect Origins

Class Collembola

Springtails

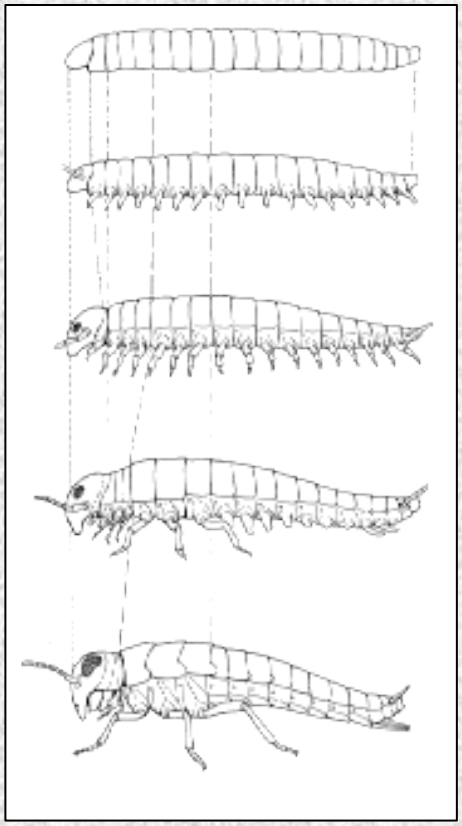
- Old group, 400 MY
- Among first Arthropods on land
- Small, live in leaf litter
- Jump by flicking tail

Springtails - Collembola, isotomurus species
https://www.youtube.com/watch?v=aX_s2edYauo

The Springtail – Part I and 2
https://www.youtube.com/watch?v=OwOL-MHcQ1w
https://www.youtube.com/watch?v=0Sq2gjsysG0

Insect Origins

- Oldest terrestrial Arthropods – 400 MYA, scorpions, centipedes, and millipedes
- Many Paleozoic Insect groups became extinct
- Oldest modern flying Insects - Carboniferous



Order Thysanura – Silverfish

- Never develop wings
- Feed on starch and glue

https://www.youtube.com/watch?v=ErBgOTBenIA

Order Plecoptera
Stoneflies

- Primitive group
- Carboniferous
- Generalized anatomy
- Chewing mouthparts
- Wings, but not strong fliers
- Most of life spent as a nymph in the water
- Adults short-lived
- Intolerant of pollution

Imitation Stonefly for Fly Fishing

Order Ephemeroptera - Mayflies

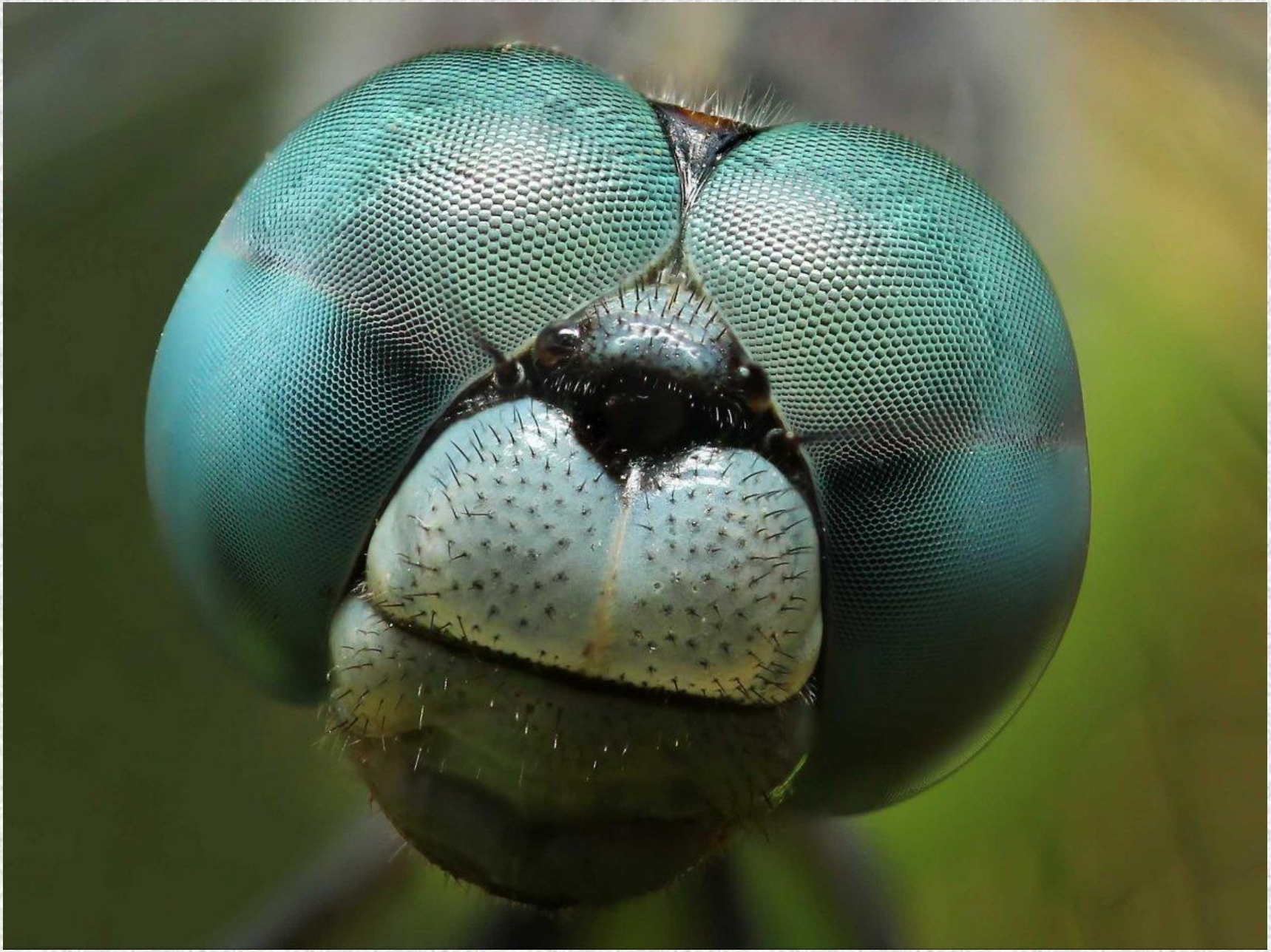
- Live for months as wingless aquatic larvae
- Adults emerge in great swarms, short-lived,
- Adults do not eat, mate only and lay eggs

