External Anatomy of the Insect

The purpose of this laboratory is to familiarize you with the general external anatomy of the typical insectan body. The subjects of study are the lubber grasshopper, *Romalea*, and the house cricket, *Acheta*.

SEGMENTATION

Vocabulary

Sclerite	Tergum	Pleuron
Suture	Tergites	Pleurite
Apodeme	Sternum	
Conjunctiva	Sternites	

There are four principal regions of an insect body segment: tergum (dorsal), sternum (ventral) and two pleura (lateral). Hardened plates in the exoskeleton are called **sclerites**. Sclerites that are subdivisions of the major regions are tergites, sternites and pleurites, for the respective regions tergum, sternum and pleuron. (see section 2.2 Segmentation and Tagmosis in your textbook)

As you identify the locations of various sclerites and sutures compare them between the grasshopper and the cricket. You might also try to locate them on another insect whose body parts are modified for a particular function.

THE HEAD

You are to observe the general features of the grasshopper and cricket head (See Section 2.3 in your textbook.). Note the form and orientation of the head. Locate the following primary structures: **antennae**, **compound eyes** and **mouthparts**. Note the articulations of the antennae and mouthparts and how they move relative to the sclerotized head capsule.

With the insect facing you examine the head's anterior. The **labrum** is the most ventral sclerite. The labrum is bilobate and forms the 'upper lip'. The labrum is probably formed from a fusion of the segmental appendages.

The **clypeus** is the rectangular sclerite dorsal to the labrum. The suture just dorsal to the clypeus is the **epistomal suture**. Above the epistomal suture is a triangular sclerite called the **frons**. The frons is framed laterally by the **frontal sutures** and ventrally by the epistomal suture. The **coronal suture** runs dorsally along the midline from the frons toward the vertex. Together the coronal suture and the frontal sutures form an inverted Y called the **ecdysial suture** (= epicranial suture) because this is where the cuticle splits when the insect molts. The ecdysial suture may or may not be apparent in an adult insect. Why?

The sclerites ventral to the compound eyes and lateral to the frons are the **genae** (singular **gena**). The top of the head is the **vertex** that is divided into left and right halves (the **parietal sclerites**) by the coronal suture.

Ocular sutures and **antennal sutures** surround the compound eyes and antennae, respectively. Examine the facets of the compound eye using the microscope. Each unit is an **ommatidium** capable of detecting light. Find the 3 **ocelli**, one between the base of each antenna and the compound eye, the other one in the mesal ridge between the compound eyes.

Find the membranous **cervix** (or **cervical membrane**) between the head and the thorax. The membranous connection allows the head to move freely. Many insects have one or two sclerites located in the cervix allowing for muscle attachment. Locate these **cervical sclerites** on the grasshopper.

Head/Mouthpart Orientation.
Insect mouthparts can be directed ventrally (**hypognathus**), anteriorly (**prognathus**) or posteriorly (**opisthognathus**). Using the collection, find specimens with **prognathus, hypognathus** or **opisthognathus** arrangements?

With reference to the angle of the mouthparts relative to the body axis, what types of head do the grasshopper and cricket have?

Mouthparts. Carefully remove the mouthparts and compare them with Figure 2.10 (page 33) in your textbook. Note the cutting surfaces of the hard unsegmented **mandible** and the **two condyles** where the mandibles articulate with the head capsule. Posterior to the mandibles is a pair of segmented jaws, the **maxillae**. The basal part of the maxilla is composed of the proximal **cardo** and more distal **stipes.** The cardo articulates with the head capsule. Attached to the stipes are two lobes. The **lacinia** is the toothed mesal lobe. The **galea** is the lateral lobe. Note also that the **maxillary palp** is attached to the stipes**.** How many segments are in the prothoracic leg? The cardo and stipes of the maxilla represent the 'coxa' of the primitive leg. The first two segments of the maxillary palp are the 'trochanter' followed by the longer 'femur' & 'tibia' segments. Posterior to the maxilla is the **labium**. The labium acts as the 'lower lip' of the insect and is formed by the fusion of two segmental appendages. The **postmentum** (=submentum + mentum) is the portion of the labium that attaches to the head capsule. The **prementum** is the distal portion of the labium and bears the, **glossae**, **paraglossae** and **labial palp**. Compare one maxilla with one side of the labium—the cardo corresponds to the postmentum, the stipes corresponds to the prementum (lacinia=glossa & galea=paraglossa), and the palps have a small trochanter segment followed by a femoral, tibial and tarsal segment.

Examine the modification of the mouthparts in other insects. Pay particular attention to mouthparts of
Ephemeroptera,
Diptera (Figures 2.13 & 2.14, page 37),
Hemiptera (Fig. 11.4, page 290; Taxobox 20, page 483),
Siphonaptera (Fig. 2.17, page 39),
Hymenoptera (especially bees Fig. 2.11 page 35) and
Lepidoptera (Fig. 2.12, page 36).

