CRAB DISSECTION **Biology 337**

(adapted from Fox 2001, http://webs.lander.edu/rsfox/invertebrates/callinectes.html)

Today you will dissect the blue crab, *Callinectes sapidus*, a large crab from shallow waters along the east coast of North and South America. *Callinectes* means "beautiful swimmer"—these crabs belong to the swimming crab family Portunidae, most of whose members have **large oarlike hind legs** that are used for swimming.

The "true" crabs, or Brachyura, belong to the order Decapoda, which includes the largest and most familiar crustaceans (crabs, shrimps, crayfishes, lobsters). Unlike most decapods, which have well developed and highly muscular abdomens, in brachyurans the body is wide and D-V compressed, and the abdomen is reduced to a thin flap.

Here is a summary of important taxonomy for the blue crab: Ph. **Arthropoda**, SubPh. **Crustacea**, Cl. **Malacostraca**, O. **Decapoda**, SubO. **Brachyura**, F. **Portunidae.**

Note: start your dissection in a dry tray. Add water after cutting the window in the carapace.

EXTERNAL ANATOMY

Body and Tagmata

The ancestral tagmata (head, thorax, and abdomen) are reorganized into three different tagmata:

(1) **Cephalothorax:** a tagma resulting from fusion of the head and first three thoracic segments, which bear the **maxillipeds** (true for all decapods)

(2) **Pereon:** the remaining unfused thoracic segments are sometimes referred to as the pereon, and bear the **pereopods**. *Dorsally* these segments are indistinguishable from the cephalothorax because they are all covered by the large, shield-like **carapace**, which is an outgrowth of the most posterior head segment. *Ventrally*, the 5 segments of the pereon are recognizable and bear the 5 pairs of **pereopods** that make up the "10 legs" of a decapod.

(3) **Abdomen** (or **pleon**): highly reduced and folded under the thorax, but may bear highly modified **pleopods.**

The ventral surface of each segment of an arthropod is covered by an exoskeletal plate known as a **sternite**; together the sternites form the ventral surface (Fig 2).

Carapace

The carapace has a long **lateral spine** and eight prominent **teeth** on each anterolateral margin (Fig 1). [These features—spines, teeth, and surface texture—are good clues to identifying local species.] The lateral extensions of the carapace enclose large **branchial chambers** that house the **gills**. **Eyestalks**, each with a **compound eye**, protrude from two carapace notches, the **orbits**. The **rostrum**, a pointy process at the anterior end of the cephalothorax (Fig 1), is small in this species but elongated in others. Dorsally, crossing the midline of the carapace is the short, shallow, transverse **cervical groove**, which marks the approximate division between head and thorax.

Abdomen

The **abdomen** (Fig 2), also called the **pleon** (with appendages called **pleopods**), is flexed beneath the thorax. In the brachyuran "true crabs," the abdomen varies with sex and maturity: it is broad and rounded in **mature females**, nearly an equilateral triangle in **immature females,** and narrow with a broad base in **males**. *What is the sex/stage of your crab?* _________
Do you notice any other external differences between males and females?

Abdominal segments. Extend the abdomen away from the thorax *[imagine how much larger and more muscular it would be in a crayfish or shrimp!]*. As in all malacostracans, how many true segments should be present in the abdomen? ________ Count from posterior to anterior starting from slender segment 6, which is anterior to the terminal **telson** (not a true segment). In ***females***, the segments 5 to 2 are all independent and easily counted. In ***males***, segments 5, 4, and 3 are visible but fused together and narrowed posteriorly, whereas segment 2 is separate and wide (Fig. 2). In both sexes, segment 1 is hidden under the edge of the carapace.

The transparent **intestine** runs along the ventral midline of the abdomen, under the thin ventral exoskeleton, and terminates at the **anus** on the telson (Fig 2). Press the posterior end with a probe to extrude feces (if present) from the anus, confirming its identity and position.