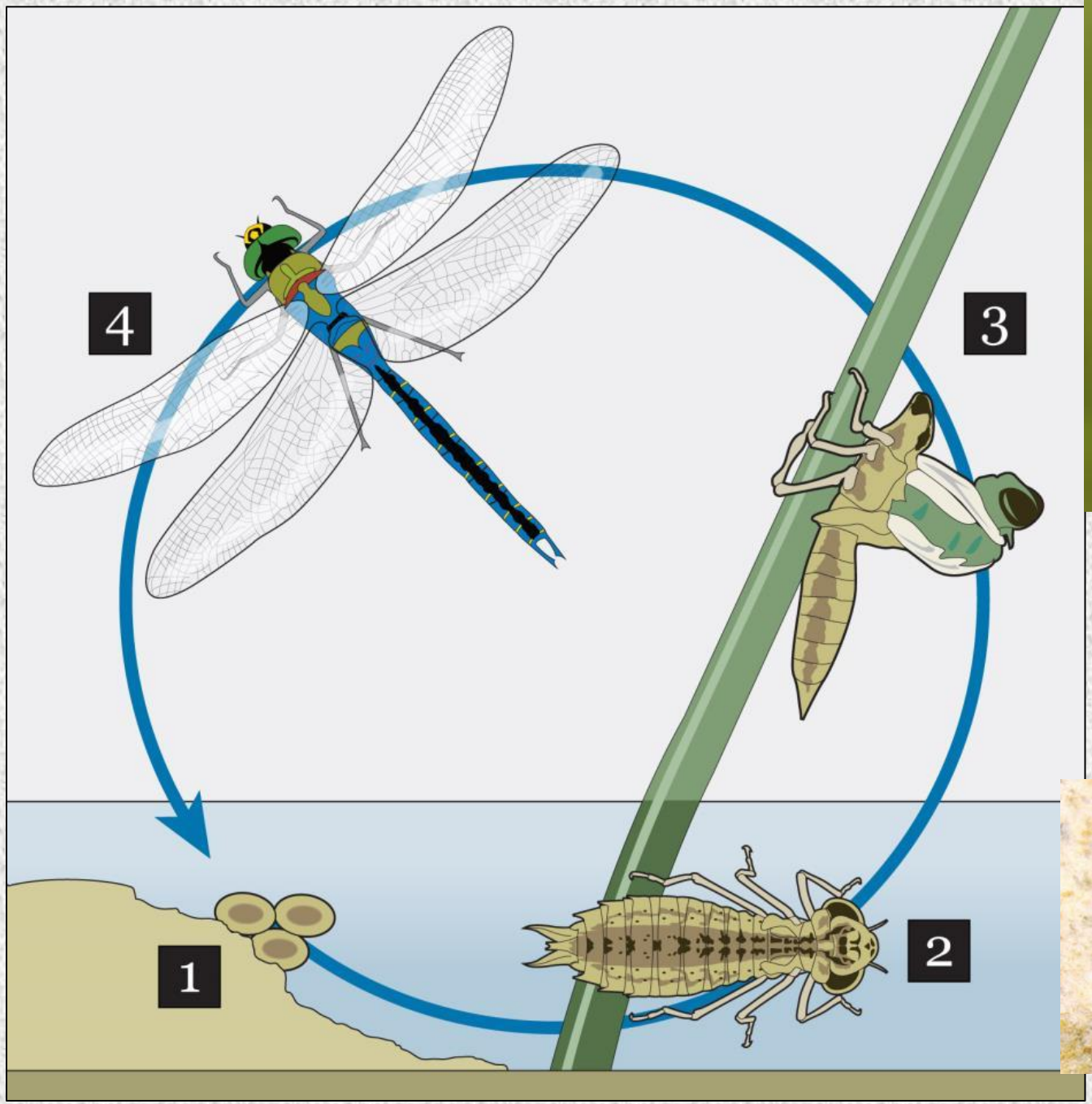
Swarming Mayflies in Wisconsin
https://www.youtube.com/watch?v=Nz_gAjp3zYc

Order Odonata
Dragonflies and Damselflies

- Ancient flying insects
- Cannot fold wings
- Larvae develop underwater, voracious predators
- Adults fast fliers, seize prey on the wing
- Damselflies more delicate

The Secret World of Dragonflies
https://www.youtube.com/watch?v=edW30jsCy6M
Dragonflies Hunting
https://www.youtube.com/watch?v=XWROwMxepoM
Sky Hunters, The World of the Dragonfly
https://www.youtube.com/watch?v=knlXTU1R_rE




4
3
1
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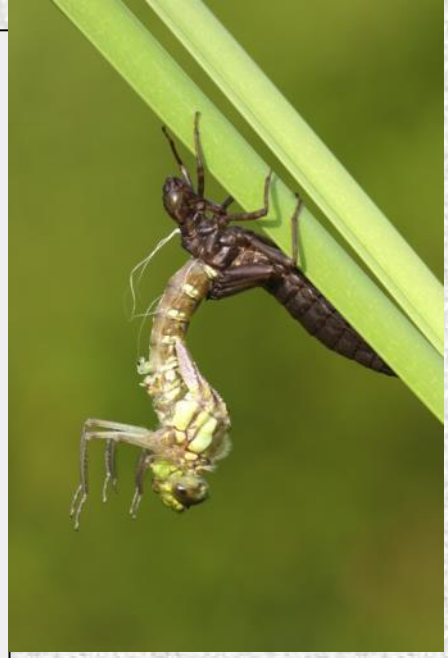


Order Orthoptera
Crickets and Grasshoppers

- Long hind legs used for hopping
- Chewing mouthparts
- Most can fly
- Sometimes swarm and destroy crops
- Young develop directly into adults, no metamorphosis
- Grasshoppers have shorter antennae than crickets, tend to be diurnal
- Crickets nocturnal

Edible Grasshoppers

Entomophagy, the consumption of insects as food

Edible insects
https://www.youtube.com/watch?v=r9M2JPscbmQ
Why eating insects makes sense
https://www.youtube.com/watch?v=euTBQOrpOmM
Edible Insects--Cambodian-style!
https://www.youtube.com/watch?v=0yULy-ikeEU

A delicious bug meal, another way to reduce your carbon footprint

Order Coleoptera
Beetles

- “Sheathed wing”
- First pair wings hardened, often shiny, as long as body, protect membranous flying wings
- Almost ¼ to ½ of all known animals are beetles
- Eat wide range of foods
- Many have chemical defenses
- Larvae often destructive


(c) A. Bockoven

Order Hemiptera
True Bugs

- “Half wing” part of first wing toughened or hard
- Posterior half of the front wings somewhat translucent or thinner and with veins
- Piercing and sucking mouthparts

Order Diptera
Flies: mosquitos, gnats, midges

- “Two wings”
- Single pair of wings
- Hindwings reduced to halteres, stabilizers
- Sucking mouthparts
- Some pollinators, fly syndrome
- Some carry disease, mosquitos - malaria