To what are the mouthparts of each of these groups adapted?

Mouthpart Adaptations. Examine insects in the general collection or the box containing insects that have modified mouthparts and find insects with the following types of mouthparts:
Mandibulate / Haustellate
Sponging, Piercing-sucking, Siphoning, Vestigial, Chewing-lapping

Antennae. Using a dissecting microscope, look at the grasshopper antenna and its attachment to the head capsule. Identify the **scape, pedicel** and **flagellum**. See Figure 2.19 (page 42) for parts and types of insect antennae.

What types of antennae do the grasshopper and cricket have?
Use the general collection, specimens in the Antennal Modification box and the prepared slide to find the following types of antennae:
Filiform, Moniliform, Capitate, Clavate, Setaceous, Serrate, Pectinate, Plumose, Aristate, Stylate, Lamellate (=Flabellate), Geniculate

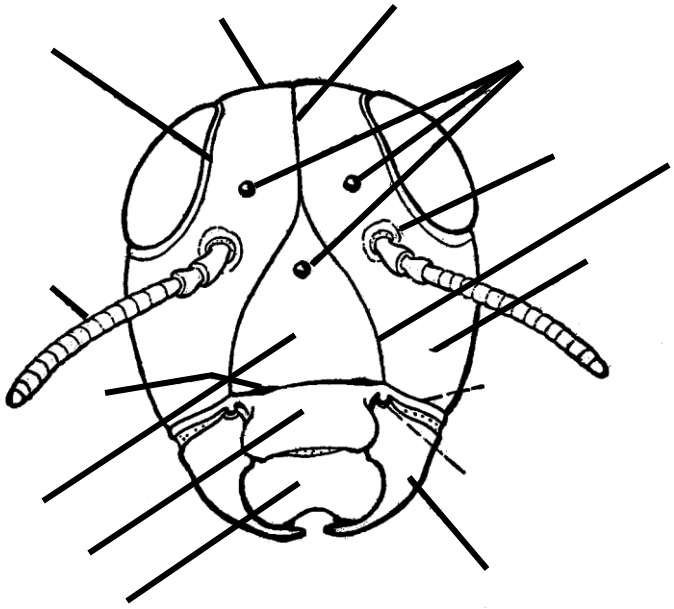
Can you specify each antennal type and locate its scape, pedicel and flagellum?

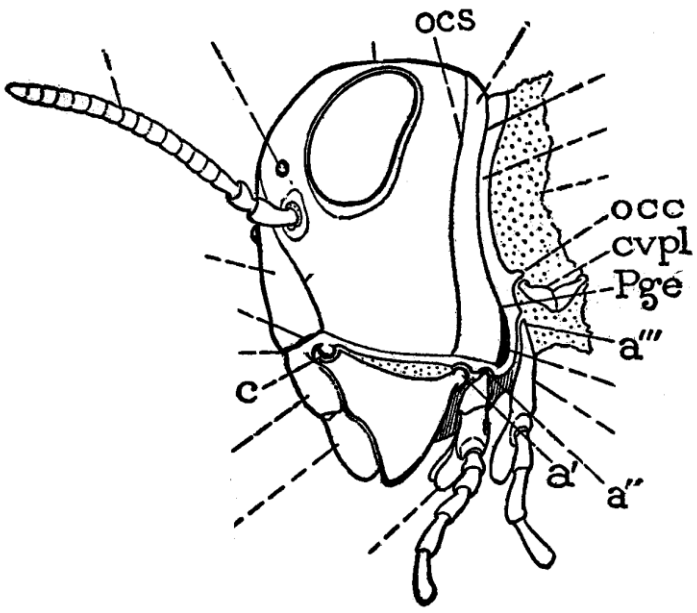
Cut off the head of the grasshopper and examine the posterior region. The **foramen magnum** or **occipital foramen** is the opening in the back of the head capsule. The foramen is closed ventrally by the base of the labium (lower lip). Note the two horseshoe shaped sclerites framing the foramen, the anterior **occiput** and the posterior **postocciput**.