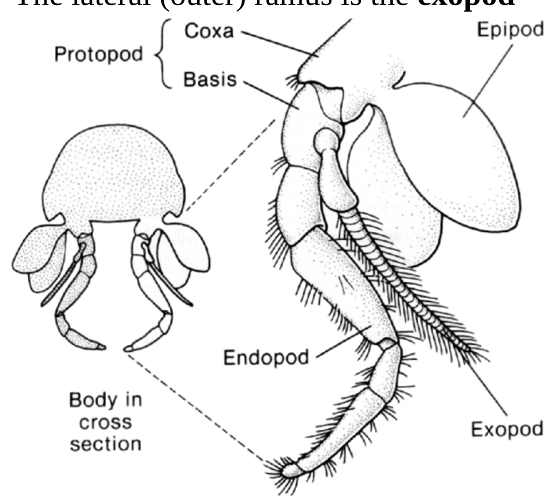
In ***males***, the abdomen fits into a longitudinal groove on the thorax. In females, the **gonopores** are in the walls of this thorax groove. If you have a ***female***, find these pores, which are large triangular openings in the **sternites of the sixth thoracic segment**.

Appendages

The sections of an appendage are called **articles** (the term **segment** is reserved for body sections). Articles are **serially homologous** among appendages; that is, the same articles can be found in each appendage within an individual, although their form may be modified for different functions in different segments.

**** DTQ**: How does the "serial homology" among articles differ from previous definitions of homology used in this course? ***(***put all DTQ answers on Lab G worksheet)***

Recall the following basic features of a crustacean **biramous** appendage. The first (proximal) portion, which joins to the body, is the **protopod**, usually made up of two articles, the **coxa** and **basis**. From the protopod arise two branches, or **rami**. The lateral (outer) ramus is the **exopod** and the medial (inner) is the **endopod**. (Typically the exopod is the branch that is lost to form a **uniramous** appendage.) Additional outgrowths on the sides of the exopod and endopod have their own special names: those on the *exopod* side are called **exites**, while on the *endopod* side they are **endites**. An exite located on the protopod has a special name: an **epipod**. Following the basis along each ramus are the **ischium, merus, carpus, propodus, and dactyl**, although fusions can reduce the number of joints between articles. Label these articles to the right. These names are all distinguished in order to be able to identify homologous branches, outgrowths, and articles.



Using the guide below, examine each appendage in turn **without removing it** from the animal. Some specialized appendages are illustrated in Figures 3-9. **Go in reverse order** from how the appendages are numbered (posterior to anterior): start with **pleopods**, then work forward through **pereopods**, **maxillipeds**, and **mouthparts**, to end with **antennae**. (Unlike many other crustaceans, crabs have no uropods, which are on the posterior abdominal segment(s) of shrimp, lobsters, crayfish, and many other crustaceans.)

Pleopods

Like the abdomen (pleon), the pleopods are sexually dimorphic, *so be sure to look briefly at both sexes.* ***Males*** have only two pairs (Fig 2), and both function only in sperm transfer: the long, curved, tubular **gonopod** on segment 1 (not the penis!) is the intromittent organ used to deliver spermatophores to the female gonopore. The shorter **2nd pleopod** acts as a piston to push spermatophores through the hollow tube of the gonopod.

Females have paired biramous pleopods on abdominal segments 2 through 5. The long **setae** hold and ventilate eggs along with movements of the abdomen (see Fig. 3).

Pereopods

In crabs, the five pairs of **stenopodial** (slender) pereopods all lack exopods (they have only a protopod and endopod) and thus are **uniramous** (the gills are outgrowths [exites] of the endopod rather than exopods). In almost all swimming crabs (Portunidae), pereopod 5 is a paddle-shaped **swimming leg** (Fig 1).

On the 1st, 3rd, and 5th pereopod, identify the homologous seven **articles**, noting differences in limb morphology and function (Fig 1). The short **coxa** articulates with the body (Fig 2). The next two articles, the **basis** and **ischium**, are fused together to form the **basischium**--find the suture marking the line of fusion. The basischium is followed by the **merus**, **carpus**, **propodus**, and **dactyl**. The dactyl and propodus of pereopod 5 are both flattened to form the paddle; in pereopod 3 they are elongate and slender; and in pereopod 1, the dactyl forms a **movable finger** that opposes an **immovable finger** created by an extension of the propodus. The latter appendage is the **cheliped** and the distal pincer is the prehensile **chela,** or claw.