Flies lifecycle (#115)
https://www.youtube.com/watch?v=lcjAedlIPoU
World's Weirdest: Flies and Maggots
http://video.nationalgeographic.com/video/weirdest-housefly-maggots

Non-technical Videos of Household Bugs by Eric Hufschmid

Sewer fly
https://www.youtube.com/watch?v=3VsyroGlnjI

Fruit flies
https://www.youtube.com/watch?v=cM0e1MDAwfs

Spontaneous Creation - Dermestid Carpet Beetles
https://www.youtube.com/watch?v=Nkw8mER4Ryg

Spontaneous Creation Part 2 - Flies
https://www.youtube.com/watch?v=Fso0FynwVgU

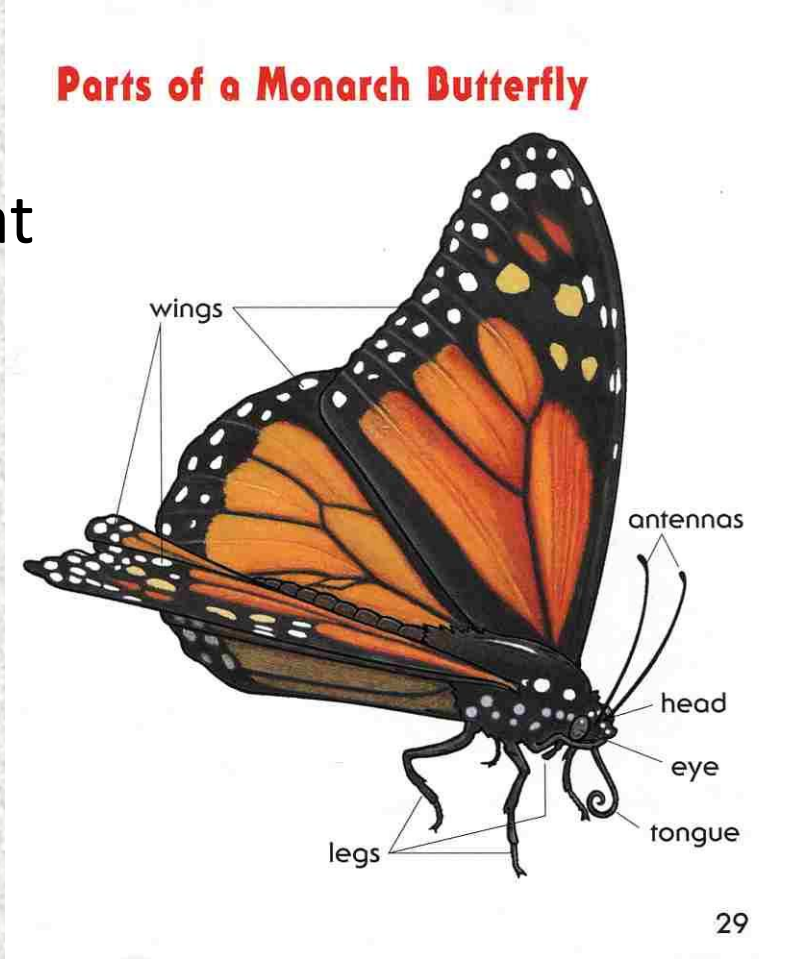
Drain bugs and crystals - worms, lice
https://www.youtube.com/watch?v=K0ujQZmapCw

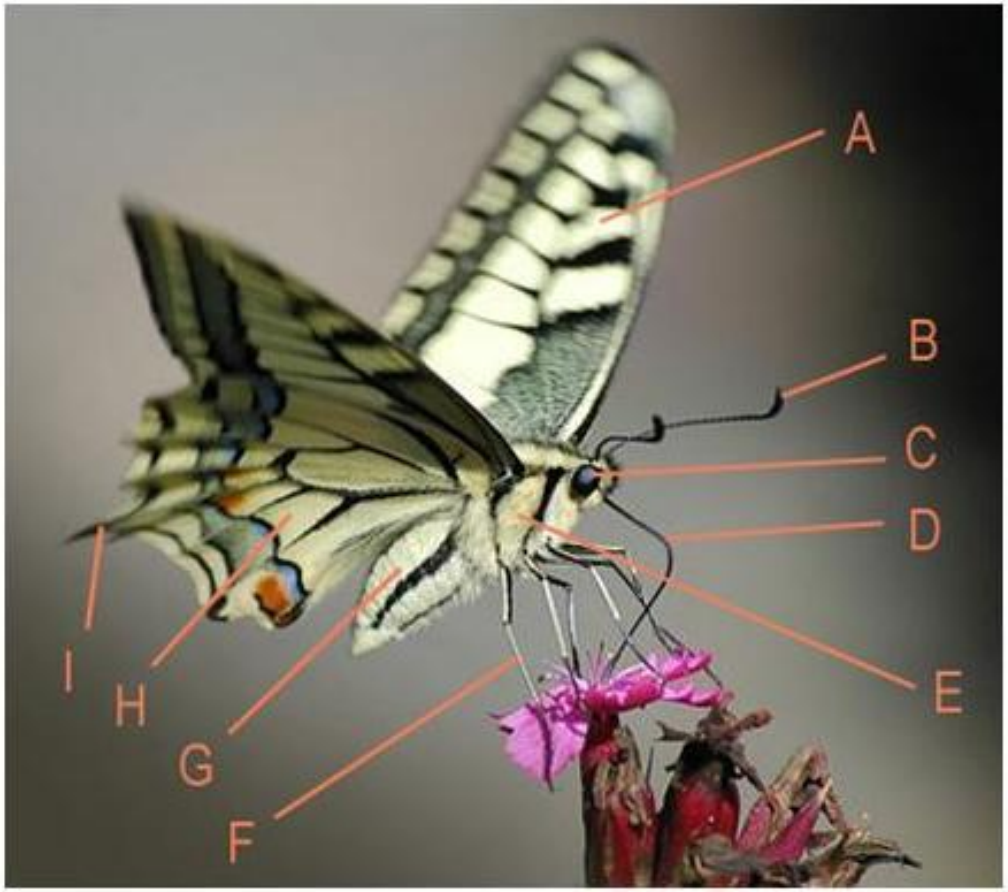
Citrus scale bugs
https://www.youtube.com/watch?v=1wCGfZkv88A

Virgin births - Moths
https://www.youtube.com/watch?v=_vDcyBdisxU

Order Lepidoptera
Butterflies and Moths

- 4 large wings, covered with small overlapping scales
- Thin antennae, small clubs at end
- Long **proboscis** for drinking nectar from flowers
- Caterpillars browse vegetation
- Pupae encased in cocoon
- Adults sip nectar