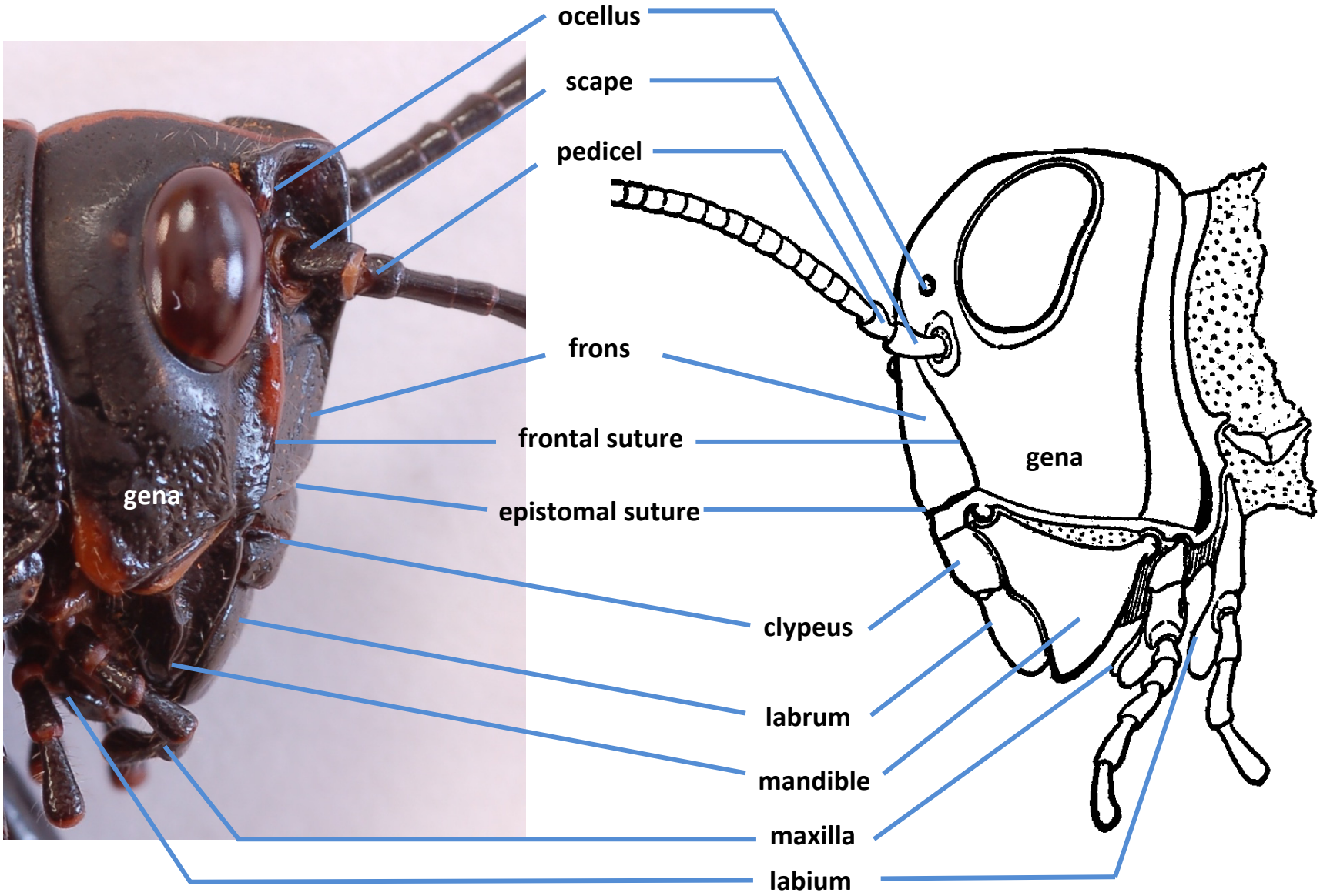
An internal skeleton of the head, the **tentorium,** is formed by the invagination of the exoskeleton at four places on the head. **Anterior tentoral pits** are located along the epistomal suture. The **posterior tentorial pits** are found at the ventral portion of the occiput and postocciput. **What is (are) the function(s) of the tentorium?**

