Overview of the Class Arachnida
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Biology 316 - General Entomology

A. Subphylum Chelicerata
1. Review of the characteristics
   a. Six pairs of appendages
   b. The first pair of appendages is the chelicerae.
   c. Lack antennae
   d. Lack mandibles (mouthparts)
   e. The body is divided into two distinct tagma (regions), the prosoma (cephalothorax) and the opisthosoma (abdomen).

B. Class Arachnida - spiders, mites, ticks, scorpions, etc.
1. Review of the general characteristics
   a. Primarily terrestrial and predaceous, there are over 70,000 described species worldwide with about 8,000 being found in North America.
   b. Arachnids were the first arthropods to move into terrestrial environments. Scorpion fossils first appear in Silurian deposits (420 million years ago).
   c. In addition to the chelicerae, arachnids also possess a pair of pedipalps, the second pair of appendages usually not used for locomotion.
   d. They usually have sucking mouthparts or a strong sucking pharynx used to ingest prey fluids.
2. Team Project - D takes notes, A speaks
   a. List ten words or phrases that are "gut reaction" descriptors (please, no scientific terms!) of the Arachnida.
3. Gas exchange
   a. The primitive state of arthropods is to be aquatic and use some form of gill-like structure for respiration.
b. Terrestrial lifestyle has arisen perhaps four times within the Arthropoda, depending upon which phylogeny proves to be correct.

c. For arachnids, gas exchange is via book lungs, structures very similar to the book gills found in the Merostomata (horseshoe crabs).

d. A book lung is an assemblage of hollow, flat plates through which air circulates. Hemolymph flows among these plates and carbon dioxide and oxygen are exchanged passively via diffusion along a concentration gradient.

e. Some forms have specialized musculature that allows the spiracles (opening to the outside) to be closed or opened.
f. Many arachnids also possess trachea, respiratory tubules, and tracheal lungs. These structures are probably not homologous to the tracheal system seen in the hexapods. Although all arise as ectodermal invaginations.

4. Team Project - B takes notes, C speaks
   a. List two ways that gas exchange in arachnids is similar and dissimilar to gas exchange in humans.

5. Digestion
   a. Despite the diversity in body form within the Arachnida, the digestive tract is remarkably similar among the Orders.
   b. Most arachnids are carnivores.
   c. All lack jaws, necessitating the consumption of very fine particles.
   d. Most use their chelicerae or pedipalps to capture prey and to break it into very small fragments. Some also use their walking legs to "mince" prey.
   e. The esophagus is very narrow in all groups and most depend upon a pumping system to obtain fluid food.
   f. All groups have diverticula or digestive glands associated with the midgut that produce digestive enzymes.
   g. The midgut shows extensive infolding, increasing surface area to volume.
   h. Prior to ingestion, salivary secretions are put on the outside of the prey item allowing for predigestion and softening before it is swallowed.
   i. This is a slow process and many groups have developed venom that immobilizes the prey as it is slowly predigested. (Pleasant thought, no?)
   j. Venom glands appear in various structures within the arachnids suggesting independent evolution.

6. Excretion (see spider diagram from previous section)
   a. Two kinds of excretory organs are found in the arachnids, coxal glands and Malpighian tubules.
b. The coxal glands are considered to be ancestral, while Malpighian tubules are derived. The Malpighian tubules of the arachnids are NOT homologous to those of the hexapods. The Malpighian tubules arise from the midgut in arachnids and from the hindgut in hexapods.

c. Coxal glands are highly modified nephridia and resemble those seen in the Merostomata. They are most efficient at excretion in aquatic environments.

d. The coxal gland consists of an opening to the outside near the base of certain walking legs, a complicated tubular network called the labyrinth, and a sac-like structure called the sacculus. Nitrogenous wastes are picked up via the labyrinth and are temporarily stored in the sacculus. The actual morphology varies somewhat from group to group.

e. Malpighian tubules (named after the 17th century Italian scientist, Marcello Malpighi) are blind tubules that connect to the gut near the union of the midgut and the hindgut. In arachnids the tubules form a branched mass that often times...
connects to a stercoral pocket or sac, where nitrogenous wastes are stored prior to excretion.

f. The primary excretory product of arachnids is guanine, although uric acid and other compounds are also excreted. Guanine, like uric acid, is insoluble in water and relatively non-toxic. It can be excreted with little associated water loss.

7. **Team Project - A takes notes, D speaks**
   a. List two ways that excretion in arachnids is similar and dissimilar to excretion in humans.

8. **Circulation**
   a. Arachnids, like other arthropods, have an open circulatory system.
   b. They have a dorsal heart with ostia (small holes) connected to the pericardial sinus and giving rise to open-ended vessels.
   c. Hemolymph is pumped from the heart to the vessels that empty into the hemocoel.
   d. Hemolymph enters the heart through the pericardial sinus via expansion of the heart through the action of suspensory ligaments.

9. **Nervous system and sensory structures**
   a. The central nervous system of arachnids, like all arthropods, consists of a ventral, solid nerve cord and a series of fused ganglia associated with various body segments.
   b. The cerebral ganglion (brain) gives rise to the nerves to the eyes and the chelicerae.
   c. Opisthosomal ganglia primarily innervate the walking legs.
   d. For all arthropods, most tactile receptors are movable bristles or setae whose internal ends are associated with sensory neurons.
   e. Chemoreception also occurs via setae. The outer layer of arthropods, the cuticle, is nearly impermeable, necessitating specialized setae with permeable cuticular coverings. Others have small pores or slits through the cuticle, sometimes through hollow setae, that allow chemicals to contact chemoreceptor neurons.
f. Arachnids possess simple eyes. We will discuss eyes in detail when we cover the individual orders in lecture.

10. Reproduction

a. Terrestrial arthropods must overcome the challenges of producing eggs or offspring that are resistant to desiccation.

b. Unlike their aquatic cousins, the horseshoe crabs who deposit their eggs in a watery environment, arachnids are almost entirely terrestrial.

c. We will cover the details of reproduction as we cover the orders, but a few generalities are worth mentioning here.

d. Fertilization is internal with the pedipalps or the chelicerae serving in sperm transfer. In some, the sperm packet is placed on the ground and the female picks it up. Most males lack a penis; Opiliones and some Acari possess a penis.

e. The sperm packet that is transferred to the female is called a spermatophore.

f. Sperm is stored in the female is special chamber or receptacle (seminal receptacle) where they are released by the female as she deposits the eggs. Oviposition may occur months after sperm transfer.

g. Developing embryos are protected by an egg case or cocoon or are brooded within or on the female.

11. Phylogeny

a. Based on 93 morphological characters, 1000 bases of the 18S rDNA, and 350 bases of the 28S rDNA, Wheeler and Hayashi (1998) produced the following cladogram:

b. The starred groups are ones covered in this course.