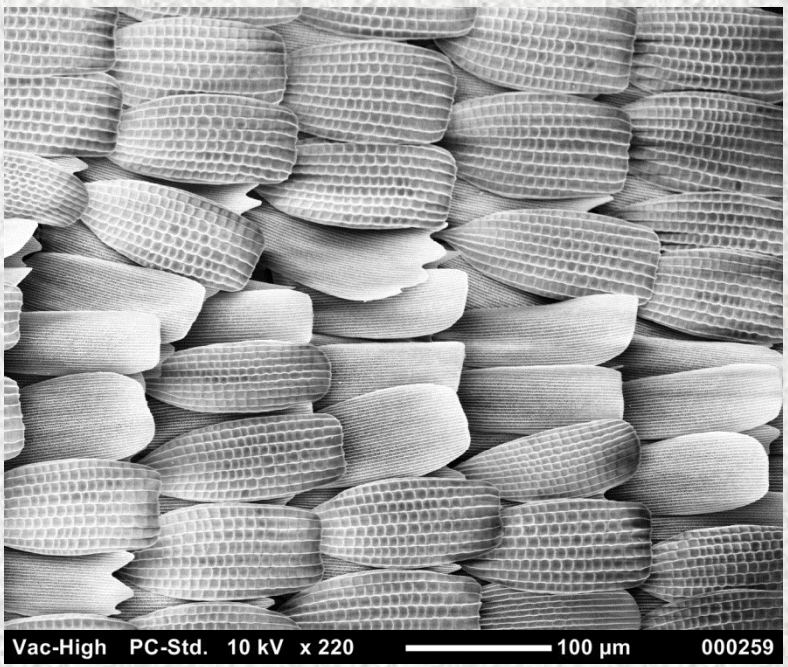


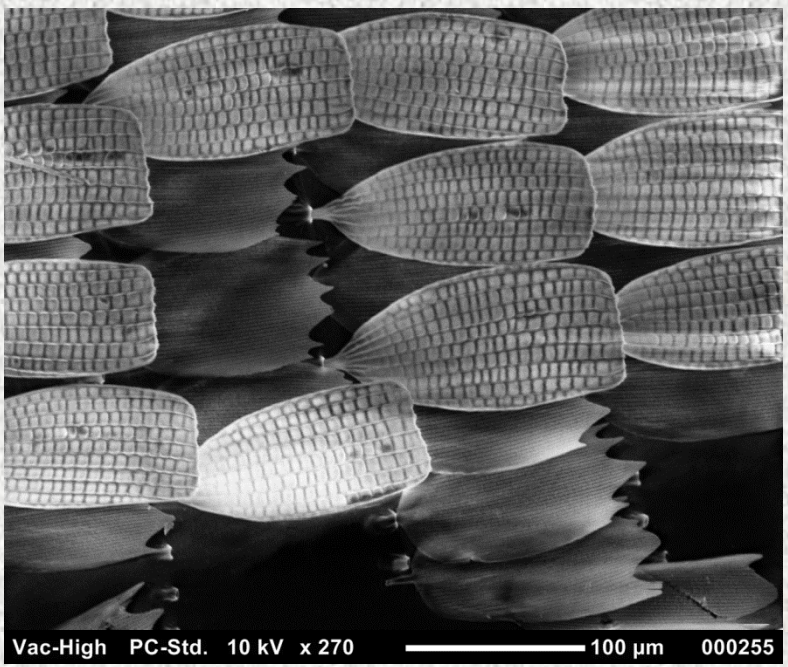


A. 2 Forewings
B. 2 Antennae
C. Head and 2 Eyes
D. Proboscis
E. Thorax
F. 6 Legs
G. Abdomen
H. 2 Hindwings
I. Scale on the wing

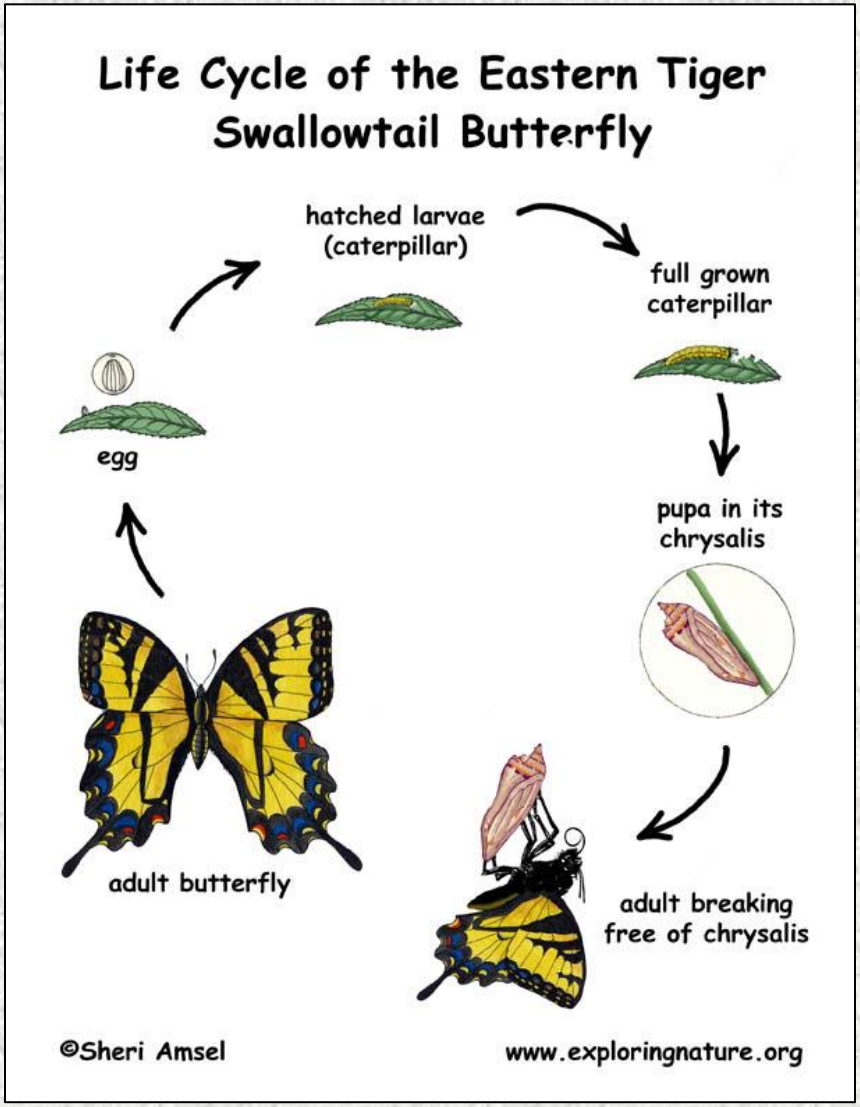
The wings are made up of many tiny scales and veins.