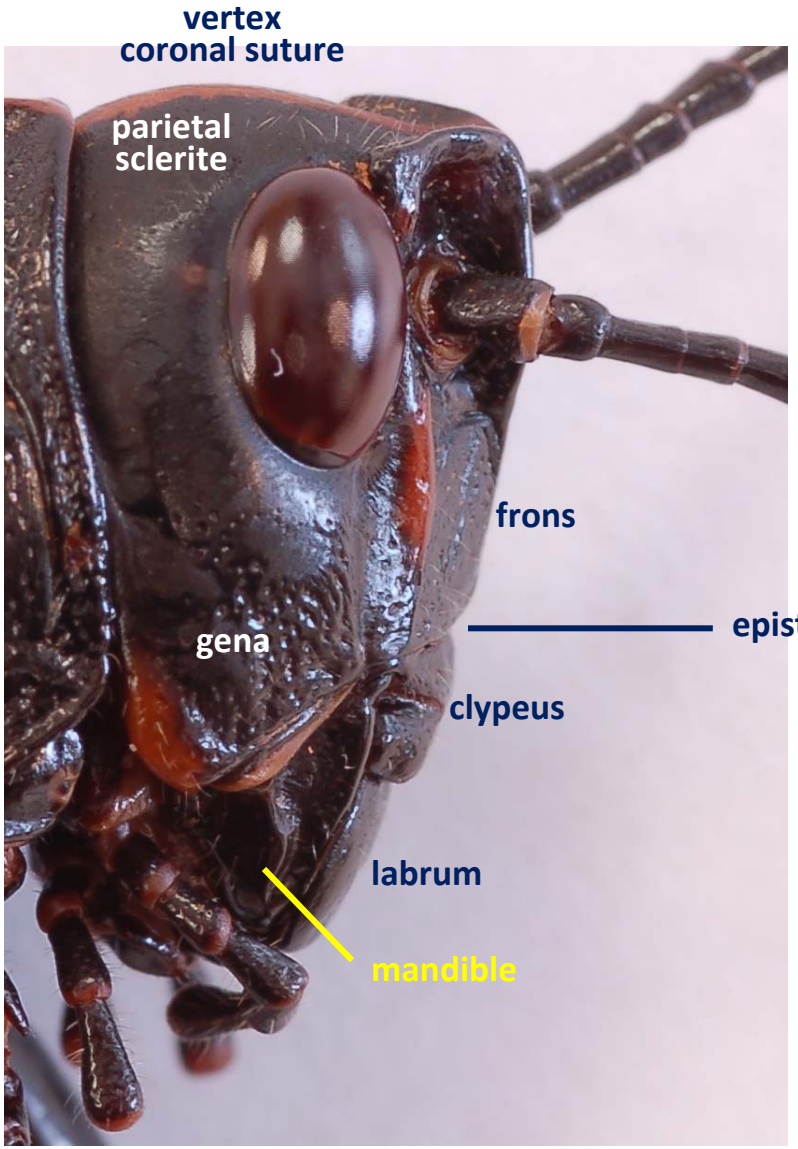
Examine the 'cleared' head capsule of the cricket and grasshopper under the scope to see the tentorium.

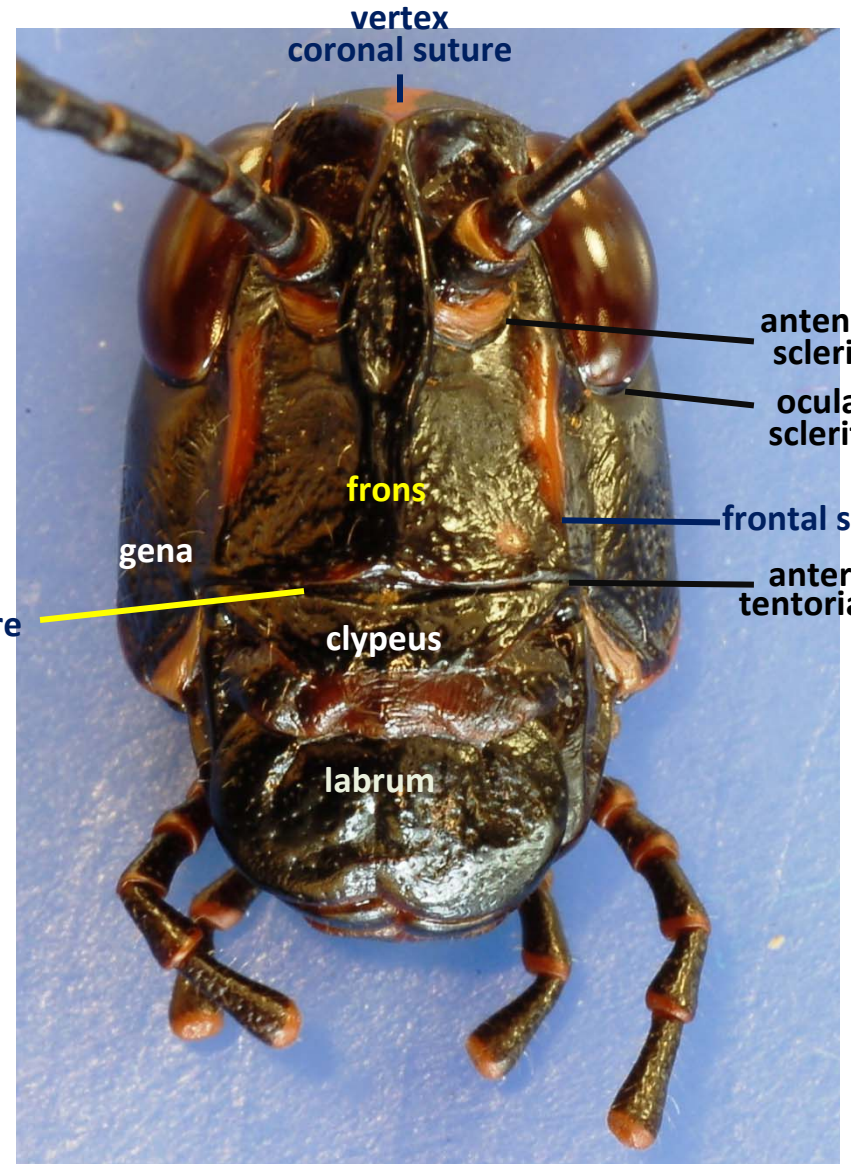
Label the head structures indicated in the following diagrams.






