Sight ID

- Phylum Arthropoda
- Subphylum - Chelicerata
- Class Arachnida
- *Loxosceles reclusa* – Brown Recluse
- Distribution in TN: Statewide
- Distribution in US: Southeast

ID Marks
- Fiddle on cephalothorax w/ neck of fiddle toward abdomen
- Abdomen has no spots or stripes
- Legs are a single color
Target Objectives for Arthropods

• Describe the characteristics of arthropods.
• Explain the main adaptations contributing to arthropod success.
• List the four main groups of arthropods and describe the features of each.
Phylum Arthropoda
Section 21.8

Phylum Arthropoda:
Trilobites, chelicerates, myriapods, crustaceans, and insects

Over 1,000,000 species of arthropods exist!

Deuterostomes
Mouth arises from second opening in embryo

Ecdysozoa
Periodic molting

Lophotrochozoa
Characteristic larvae and DNA sequences

Bilateria
Bilateral symmetry, three germ layers

Eumetazoa
True tissues

Radiata
Radial symmetry, two germ layers

Parazoa
No tissues

Ancestral protist
Multicellularity

Chordates
Echinoderms
Arthropods
Roundworms
Annelids
Mollusks
Flatworms
Cnidarians
Sponges

Figure 21.2
Arthropods Have Jointed Appendages

Key features

- Bilateral symmetry; three germ layers
- Molt cuticle
- Jointed appendages, exoskeleton, segmentation
- True tissues
- Multicellularity
- Protostomy
- Chordates
- Echinoderms
- Arthropods
- Roundworms
- Annelids
- Mollusks
- Flatworms
- Cnidarians
- Sponges
Phylum Arthropoda

- “jointed foot”
- Largest phylum
- 900,000 species
  - 75% of all known species
- Insects, spiders, crustaceans, millipedes, scorpions, ticks, etc.
Phylum Arthropoda (cont’d)

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

• The arthropod body plan consists of a segmented body, hard exoskeleton, and jointed appendages

• This body plan dates to the Cambrian explosion (535–525 million years ago)

• Early arthropods show little variation from segment to segment
• Arthropod evolution is characterized by a decrease in the number of segments and an increase in appendage specialization

• These changes may have been caused by changes in *Hox* gene sequence or regulation
EXPERIMENT

Origin of *Ubx* and *abd-A* Hox genes?

Common ancestor

Other ecdysozoans

Arthropods

Onychophorans (velvet worms)

RESULTS

Ant = antenna
J = jaws
L1–L15 = body segments
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
1. **Exoskeleton**
   - External: not enveloped by living tissue
   - Protection
   - Secreted by underlying epidermis
     - **Waterproof barrier**
     - **Chitin +/- calcium, lipoproteins**
     - **Modifications**
       - Can be site for muscle attachment
       - Energy stores- flying
       - Sensory receptors
       - Gas exchange
       - Bristles
1. **Exoskeleton (cont’d)**

- Varies from soft and permeable to hard, impermeable
- Between segments of body/appendages = thin + flexible
- Must be shed (ecdysis = molting) to allow growth
- Relatively heavy
  - Limits size
2. Efficient locomotion

- Tagmatization, more specialized than annelids
  - Regions = tagma/tagmata
  - Jointed appendages

Crayfish mouthparts
- Crushing food
- Food handling
- Drawing water into gills
- Touch, taste, food handling
3. Air piped directly to cells

- More efficient than most other invertebrates
- Most have efficient tracheal system of air tubes; some breathe by gills
- Limits size
4. Highly developed sense organs
   • Sight, touch, smell, hearing, balance, chemical reception

Displacement of seta initiates a nerve impulse in a receptor cell at its base

Eyes convert light energy into nerve impulses
5. Complex behavior patterns

- Complex, organized activities
- May be innate (unlearned) or learned
6. Limited **intraspecific** competition

- Many arthropods undergo metamorphosis
  - *meta* = between/after; *morphē* = form; *osis* = state of

- Different stages (ie. larva, adult) have different nutrition/habitats

.:. no competition
Research questions

• What is metamorphosis and why has it contributed to arthropod success?

• What phylum is most closely related to Phylum Arthropoda?
Arthropod Groups

1. Subphylum Trilobita
   - extinct trilobites

2. Subphylum Chelicerata
   - horseshoe crabs, spiders, ticks, mites, and some extinct groups

3. Subphylum Myriapoda
   - centipedes, millipedes

4. Subphylum Crustacea
   - crabs, lobsters, shrimps, barnacles

5. Subphylum Hexapoda
   - Insects
Subphylum Trilobita

- tri = three; lobos = lobes
- Divided into 3 longitudinal regions
- Extinct
- Oval, flattened
Subphylum Chelicerata

- Named for claw-like feeding appendage called chelicerae
- Horseshoe crabs, spiders, ticks, mites, scorpions
Subphylum Chelicerata (cont’d)