Emerald Swallowtail
Papilio palinurus
Wing Scales
MBG Butterfly House



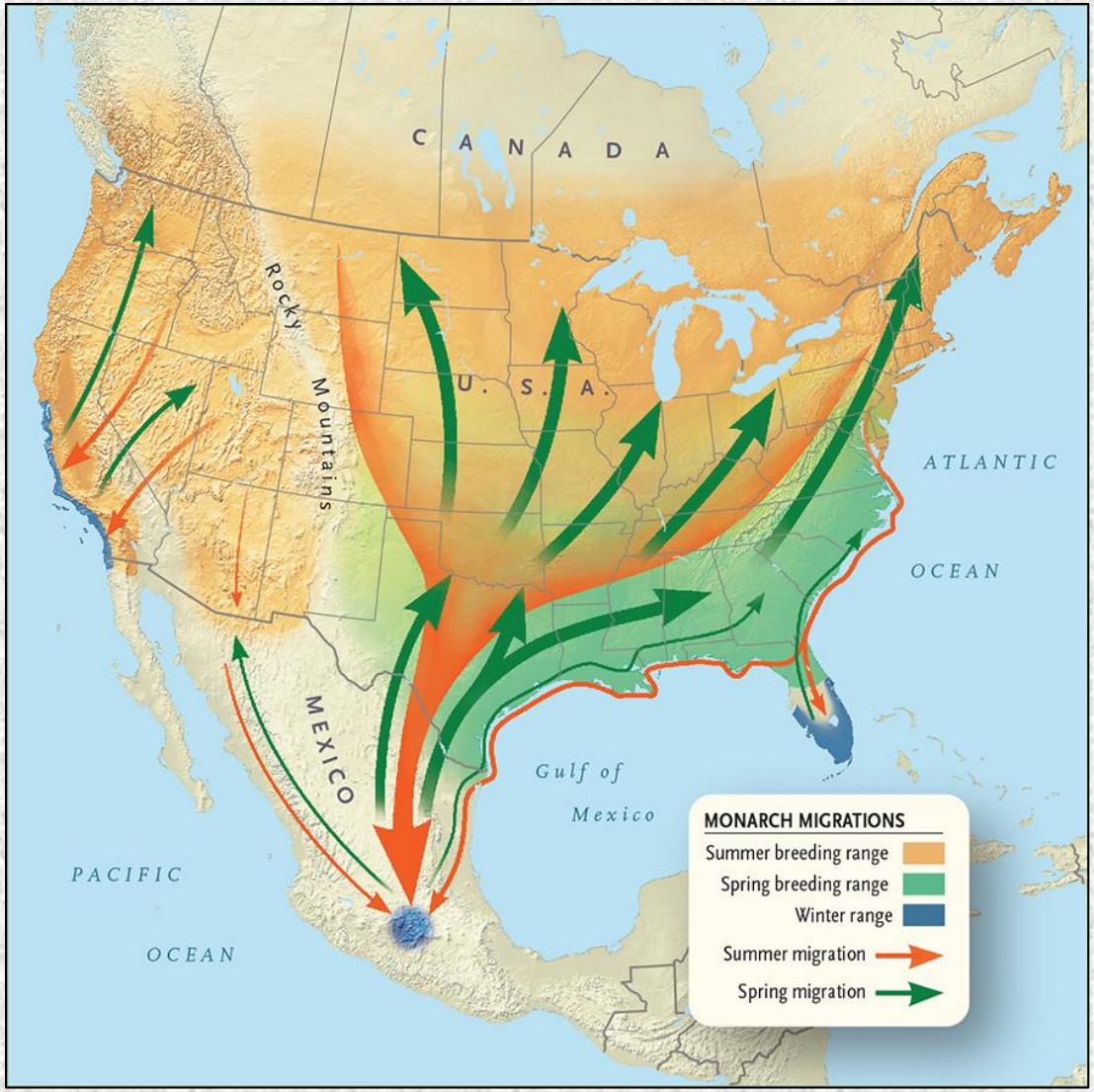


Butterfly Metamorphosis



Monarch Butterfly Metamorphosis time-lapse
https://www.youtube.com/watch?v=ocWgSgMGxOc

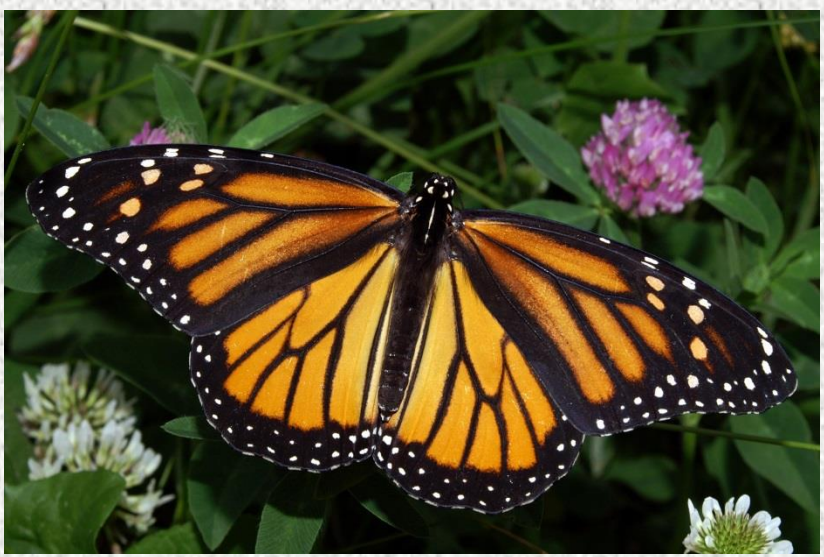
Monarch Butterfly Migration



Incredible Journey Of The Butterflies
https://www.youtube.com/watch?v=WdfIuVcwcQs
Why fewer monarch butterflies are surviving their winter migration to Mexico
https://www.youtube.com/watch?v=YUqwAAoBcPA

Monarch Migration (Part 1 of 2) - From Missouri to Mexico
https://www.youtube.com/watch?v=lWjNZvW0AkE

Monarch Migration (Part 2 of 2)
https://www.youtube.com/watch?v=oPKISz2ktuo



Lepidoptera - Moths

- Related to butterflies
- Most lepidopterans are moths, 160,000 spp.
- Mostly nocturnal, some diurnal
- Attracted to lights
- Dull colors
- Antennae lack clubs
- Silk Moths make silk
- Some pests in forest, damage clothes

