Subphylum Myriapoda and Insect External Morphology and Sensory Structures

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Biology 316 - General Entomology

A. Subphylum Myriapoda

1. Characteristics

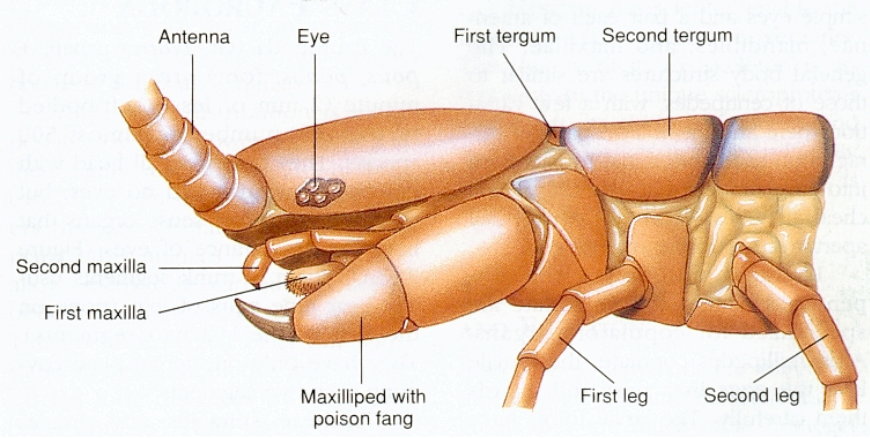
a. All myriapods are terrestrial. As such, they show similar adaptations to prevent desiccation and enhance land-based mobility that were seen in the arachnids.

b. They have mandibles for crushing food items.

c. Tracheal system for gas exchange. Note: this tracheal system may or may NOT be homologous to that seen in the arachnids. No book lungs.

d. Excretion of nitrogenous wastes via Malpighian tubules (again, may or may NOT be homologous to those seen in the arachnids) and no coxal glands.

e. One pair of antennae.



2. Class Chilopoda (centipedes)

a. Dorso-ventrally flattened with first body segment appendages modified into poison fangs.

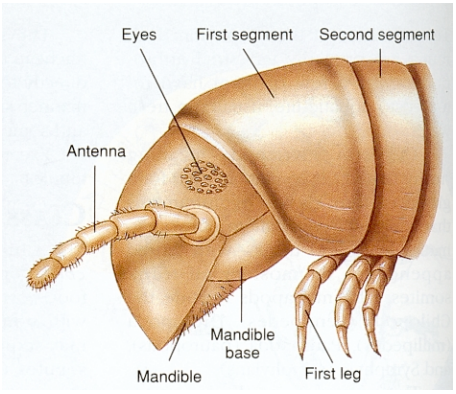
b. One pair of appendages per somite (segment).

c. All are predatory and inhabit moist habitats.

3. Class Diplopoda

a. Cylindrical in shape with fusion of somites to form diplosegments each bearing two pair of appendages.

b. All are either scavengers or herbivores found in moist habitats.



B. Subphylum Hexapoda

1. Characteristics

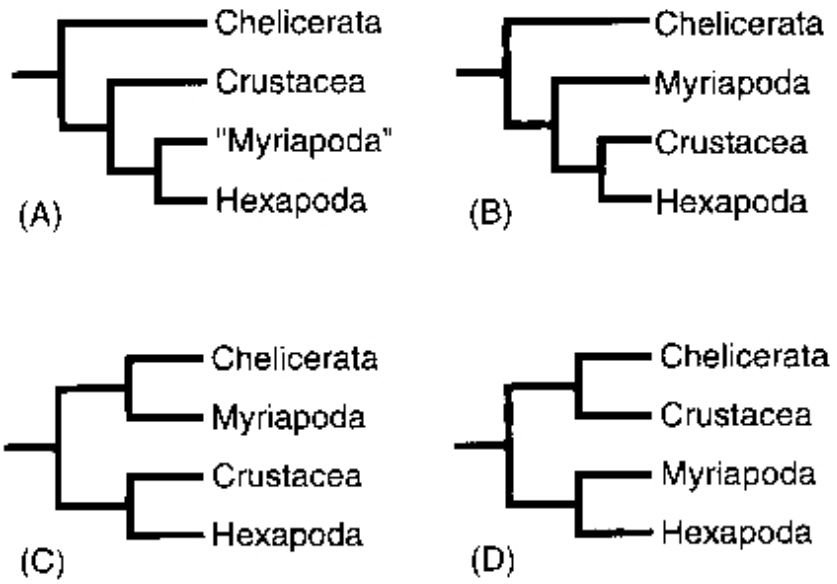
a. Body divided into three distinct regions (head, thorax, abdomen).