ocellus
scape
pedicel
frons
frontal suture
epistomal suture
clypeus
labrum
mandible
maxilla
labium
gena
gena


vertex
coronal suture
parietal
sclerite
frons
gena
epistomal suture
clypeus
labrum
mandible


vertex
coronal suture
antennal
sclerite
ocular
sclerite
frons
frontal suture
gena
anterior
tentorial pit
clypeus
labrum

THE THORAX

In the apterygote insects the three thoracic segments are similar in size and structure. In the pterygote insects the thorax is highly modified (Figure 2.20, page 43 in your Textbook). Examine the three segments of the grasshopper thorax. Name the three segments. Note where each begins and ends. The **prothorax** is quite large and is somewhat independent of the other segments. The large shield that covers the dorsal and lateral sides of the prothorax is the **pronotum**. In the grasshopper the pronotum is enlarged and extends back covering all or part of the succeeding **tergum**. The lateral extension of the pronotum almost completely covers the lateral walls of the segment, the pleura. The grasshopper's pleura are reduced in the prothorax and are visible only as minute triangular sclerites ventral to the edges of the tergum and in front of the bases of the prothoracic legs.

Examine the **prosternum** located ventrally between the forelegs and note that it is divided into an anterior **basisternite** and a posterior **sternellum**. A suture separates the basisternite from the sternellum. Carefully remove the prothorax to expose the intersegmental membrane. Find the mesothoracic **spiracles**, a vertical slit between two small sclerites. Now compare the structure of the mesothorax and metathorax with the prothorax. Note that the two are united and not easily moved compared with the prothorax. This rigidity is an adaptation for flight (WHY?) and the two thoracic segments are collectively called the **pterothorax**.

In the pterothorax the terga, pleura and sterna are all well developed (see Figure 2.20). Spread the wings and examine their attachment to the thorax. Locate the axillary sclerites. What taxon is defined by possession of these structures?

Tergum. Examine the mesonotum and locate the following sclerites: The **prescutum** is the narrow anterior sclerite with expanded lateral areas. The **scutum** is posterior to the prescutum and is typically the largest and most prominent tergite. The **scutellum** is the posterior sclerite that is formed by a V-shaped suture. Together these three sclerites (prescutum, scutum and scutellum) form the **alinotum, the wing bearing portion of the notum**. Posterior to the alinotum is the **postnotum**. Internally the postnotum bears a large plate **(phragma)** that provides a large surface area for the attachments of the dorsal longitudinal muscles.

Pleuron. The pleura of the mesothorax and metathorax are divided into two parts, the anterior **episternum** (='above sternum') and the posterior **epimeron** (='above thigh'). The **pleural suture** divides these two pleurites and represents an internal inflection of the cuticle (pleural ridge or apophysis). What are the functions of this inflection? Find the metathoracic spiracle.

Sternum. Locate the basisternite and sternellum of the pterothoracic segments. Two pits connected by a suture mark the posterior edge of the basisternite. These **furcal pits** mark an invagination of the cuticle forming the **furcal arms** (=sternal apophyses) an internal skeletal rod. A third pit, the **spinal pit**, marks another internal skeletal rod called the **spina**. What are the functions of all these skeletal rods?

Legs. Examine the legs of the grasshopper and cricket. Note that each pair is attached to one segment of the thorax. Can you identify the segments of the leg? Note the **arolium** between the tarsal claws. Compare the tarsus of the grasshopper with that of a fly