Luna Moth life cycle
https://www.youtube.com/watch?v=atOSro3_W7c
Moth lays eggs in reporter's ear on live TV
https://www.youtube.com/watch?v=QQkbFXsaEQ4

Silkworm Moth, *Bombyx mori*

- Feeds on the leaves of the mulberry tree
- Cocoon thick , composed of a single thread commonly 900 meters (2,950 ft) long.
- Unraveled to provide commercial silk
- Domesticated 5,000 years ago in China

How silkworms make silk

https://www.youtube.com/watch?v=77ktNSPFbwQ

Order Hymenoptera
Bees, Wasps, Ants

- Very numerous and diverse
- Social ants and bees, worker and soldier castes, live in colonies controlled by a queen

- Bees important pollinators
- Flowers pollinated by bees are typically yellow or blue, provide nectar and pollen

Honey bees are important pollinators in agriculture

Vanishing Bees - Colony Collapse Disorder
https://www.youtube.com/watch?v=-40EBgMKl_0

Beekeeping Videos

Beekeeping
https://www.youtube.com/watch?v=n_-Z4Ha_4rc

Beekeeping Basics: Getting Started
https://www.youtube.com/watch?v=eFXvwefNr30

Beekeeping for Beginners -- Hive Set Up
https://www.youtube.com/watch?v=zDZDYgBkCx0

Portrait of an Urban Beekeeper
https://vimeo.com/93107778

Eastern Missouri Beekeepers Association
http://www.easternmobeekeepers.com/

The Beekeeper Stands Between Humans And Extinction
https://www.youtube.com/watch?v=Orb7nE6WQZY

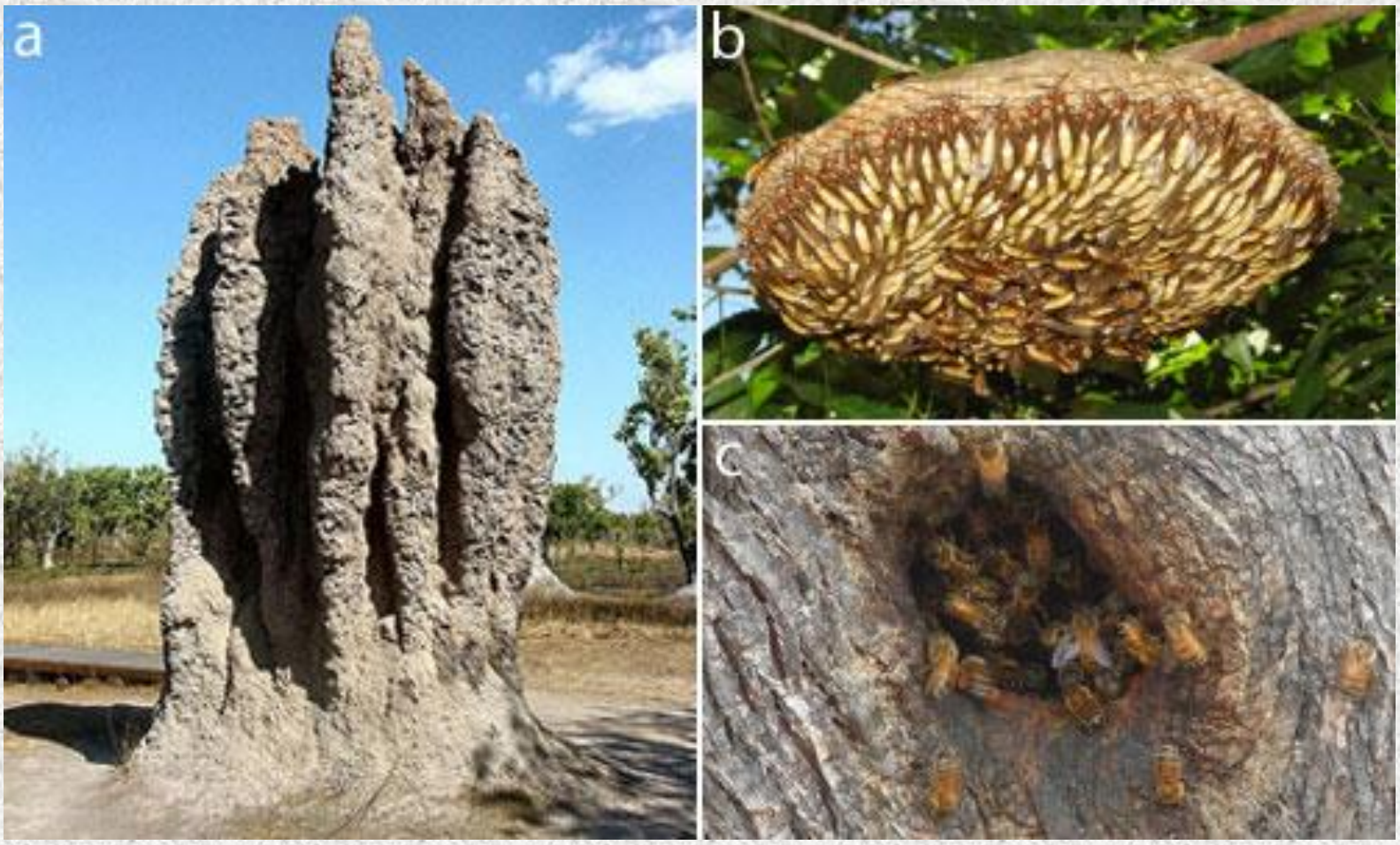
Colony Collapse Disorder
Honeybees

- Occurs when the majority of worker bees in a colony disappear and leave behind a queen, plenty of food and a few nurse bees to care for the remaining immature bees and the queen.
- 1972 to 2006, dramatic reductions in feral bees and commercial hives
- Possible causes – neonicotinoid pesticides, parasitic mites, disease, loss of habitat, stress

Queen of the Sun A Documentary Film on Bee Colony Collapse Disorder
https://www.youtube.com/watch?v=EugUEjH7j7A
Colony Collapse Disorder: An Urban Perspective
https://www.youtube.com/watch?v=QWPwhi2ZYxc