b. The thorax bears three pairs of walking legs and in species with wings, one or two pair of wings.

c. No abdominal appendages.

d. Malpighian tubules and tracheal system are present. These are NOT homologous to those in the arachnids, but it isn't clear how they relate to those in the myriapods.

2. Review of different hypotheses regarding the phylogeny of the arthropods



a. Trees (B) and (C) currently have the most supportive data.

b. In the case of (B), Malpighian tubules and the tracheal system could be ancestral to the Myriapoda-Crustacea-Hexapoda clade with the Crustacea losing them secondarily.

c. If (C) is the correct tree, could we have had three independent evolutionary events of such structures?

3. Team Project - B takes notes, C speaks

a. Give an argument to support one of the trees above. You may use any combination of characters.

C. Insect integument (body covering)

1. Primary function is forming the exoskeleton

a. The exoskeleton is composed of hardened plates called sclerites.

b. The system of sclerites provides protection against the external environment.

i Abrasion

ii Desiccation

iii Entry of pathogens and parasites

iv Sometimes predation

c. Provides support and sites for muscle attachment

d. Sensory and exocrine structures interface with the external environment via the exoskeleton.

e. Coloration vital for camouflage, mimicry, warning coloration, and mate recognition occurs in the exoskeleton.

2. A modified form of the integument lines portions of the alimentary canal, the tracheal system, genital ducts, and the ducts of dermal glands.

3. The body wall is composed of three layers (Fig 2-1)

a. Cuticle - an acellular layer of three parts

i The outermost layer, the epicuticle, is not chitinous but contains wax that renders the insect very resistant to desiccation.

ii The two inner layers contain chitin, a polysaccharide, embedded in a protein matrix. Chitin is a chemical cousin to cellulose.

(1) The exocuticle is hard (sclerotized), inflexible, and lost during molts. Sclerotization is a tanning process whereby the proteins of the exocuticle become hard. It is brought about by phenols and quinones and varies with the insect and the body part. Caterpillar bodies are nearly unsclerotized and are very soft while the mandibles of some beetles are so hard they can cut through metals such as lead, tin, and copper.

(2) The endocuticle, lying below the exocuticle, is pliant (unsclerotized) and absorbed during molting.

b. Epidermis - a cellular layer beneath the cuticle.

i Secretes the cuticle

ii Secretes the exocrine glands - glands whose products are secreted into the external environment or internal spaces via apertures or ducts

(1) defensive chemicals such as the "stink" of true bugs, alarm pheromones of aphids, and sticky substances of soldier termites

(2) pheromones used in interspecific communication

(3) structural materials like the wax of honeybee hives, silk of lepidopterans, and the filamentous gunk of white flies

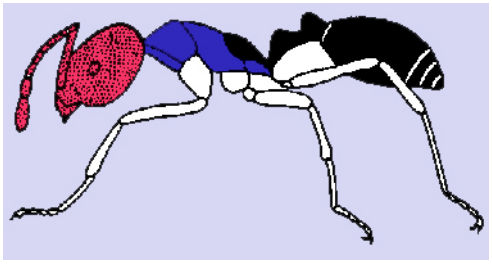
iii Form the modified cells that produce sensory structures like setae