• **Cephalothorax**
  - Fused head and thoracic region
  - 6 pairs of appendages

• **Abdomen**
  - contains digestive, reproductive, excretory, and respiratory organs
Subphylum Chelicerata (cont’d)

- Appendages attached to cephalothorax
  - Pair of chelicerae (clawlike feeding appendages)
  - Pair of pedipalps (usually sensing or feeding)
  - Four pairs of legs (5 in horseshoe crabs)
Subphylum Chelicerata (cont’d)

• No antennae
• Most suck liquid food from prey
Class Arachnida

- Spiders, ticks, scorpions
- Most are predaceous
Class Arachnida (cont’d)

• Most are harmless/beneficial to humans
• Some spiders (ie. black widow, brown recluse spider) give painful, dangerous bites
Class Arachnida (cont’d)

- Scorpion sting can be painful, dangerous
Class Arachnida (cont’d)

- Some ticks and mites spread disease, cause irritation

Dust mite
Class Arachnida (cont’d)

• Lyme disease
  - Caused by tick

![Tick Image]
More on spiders ...... 
Order Araneae
Spiders

- cephalothorax and abdomen shows no external segmentation
Spiders (cont’d)

- All predaceous
  - Mostly insects
- Chelicerae have fangs
Spider Urban legends

Debunked!
• **MYTH:** Daddy longlegs (Harvestmen) are one of the most poisonous spiders but their fangs are too short to bite humans: **MYTH (!!!!!!!)**

• Daddy longlegs: Order Opilionid

• Spiders: Order Araneae

• One basic body segment (no pedicel)

• Don’t produce silk

• No venom, fangs
Spiders: Class Araneae

Spider love.....

- Spiders, like most arthropods, are dioecious
- Mating habits
  - Pheromones- chemicals that elicit behavioral change
  - Rituals- males pluck female’s web (pattern is species-specific)
Spiders: Class Araneae

- **Male builds small web, deposits sperm**
  - Collects sperm in cavities of pedipalps
  - Pedipalps have ejaculatory duct
  - Inserts pedipalps into female genital opening
Spiders: Class Araneae

- Eggs laid in silk case
  - Carried, attach to web, bury
A lycosid (wolf spider) preparing egg sac

M. C. Barnhart
Wolf spider parental care- after the eggs hatch, the young ride on mom for several days.
Brown recluse

- Violin-shaped stripe on back
- Necrotoxin
  - hemolytic
Loxosceles reclusa

• Necrosis of tissue
Day 3
Day 4
Day 5
Day 6
Day 9
Day 10
Myriapods

- Subphylum Myriapoda includes millipedes and centipedes
- Myriapods are terrestrial, and have jaw-like mandibles
- Millipedes eat decaying leaves and plant matter
- Millipedes have many legs, with two pairs per trunk segment
• Centipedes are carnivores
• Centipedes have one pair of legs per trunk segment
(b) Centipede

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Figure 33.34

(a) Millipede

(b) Centipede
Target Objectives for Arthropods

• Describe the characteristics of arthropods.
• Explain the main adaptations contributing to arthropod success.
• List the four main groups of arthropods and describe the features of each.
Insecta

- Subphylum Hexapoda, insects and relatives, has more species than all other forms of life combined
- They live in almost every terrestrial habitat and in fresh water
- The internal anatomy of an insect includes several complex organ systems
Grasshopper External Anatomy

- Head
  - Clypeus
  - Labrum
  - Mandible
  - Maxilla
  - Labium (lower jaw)
  - Frons
  - Gena (cheeks)
Grasshopper External Anatomy

- Head
  - Clypeus
  - Labrum
  - Mandible
  - Maxilla
  - Labium (lower jaw)
  - Frons
  - Gena (cheeks)
Grasshopper External Anatomy

• Body
  – Thorax  -Head  -Forewing  -Tympanum
    • Prothorax  -Abdomen  -Hindwing  -Leg
    • Mesothorax  -Antenna  -Spiracles
    • Metathorax  -Eye  -Ovipositor
Grasshopper External Anatomy

- Leg
  - Claws
  - Coxa
  - Femur
  - Tibia
  - Tibial Spurs
  - Trochanter
  - Tarsus
• Insects diversified several times following the evolution of flight, adaptation to feeding on gymnosperms, and the expansion of angiosperms

• Insect and plant diversity declined during the Cretaceous extinction, but has been increasing in the 65 million years since
• Flight is one key to the great success of insects
• An animal that can fly can escape predators, find food, and disperse to new habitats much faster than organisms that can only crawl
• Many insects undergo metamorphosis during their development

• In **incomplete metamorphosis**, the young, called nymphs, resemble adults but are smaller and go through a series of molts until they reach full size
Life Cycle

Simple Metamorphosis
• Insects with **complete metamorphosis** have larval stages known by such names as maggot, grub, or caterpillar

• The larval stage looks entirely different from the adult stage
Figure 33.37

(a) Larva (caterpillar)
(b) Pupa
(c) Later-stage pupa
(d) Emerging adult
(e) Adult
Most insects have separate males and females and reproduce sexually.