Are the chelipeds symmetrical? As in many decapods, the claws can show some bilateral <u>a</u>symmetry: the **cutter cheliped** is smaller and its teeth are a little smaller and sharper. The **crusher cheliped** is stouter, to house a larger muscle, with broader teeth. Measure the depth of each cheliped, as well as carapace length, to the nearest 0.1 mm using calipers,. Record this information, along with sex on the blackboard. *Which cheliped is the crusher?* ________

Note that in ***males*** the **gonopore** is located at the tip of a long, thin, limp, transparent **penis** on the proximal edge of the coxa of pereopod 5 (Fig 2). The penis is neither an appendage nor the intromittent organ—it loads a spermatophore into the gonopod (the intromittent organ), which is then discharged into the female gonopore using the piston-like second pleopod.

Before proceeding with appendages, find the large opening in the carapace just dorsal to the coxa of the cheliped. This opening is the **inhalant aperture** that leads into the **branchial chamber** (Fig 2) where the gills are located. [More later.]

<u>Autotomy</u>. Pereopods can be voluntarily **autotomized** (what does this mean?) to help the animal to escape predation or to reduce blood loss from a wound. A special **fracture plane** is located at the line of fusion of the basis and ischium; the animal is designed internally to *limit blood loss* at this point. If your crab is missing any of its legs, the end of the stump will be cleanly sheared at this fracture plane and covered by a **membrane**. This membrane was penetrated by only a small hole through which passed an artery and nerve (before autotomy). In this clever design, a one-way valve over this hole prevents loss of blood from the hemocoel after autotomy. Regeneration of the limb begins before the next molt.

**** DTQ:** Given the presence of this special membrane to limit blood loss, why have the basis and ischium become fused? (*Hint: aside from an articulating membrane connecting two plates, what do joints need?)*

Maxillipeds

The three pairs of **maxillipeds**, on the anterior segments of the thorax, are **biramous** (unlike the uniramous pereopods you just examined). The maxillipeds and mouthparts are stacked (in sequence, from posterior to anterior) over one another, so only maxilliped 3 is visible. After studying each appendage, move it forcefully aside to reveal the one beneath (and anterior to) it. **Do not detach the maxillipeds from the body**.

Maxilliped 3. The third maxillipeds cover the mouth field (Fig 2) like a pair of doors. *(At some point, go and watch the operation of maxilliped 3, the most obvious mouthpart in the live crab.)* Each is biramous, with a wider **endopod** that includes the usual **ischium**, **merus**, **carpus**, **propodus**, and **dactyl**. The **exopod** includes a long, narrow article and a multiarticulate flagellum that is used to groom the face. Connected to the protopod is a long setose **flabellum** extending through the inhalant aperture into the branchial chamber. If you move the maxilliped, the flabellum will move also, making it easier to recognize.

**** DTQ:** Given its location, what might be the function of the flabellum? How would it move, and how might its movement compromise another function? ***(answer on Lab G worksheet)***

Maxillipeds 2&1. The **second** and **first maxillipeds** are smaller, with similar articles and **flabellae** that extend into the branchial chamber (Figs 5, 6). Note the two **exhalant apertures** for the branchial chamber—not as obvious as the inhalant chambers—that are lateral to maxillipeds 2&1. Water can exit even when the third maxillipeds close over the mouth field.

Head appendages

The remaining five pairs of appendages—three mouthparts and two antennae—belong to the head segments. Move the three maxillipeds aside to reveal the true mouthparts.

Maxilla 2&1. The posteriormost head appendage, **maxilla 2** (Fig 7), is small and much more delicate than the maxillipeds. It includes, however, an extremely important part: a large flat **gill bailer** (the **exopod** of this maxilla) that you will find covering the inside of the exhalent opening. This flexible plate is fluttered back and forth to **generate the respiratory current (important!)**. **Maxilla 1** is smaller (Fig 8). *(Go and watch the operation of the gill bailers in the live crab.)*

Mandible. This larger and harder appendage (Fig 9) consists of a heavily calcified protopod from which arises a small palp. The smooth white **cutting surface** of the protopod is visible. Push the mandibles back and forth and watch their motion.

Push the two cutting surfaces apart and notice the soft protuberant **upper lip**, dorsal to the **mouth**. Gently insert your blunt probe into the mouth to confirm its location.

Antenna 2. Both pairs of antennae are small and inconspicuous (Fig 1). The lateral **2nd antennae** are uniramous (Fig 10). Using magnification, look for a calcified and movable **operculum** at the base of the antenna on its ventral side. This operculum covers the external opening of the nephridium, the **nephridiopore**. Insert the tip of a needle and lift the operculum to demonstrate its mobility. In living animals urine may escape when the operculum is lifted.