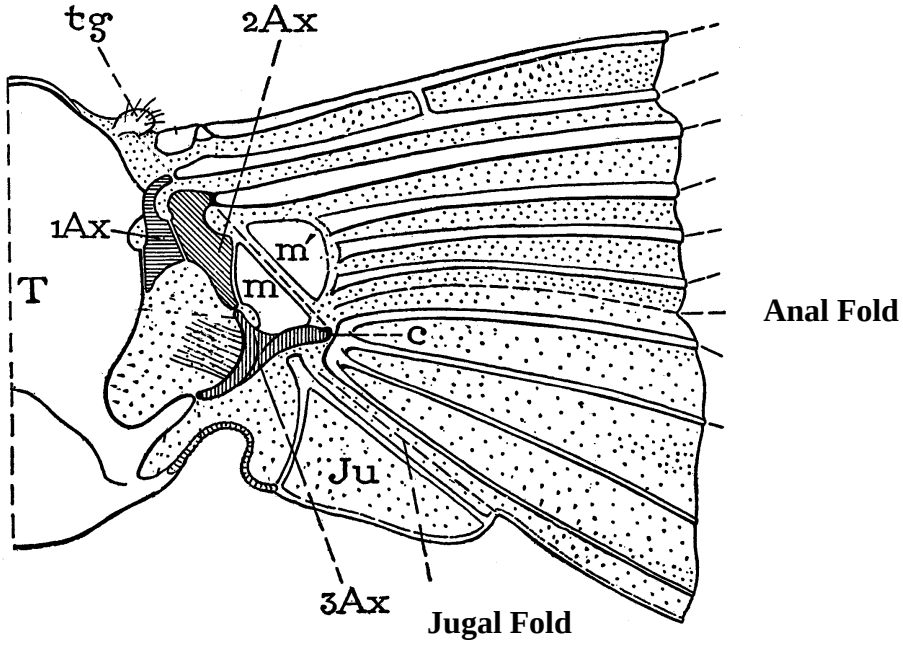
Be sure to examine the box of insects having modified legs find insects with the following leg types: **Cursorial, Raptorial, Fossorial, Natatorial, Saltatorial, Prehensile (check the slide of a louse)**

Wings. Can you find the major wing veins in the wings of your grasshopper? Also examine the prepared slide of a fly wing. Note the reduction in wing veins. What wing modifications are common to both grasshopper and cricket (characteristic of the Orthoptera, Mantodea, and Blattodea)?

Be sure to examine the wing modifications on insects in the collection and be able to identify: **Elytra, Hemelytra, Stigma, Nodus, Haltere, Tegmina, Hamuli, Frenulum, Jugum**

Major Wing Veins & Axillary Sclerites

Modified from Snodgrass 1935
Label the major wing regions and wing veins (see Figure 2.22 and 2.23, pages 46 7 47 in your textbook).



Generalized Pterothoracic Segment

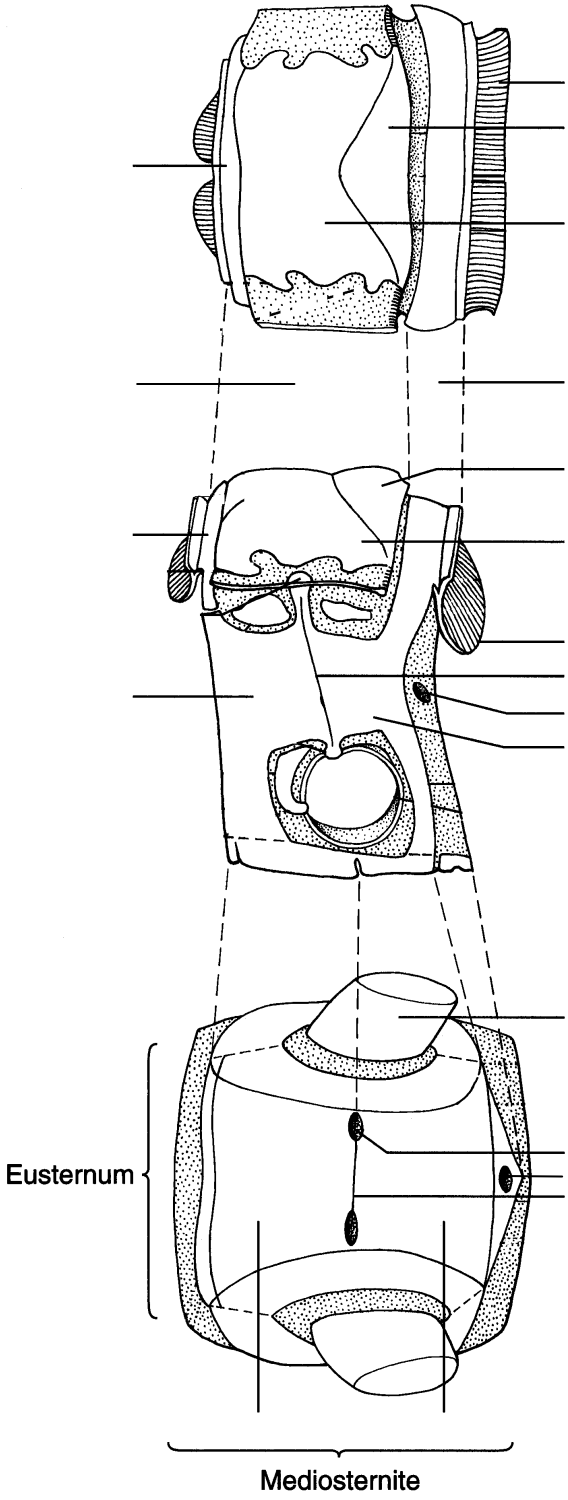
Modified from Romoser & Stoffolano 1998

Label the sclerites and sutures on the following diagram of a pterothoracic segment.