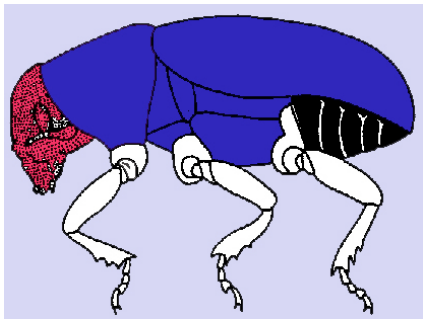
c. Basement membrane - an acellular layer lying below the epidermis

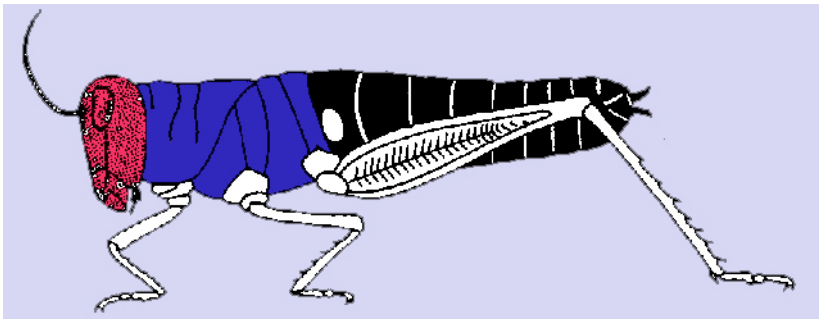
4. Sutures are lines of fusion between two formerly separated sclerites seen on the outside of the animal.

D. Insect Tagmata

1. The three tagmata (head, thorax, abdomen)







2. General structures

a. Head - sensory, neural integration, and feeding
   - i antennae
   - ii mouthparts
   - iii compound eyes and ocelli

b. Thorax - locomotion
   - i three parts, pro-, meso-, metathorax
   - ii dorsal (top) sclerites are called nota (sing. notum)
   - iii sides are called pleura (sing. pleuron)
   - iv ventral sclerites are sterna (sing. sternum)
   - v Each of these parts is subdivided.

c. Abdomen - houses the visceral mass and reproductive structures
   - i eleven segments or metameres
   - ii dorsal sclerites are called terga (sing. tergum)
   - iii the membranous lateral regions are called pleura (like the thorax)
   - iv ventral sclerites are called sterna (like the thorax)

3. Team Project - A takes notes, B speaks

a. The insects and the arachnids share many aspects of their morphology yet the insects have 30 times the number of species compared to the arachnids. Identify three ways the insects differ morphologically from the arachnids. Explain how these differences may play a role in allowing the insects to become so speciose.

4. Head

a. General morphology (Fig 2-9)

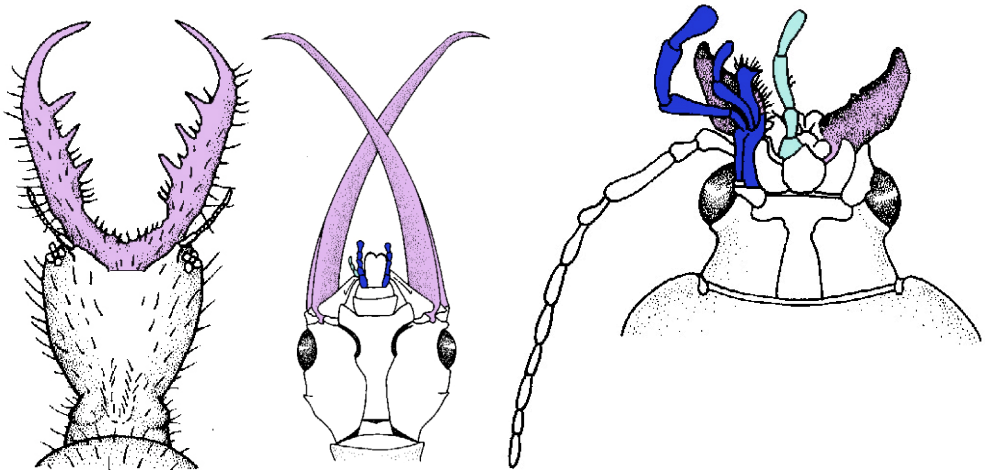
b. Antennae types (Fig 2-17)

i Note: There are many other types of antennae. Many of these are specific to certain orders and these are described in the chapter for the order (s) in which they are found.

c. Mouthparts

i Mandibulate - generally used chewing. The mandibles provide a surface for cutting and grinding food.