Antenna 1. The basal article of the peduncle is swollen and fits in a socket in the anterior body wall. The article houses a **statocyst**, containing a **statolith** resting on sensory setae, for gravity detection. The first antennae fold on themselves and fit neatly into a recess in the carapace. A small, pointed **rostrum** extends between the bases of the two first antennae (Fig 1).

Eyestalks. Eyestalks, which emerge from the **orbits** on the carapace (Fig. 1) are *not* appendages. A large **compound eye**, at the end of each eyestalk, is composed of hundreds of independent photoreceptive units, or **ommatidia**. A **cuticular lens** covers each ommatidium.

INTERNAL ANATOMY

Turn the crab dorsal side up. Insert the tip of a heavy scissors beneath the lateral, posterior edge of the carapace, dorsal to the coxa of the fifth leg, and make a cut around the periphery of the carapace **dorsal to the body edge** (look at Fig 11 before proceeding). Your goal is to open a window on the top of the animal. *Be careful that you cut only the heavy calcified exoskeleton and not the organs beneath it.* Keep your scissors about 5 mm from the edge of the carapace on the dorsal side and cut completely around it. Use a scalpel to scrape (not to cut) adhering tissues inside. Try not to disturb the internal organs and tissues, which are fragile, as you remove the carapace.

The thin dark **epidermis** should be removed with the carapace. The exoskeleton and epidermis *are the entire body wall*, as there is no musculature, connective tissue, or peritoneum.

Notice two small bumps on the inner surface of the carapace almost exactly in its center. These are **apodemes** for the connection of muscles that run to the gut. Disconnect these muscles to remove the carapace.

**** DTQ:** Cutting into the carapace caused a large amount of fluid to spill out. Transfer some onto the countertop—does it appear to have any color? What is this fluid? Where did it come from?

Hemocoel

Removing the carapace has exposed the large **hemocoel**, containing the major organs. (Recall that the **coelom** is limited to small spaces associated with nephridium and the gonad only.) If your specimen is a ***ripe female*** you may now need to remove the large orange ovary (but nothing else); if ***male***, the white testes will not obscure other structures.

Within the hemocoel, the two most prominent unpaired structures on the midline are the **stomach** (anterior) and **heart** (posterior) (Fig 11). The heart lies between two heavy plates called **flancs**, which cover the powerful muscles of the swimming appendages, pereopod 5. These muscles are the "backfin" crabmeat of the seafood industry.

Note that just ventral to the hemocoel is the **branchial chamber** containing the large, triangular mass of **gills**. Given that the branchial chamber is filled with *seawater*, it must be separated from the hemocoelic sinus in which the heart and other body organs sit. The separation is **by just a thin epithelial membrane**. *Try not to damage the membrane covering the gills.* Because these structures are well protected, there is little connective tissue holding them together.

Heart and Hemal System

The opaque white **heart** (Figs 11, 12) lies inside the hemocoelic cavity known as the **pericardial sinus**, which you opened up in this dissection. Remember that this space is blood-filled and **not a coelom**. The heart has three pairs of large **ostia**, two dorsal and one lateral, through which blood enters (Fig 11). The heart is suspended by numerous elastic suspensory ligaments that run to the surrounding tissues.

Review: Be sure you recall and understand how the **ligaments**, **muscles**, and **ostia** are used for filling the heart (upon relaxation) and moving blood through arteries (upon contraction) anteriorly, posteriorly, and ventrally. The seven major arteries branch repeatedly until, by the time they reach the tissues, their diameter is that of capillaries. Blood leaves the capillaries and bathes tissues via a large hemocoel, then passes through the gills and drains back to the cardiac hemocoel. The respiratory pigment **hemocyanin**, which turns blue when oxygenated, is simply in solution in the hemolymph (rather than being carried by blood cells).

Digestive System

As in all Bilateria, the foregut and hindgut are derived from ectoderm. In arthropods they are lined with cuticle that is shed with each molt. The **midgut** is endodermal and has no cuticle.