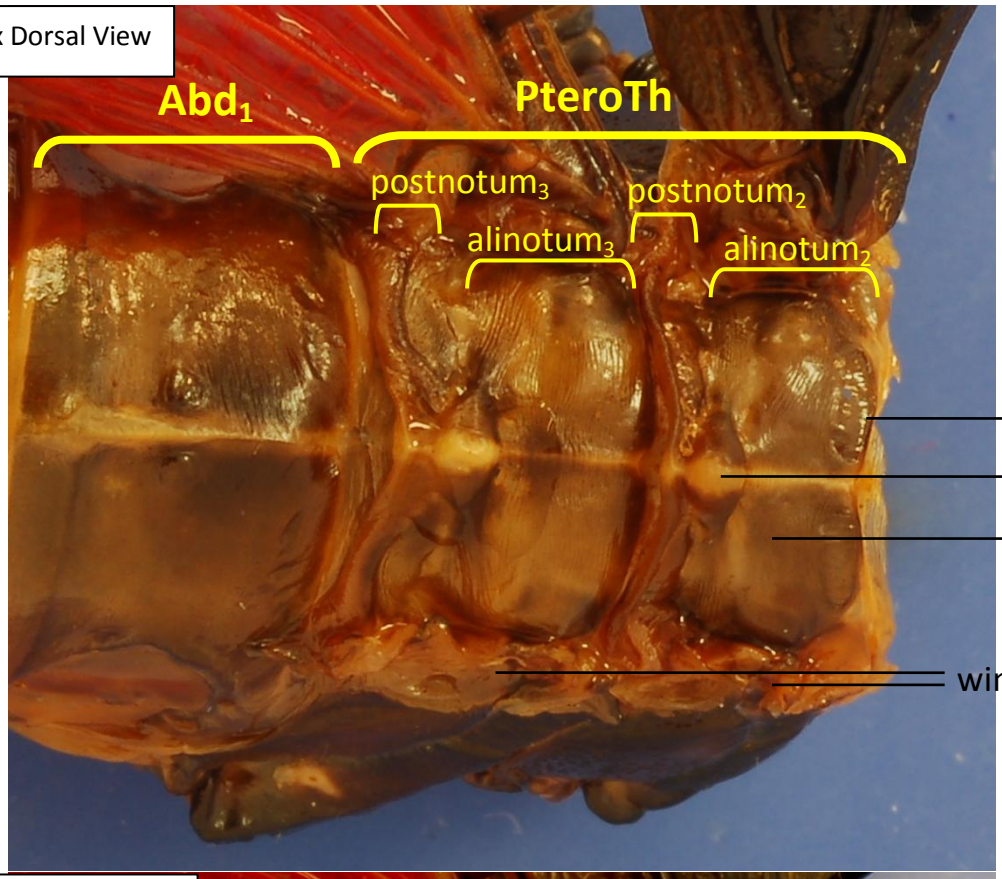
Dorsal View

Lateral View

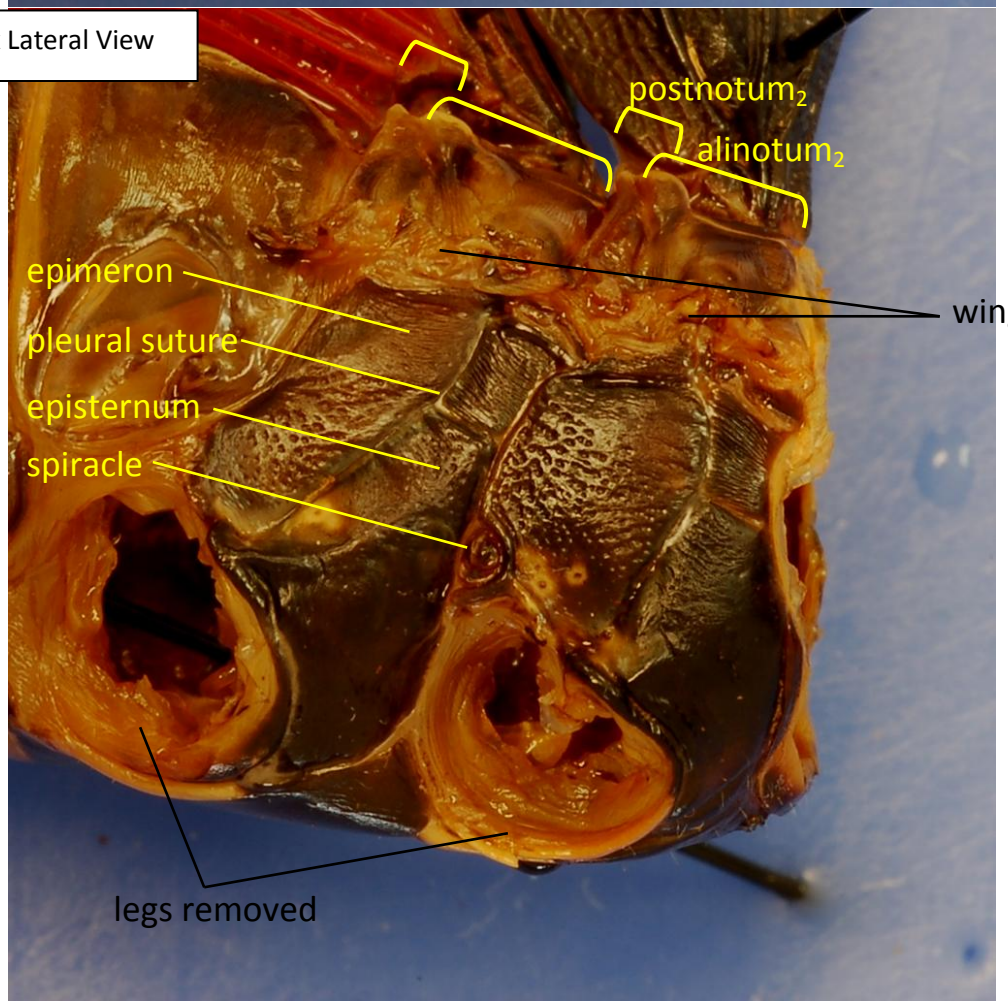
Ventral View



Pterothorax Dorsal View



Pterothorax Lateral View



THE ABDOMEN

Examine the abdomen of a grasshopper paying attention to how the terga and sterna are arranged (see Figure 2.25, page 49). Note that the pleural membrane of each segment is covered by the tergum and that the tergum overlaps the sternum. Compare the structure of the abdominal pleura with those on the pterothorax. How and why are they different? Each segment overlaps the succeeding segment and the **intersegmental membranes** allow for free movement and expansion of the abdomen.
Count the abdominal terga.
How many are there?
Note the tympanic membrane, a bean-shaped membrane on the first abdominal tergum.
What is its function? Where are the tympanic membranes of the cricket?

The first eight abdominal terga are nearly identical and bear a pair of spiracles. The terga of segments nine and ten are narrower, are partially fused and never have spiracles. Segment 11 is a convex diamond-shaped plate called the **epiproct**, because it lies above the anus. A pair of triangular sclerites are lateral to the epiproct. These are the **paraprocts** and are part of the 11^{th} sternum. The **cerci** are the appendages of the 11^{th} segment and are **serially homologous** to mouthparts and legs. Use a pin to lift the epiproct and note the arrangments of the epiproct and paraprocts to the anus.