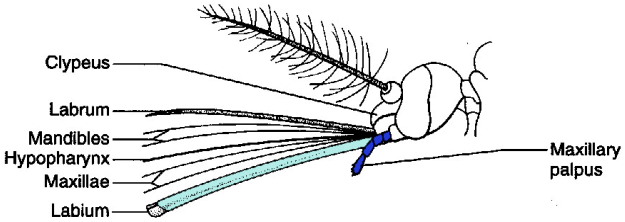
ii Mandibles are considered to be the ancestral condition. All other mouthpart types are modified from the basic mandibulate morphology. Mandibles are show in purple below.

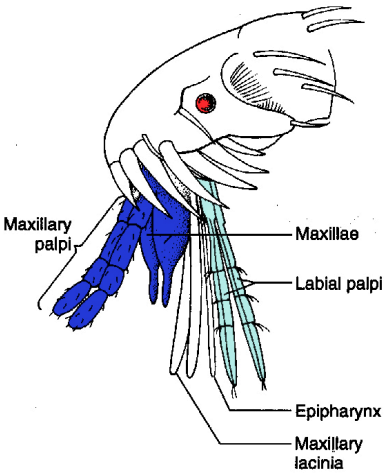


iii Several examples of modified mandibles include those of the ground beetle and the antlion larva (catching and holding prey) and the male dobsonfly uses his to hold the female during mating.

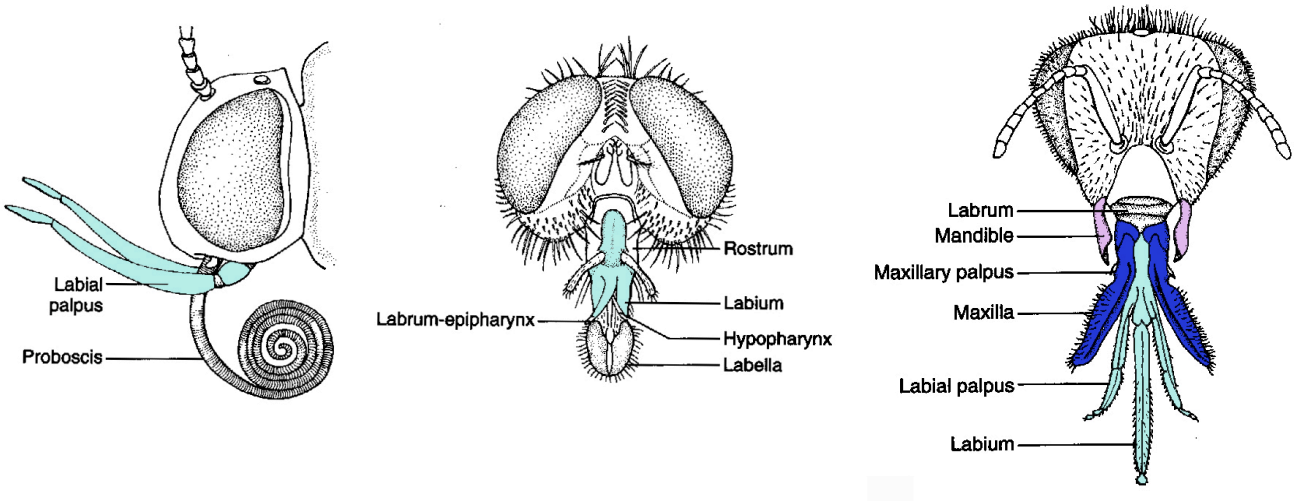
iv Haustellate - generally used for sucking

(1) Stylate haustellate have stylets, sword-like or needlelike modifications of one or more of the generalized mouthparts. The stylets allow for piercing or abrading plant or animal tissues.