Individuals find and recognize members of their own species by bright colors, sound, or odors.

Some insects are beneficial as pollinators, while others are harmful as carriers of diseases, or pests of crops.

Insects are classified into more than 30 orders.
Archaeognatha (bristletails; 350 species)

Thysanura (silverfish; 450 species)

Winged insects (many orders)

Complete metamorphosis

- Coleoptera (beetles; 410,000 species)
- Diptera (151,000 species)
- Hymenoptera (125,000 species)
- Lepidoptera (120,000 species)

Incomplete metamorphosis

- Hemiptera (85,000 species)
- Orthoptera (13,000 species)

Orders to know
The Grasshopper: the digestive system

- Grasshoppers feed on plants so their mouthparts are modified for cutting & chewing plant materials
- The **labrum** & **labium** are mouthparts that function as upper & lower lips
- They hold the food in place so the sharp **mandibles** & **maxillae** can cut it
- The food is moistened by saliva, passes through the **esophagus** & into the **crop** for temporary storage
The digestive system...

- The food then pass into the **gizzard** where it is ground & shredded & is pushed into the **midgut**
- In the midgut, enzymes are released to digest the food & nutrients are absorbed
- Undigested matter enters the **hindgut** & leaves the body
The "generalized" digestive system of insects.
The Grasshopper: Circulatory system

• Nutrients are transported through the body of a grasshopper by an open circulatory system
• Hemolymph (blood) flows through a large dorsal vessel called the aorta
• The heart is located in the abdomen & thorax pumps the hemolymph towards the head where it slowly moves through a sieve like structure called a coelom
• The hemolymph then slowly makes its way back to the heart to be recirculated
How do circulatory systems compare?
The Grasshopper: nervous system

- The central nervous system consists of a brain & a ventral nerve cord with ganglia located in each body segment.
- Ganglia are small nerve centers that control each segment & boost signals from the brain.
- In the head, nerves extend from the brain to the sensory organs:
  - **Antennae:** touch & smell
  - **Simple eyes:** measure light intensity
  - **Compound eyes:** composed of hundreds of lenses, provide a wide field of vision & detect motion.
• Other nerves extend from the segment ganglia to the muscles
• The abdominal ganglia connects to a sound sensing organ called the *tympanum*
  – It is an oval window found on the first abdominal segment which is hollow & full of air
  – Sounds cause the tympanum to vibrate, sending a signal to the nearby nerves that are interpreted as sound
Crustaceans
The Crustaceans

- Phylum Arthropoda
  - Subphylum Crustacea
    - *crustae* = shell
- Lobster, crayfish, shrimp, crab, water flea, barnacles

- Crabs
- Shrimp
- Lobsters
- Amphipods
- Euphausiids (krill)

*Phylum Arthropoda*
The Crustaceans (cont’d)

- Aquatic (mostly marine)
  - a few terrestrial forms

- Major ecological and economical importance.

- Lobsters
- Shrimp
- Amphipods
- Euphausids (krill)
• Only arthropods with 2 pairs of antennae
Crayfish External Anatomy
• Great specialization of appendages
  - Mouthparts chewing, grinding, handling
- appendages strengthened for walking or protection (chelipeds, pincer-like claws)
The cardiac stomach has 3 teeth that grind food called the gastric mill.
Crayfish also have a liver that produces digestive enzymes and enters the midgut through ducts (nearly identical to ours).
Digestive

- Crayfish eat snails, tadpoles, insects, larvae, decaying matter
- Mostly Nocturnal
Digestive Pathway:
Mouth - Esophagus - Cardiac stomach - pyloric stomach, midgut, intestine, anus
Circulatory

- Similar to worm, but is open so NO VEINS
  - System Includes
  - Heart
  - Seven arteries carry blood to body
  - Sinuses to return blood
  - Large pericardial sinus surrounding heart
  - Blood nearly colorless contains hemocyanin, a copper containing respiratory pigment
  - Can clot
Respiratory System

- Gills are very prominent during dissection
Respiration
- gills (usually)
Excretory system

• Excretory organs area pair of green glands (similar to our kidneys)

• Green gland consists of a glandular portion, a thin walled bladder, and a duct leading to the renal pore that opens to outside and is just behind the eye
What’s the difference between a crayfish and a lobster?

- Same Order, but different families
- Lobsters are bigger
- Lobsters are marine; crayfish live in freshwater creeks, ditches, or lakes
Next Class

- Read in Chapter 20 the section over Echinoderms before Thursday class
- Quiz over Grasshopper Anatomy both internal and external
- Echinodermata notes
Target Objectives for Arthropods

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