Male and female grasshoppers (and crickets) differ primarily in the posterior structure of their abdomen. Females are distinguished by the presence of an ovipositor. For grasshoppers the ovipositor are two short, hard processes with curved sharp ends (Hence the taxon name Caelifera = 'chisel bearing'). The cricket ovipositor is more spear-like and drawn out into a long tube (Ensifera = 'sword bearing').

On the ventral side of the female's abdomen you will find only eight sterna. The sterna of segments 9, 10 and 11 are reduced, displaced or absent. On A1, the sternum is separated from the tergum by a leg cavity. The other sterna are in close association with the terga of the same segment. The sternum of segment 8 is often called the **subgenital plate** because it is ventral to the genital opening and the **ovipositor**. The ovipositor is composed of two pairs of short stout appendages at the tip of the abdomen. Note the ventral and dorsal **valves** of the ovipositor. Use a pin to separate the valves of female cricket and compare them with those of the grasshopper. Can you suggest and reason for the differences in these egg-laying structures?

Compare the tip of the abdomens of males and females. Note that the eighth sternum of the male is similar to the previous seven sterna and not elongated as in the female. The ninth sternum is larger and has a transverse suture that gives the appearance of 10 sterna.

Be sure to examine the box of insects with abdominal modifications on display. Note the variation in the **ovipositors**, **cerci, epiprocts (median caudal filaments), claspers, stings, aedeagus**.

Generalized Orthopteran Abdomen & Ovipositor

From Gullan & Cranston 1994