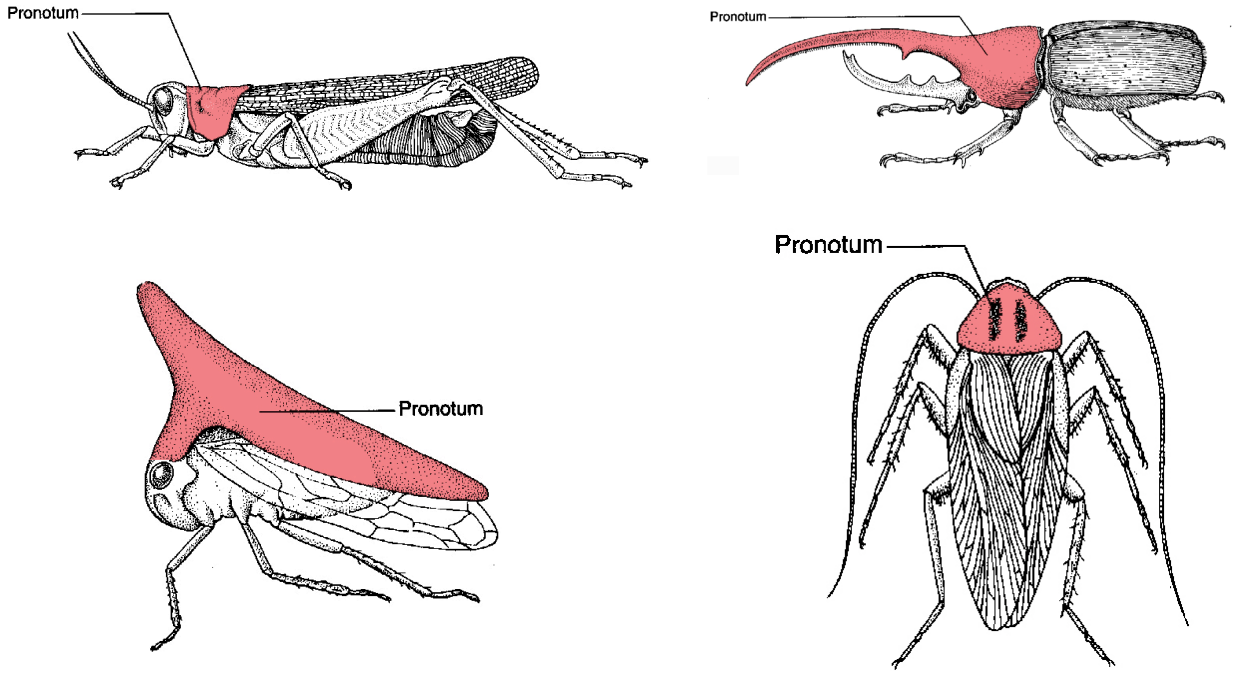
(2) Nonstylate haustellate lack piercing stylets. These insects suck exposed liquids like nectar, decaying tissues, etc.



5. Thorax

a. Wings (when present)

i The prothorax is not wing-bearing and there are many rather cool modifications of the pronotum.



ii The forewing and the hindwing attach to the mesothorax and the metathorax, respectively.