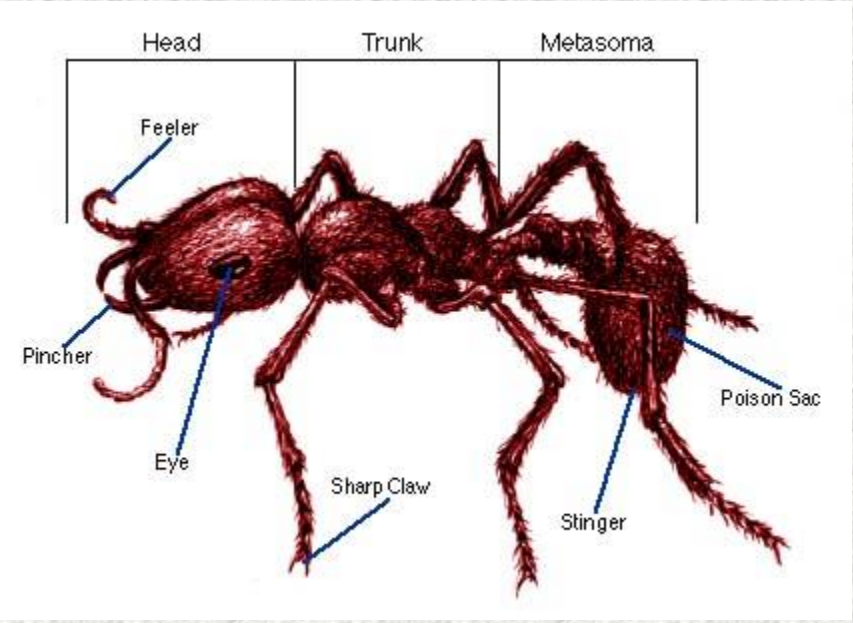
Great diversity of Native Bees

Social insects have well protected or defended nests, including termites (a), wasps (b), and bees (c).



Yellow Jackets & Fire Ants: Social Insects - Science Nation
https://www.youtube.com/watch?v=9cC01c-Zsoc

Hymenoptera - Ants



Ant Sociality

Major and minor workers of leafcutter ants

Ant colony raids a rival nest
https://www.youtube.com/watch?v=X5YaihAtnC4

Army Ants Eat Everything
https://www.youtube.com/watch?v=UozWJTuhbMQ

Imported Fire Ant Biology
https://www.youtube.com/watch?v=NYKEprUQWZ4

ANTS - Nature's Secret Power (Full)
https://www.youtube.com/watch?v=Z-gIx7LXcQM

Ant Documentary
https://www.youtube.com/watch?v=AWLdJOHXH0U

Leaf Cutter Ants Documentary
https://www.youtube.com/watch?v=LJXVa8gxrOo

Order Isoptera - Termites

- Feed on decaying wood
- Social castes – workers, soldiers, queen
- Live in large colonies with single queen
- Build giant nests in tropics

Termites - The Inner Sanctum - The Secrets of Nature
https://www.youtube.com/watch?v=DXbo5ubYS9I
Lifestyle of the Termite Queen
http://video.nationalgeographic.com/video/termite_queen

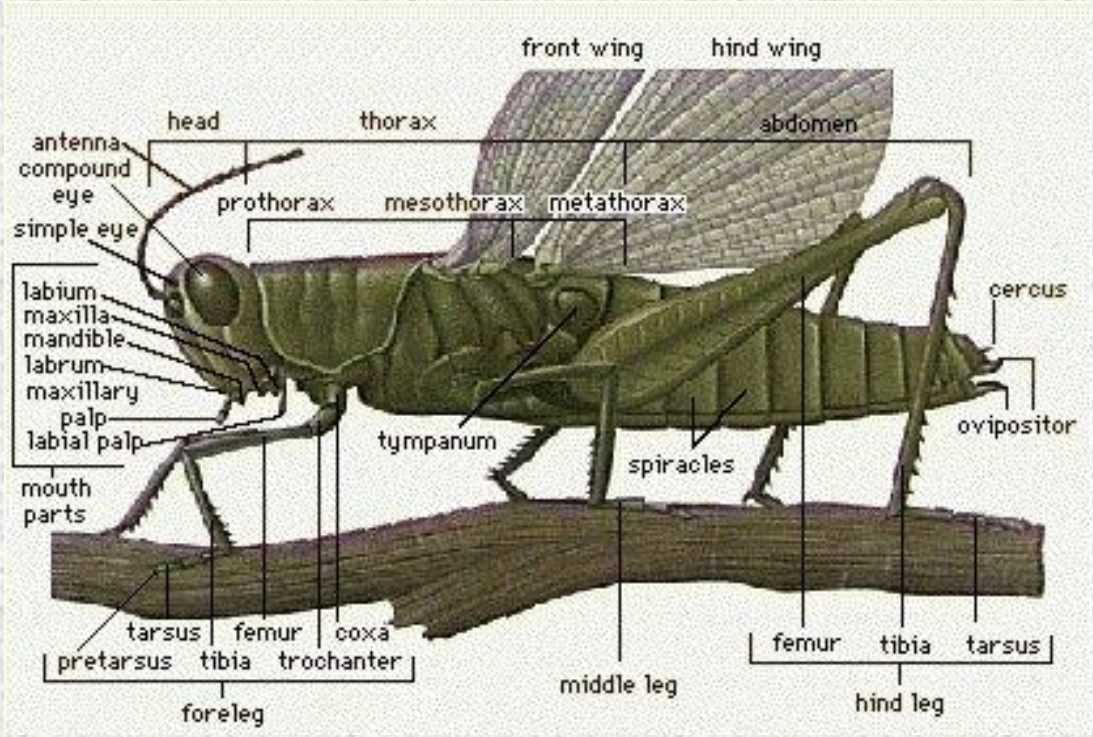
End

Class Insecta
(the insects)

- Far & away the most diverse of animal groups
  - More types of insects alone than all other animal groups combined
  - Inhabit all terrestrial & freshwater ecosystems.
  - Success largely attributed to coevolution with flowering plants.

Insect Body Plan

- Insects have 6 legs
- 3 body parts
  - Head
  - Thorax
  - Abdomen
- Most insects have wings, however in many species these are vestigal
- Have advanced excretory system composed of malphygian tubules
- Exchange gasses through a complex tracheal system