The **foregut** involves a mouth with a short esophagus that leads to the **pyloric stomach** and then to the visible **cardiac stomach** (Fig 11). The **midgut** includes several diverticula, most noticeably the large, yellow or greenish **digestive ceca** at the periphery (Fig. 11). This and other cecae secrete enzymes, absorb products of digestion, and store food reserves. All digestion and absorption occur in the midgut. The **hindgut** consists of a tubular **intestine, rectum,** and **anus**, which you already saw on the ventral side of the abdomen.

The **stomach**, the largest part of the gut (Fig 11), is exceptionally complex—its walls bear some 40 calcareous ossicles and 80 muscles. It is divided into a large, dorsal cardiac stomach (or anterior chamber) and a smaller, ventral pyloric stomach (or posterior chamber). The **cardiac stomach** is the large balloon-like structure in the anterior thorax. It is connected to the mouth by the short **esophagus**. Its walls contain the ossicles of the **gastric mill**, used for grinding food. These ossicles are shed as part of the molt! The mandibles cut food into small pieces which are passed to the gastric mill for grinding and mixing with enzymes.

Look on either side of the mouth and esophagus to find the white calcareous internal part of the **mandible** extending into the body cavity (Fig 9). The four powerful muscles that operate the mandible insert here, three of them by calcareous white **tendons**.

>>> Gently push the mandible back and forth and watch the response of the cutting edge.

Recall that you found earlier that the hindgut (**intestine**) runs along the ventral midline of the abdomen to empty through the **anus** located on the ventral surface of the telson (Fig 2). The **digestive ceca** are large, soft, amorphous, yellow or greenish organs at the periphery.

Respiratory System

Picture how the **gills** project *outside the body* into the left and right **branchial chambers** (Figs 1, 11). There is a double-fold of body wall that has been partly removed with the carapace, leaving a thin chitinous membrane covering the gills. This nearly invisible membrane is *all* that separates the branchial chamber (filled with seawater) from the hemocoel (filled with blood)! As in cephalopods, these structures are protected within this chamber and are not hidden by a thick body wall. If it is still present, find and remove this thin, transparent sheet to expose the gills.

There are **8 pairs of gills** (two are small and easily overlooked), which are **exites** (outgrowths) of the **8 thoracopods**. Each gill has a long **central axis** with two rows of closely spaced flat **lamellae**. Use a blunt probe to separate adjacent lamellae and view them under magnification. Notice how the lamellae provide an immense surface area for gas exchange. The gills also serve as the primary surface for nitrogen excretion, as the arthropods do not have specialized systems for excretion. The lamellae, of course, are covered by cuticle that is molted.

Notice that the gills divide the branchial chamber into dorsal and ventral spaces (sound familiar?—compare the following with what you know about bivalves). Trace the path of water flow: in the **inhalant aperture** to the ventral **inhalant chamber**, then across the gill filaments into the dorsal **exhalant chamber**, and then out the **exhalant aperture**. Insert a blunt probe into the inhalant aperture at the base of the cheliped and push it gently upward through the curtain of gills into the dorsal exhalant chamber above the gills, thus tracing the route taken by the respiratory water current. Now insert your probe into the exhalant aperture and note that it enters dorsally, above the gills, in the exhalant chamber.

** **DTQ**: What structure does a crustacean use to generate water flow through the branchial chamber? How does this mechanism differ from the mechanism for water flow through a bivalve mantle cavity? How is it similar to water flow through a cephalopod mantle cavity?

Note that crabs can "backflush" to clean the gills by reversing the beat of the **gill bailers**. Some crabs that burrow in sediment with the posterior end first use reversed water flow both to avoid fouling the inhalant chamber and to loosen the sediment ahead of digging.

Snip the very end from one of the gills, place it in a small dish of water, and examine it with the dissecting microscope. Examine the cut surface of the gill axis to find the blood channels, cut in cross-section. These include the **afferent vessel** that delivers unoxygenated blood to the gill and the **efferent vessel** that drains oxygenated blood away from the gill and moves it…where in the body? ________________________________

** **DTQ:** Given what you know about the path of water flow and counter-current gas exchange, predict whether you are seeing the afferent or efferent vessel at the top of the gill in your dissection and explain why. ***(put answer on Lab G worksheet)***

Lift the gills of your dissected specimen and look at the floor of the branchial chamber. You should see the narrow, setose **flabella** of the **second** and **third maxillipeds** (operated by the maxillipeds themselves--see this by wiggling the maxillipeds) and of the **first maxilliped** (operated by its own muscles). The 2nd and 3rd maxilliped flabella clean the inhalant side of the gills whereas the 1st cleans the exhalant side. The flabellae also contribute to water movement through the branchial chambers, but this is accomplished chiefly by the **gill bailers**, which are homologous structures on maxilla 2 (next to the flabellum of maxilliped 1). Make sure you can locate the **gill bailers**.