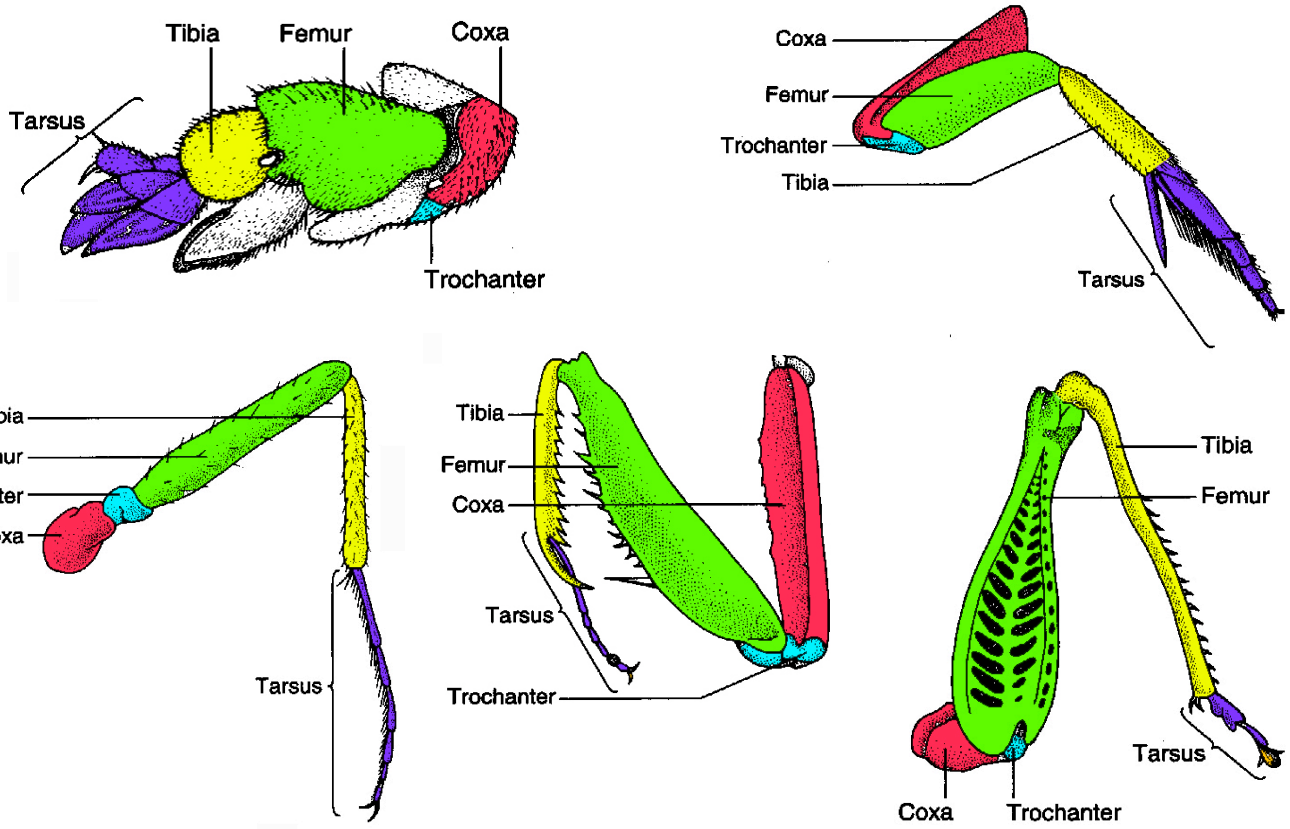
iii Wing venation is often used for identification (Note: Lecture text uses a different naming scheme that does the lab text.).

iv Wing structure varies tremendously from order to order. We will cover this variation as we cover the orders.

b. Legs

i Generalized legs include the segments: the coxa (basal segment closest the thorax), trochanter, femur, tibia, tarsus, and tarsal claw.

ii Legs also show a variety of modifications as some are used for jumping, digging, swimming, collecting pollen, making sound, detecting sound (hearing!), tasting, grasping prey, etc.



6. Abdomen

a. The abdomen varies considerably in relative size.

b. Generally the abdomen of adult insects lack appendages except for the last three segments.

c. Many insects have appendages associated with locomotion, respiration, or detection of vibrations.

d. Ovipositors exhibit modifications specific to the type of substrate on which the eggs must be placed.