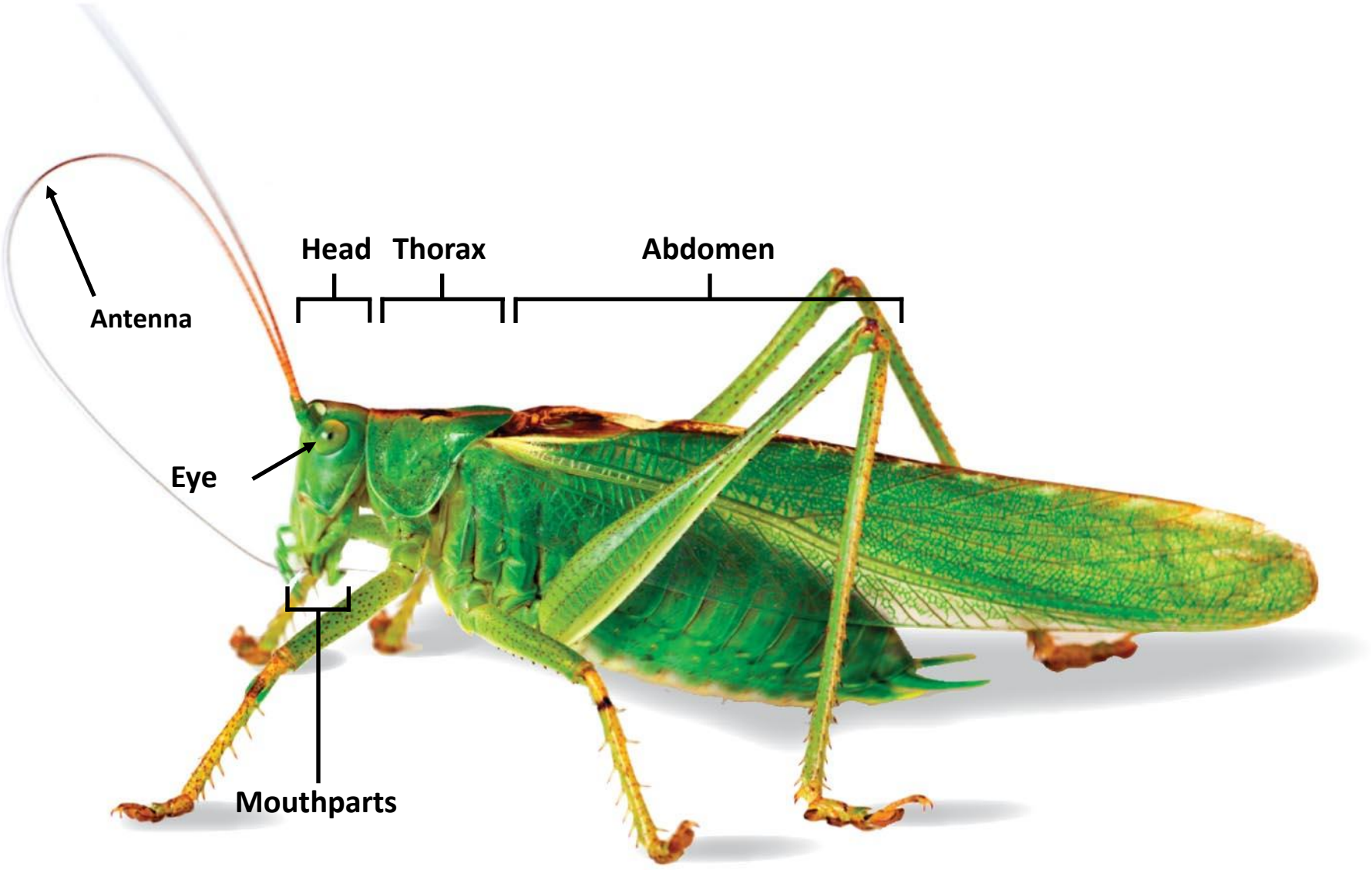


Figure 17.22

Banded Orange Heliconian

Giraffe weevil

Peacock katydid

Leaf roller

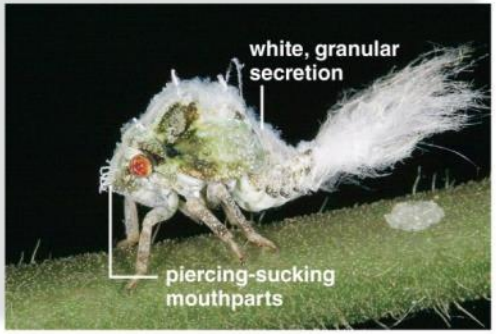
Praying mantis

Yellow jacket wasp

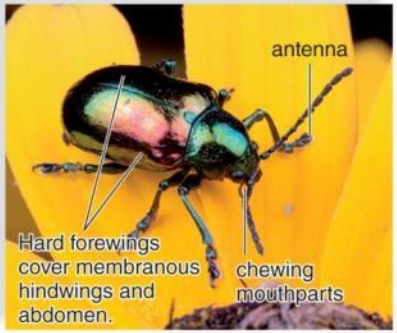
Leaf beetle

Longhorn beetle

Insect Diversity

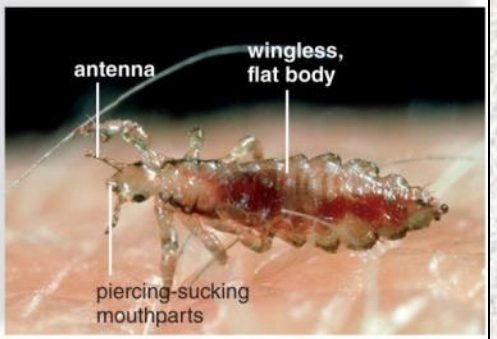


Mealybug, order Homoptera

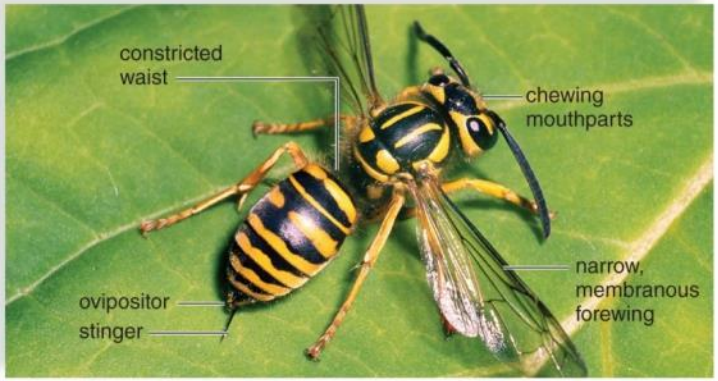


Beetle, order Coleoptera

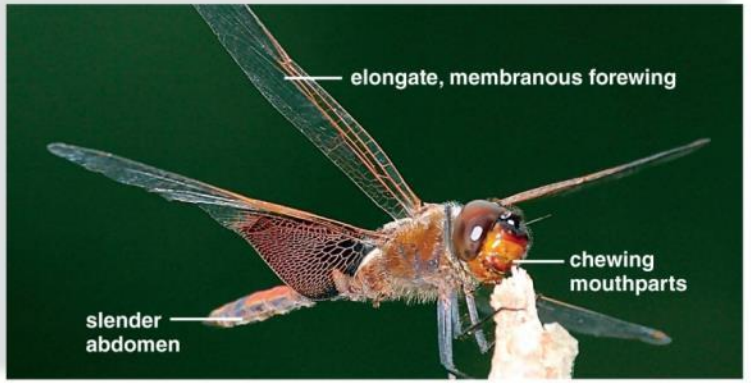
Leafhopper, order Homoptera



Head louse, order Anoplura



Wasp, order Hymenoptera



Dragonfly, order Odonata