>>> On the gill lamellae, look for the tiny stalked barnacle, *Octolasmis muelleri* (2 mm), which is commensal with several species of crabs. You might also find a small, orange, nemertean worm, *Carcinonemertes carcinophila*, that inhabits the branchial chamber of blue crabs and takes advantage of water flow. *Tell me if you find either of these.*

Reproductive System (if animals are ripe)

The morphology and appearance of the reproductive system vary depending on sex, maturity, and season. The following accounts are of mature individuals; if your specimen is immature you may not find all of the structures. Be sure to also take a look at a dissection of the other sex.

Male anatomy. Two long, indistinct, white or grayish **testes** lie dorsally in the anterior body where they may be difficult to distinguish from the digestive ceca beneath them (Fig 11). Each testis parallels the anterolateral border of the carapace. Near the stomach it turns posteriorly and parallels the border of the stomach and approaches the midline. Near the midline the testis becomes the complex, coiled and looped **vas deferens** (white, pink, or greenish). The **proximal vas deferens**, located near the midline posterior to the stomach, is highly convoluted, small-diameter tubule wound on itself to form a globular mass. The white color is due to white spermatophores, which look like tiny white eggs.

The large, conspicuous, pink **middle vas deferens** lies beside the lateral border of the stomach ventral to the testis. In mature specimens this portion is large, pink, and is the easiest part of the male system to see. A pink **jelly plug** that will be transferred to the female during copulation is formed here. The **distal vas deferens** is more difficult to follow, but leads, of course, to the penis that you identified earlier at the base of the last thoracopod.

>>> Someone should remove a few **spermatophores** from the proximal vas deferens and place them on a slide without a coverslip. Under a dissecting scope, notice that the spermatophores are ovoid in shape and packed with spermatozoa. Apply a coverslip and withdraw water until some spermatophores rupture. Examine the contents under high power (400x). The spermatozoa are small, irregular, **unflagellated** cells (no cilia or flagella throughout the phylum, even in sperm!)

Female anatomy. In a mature female, the orange **ovaries** may be small or so large they obscure other organs in the hemocoel (Fig 12). In immature females, the ovary is beige or white and less conspicuous. The right and left ovaries are connected across the midline by a narrow isthmus that forms an "H" (Fig 12). The oviducts exit the ovary and connect with the female gonopores on the sternite of thorax segment 6, where you found them earlier. The distal part of the oviduct is the **seminal receptacle**, part of which has a hard chitinous wall (Fig 12). Each receptacle is between the stomach and heart along the posterolateral border of the stomach next to the gill mass. The size and color of the receptacle varies—it may be quite large, hard, and pink following copulation when the sperm mass and its pink jelly plug are present. Later the receptacles shrink again and turn white as the jelly is absorbed.

FYI: Reproduction. Copulation occurs while the ovary is still white and immature--later it will turn orange and expand as orange yolk accumulates. Female blue crabs mate once and usually spawn twice, using the sperm from the single mating, held in the receptacle, for both spawns. The male inserts a jelly plug, formed in the middle vas deferens, to discourage other matings. The male crab carries its mate around until the female undergoes its terminal molt, when mating takes place. After the female molts, the male turns her on her back and inserts his gonopods into the female gonopores. He deposits sperm in her seminal receptacles, which lie just inside the gonopore. Sperm remain here while the female migrates downstream in the estuary. Eggs are fertilized as they move through the oviduct to the exterior. Almost two million of eggs may be shed and attached to the setae of the pleopods where they begin development. Later, the young may be released at the zoea stage of development.

Digestive System (cont.)

Once you have finished looking at the reproductive system, with your scissors make a transverse cut across the top of the cardiac stomach and look inside. Look for the **ossicles** of the gastric mill. The **pyloric stomach**, connected to the mouth by a short esophagus, is on the floor of the posterior half of the cardiac stomach. You may be able to locate the **filter press** in the pyloric stomach, which is used to sieve particles from the liquid in the stomach.

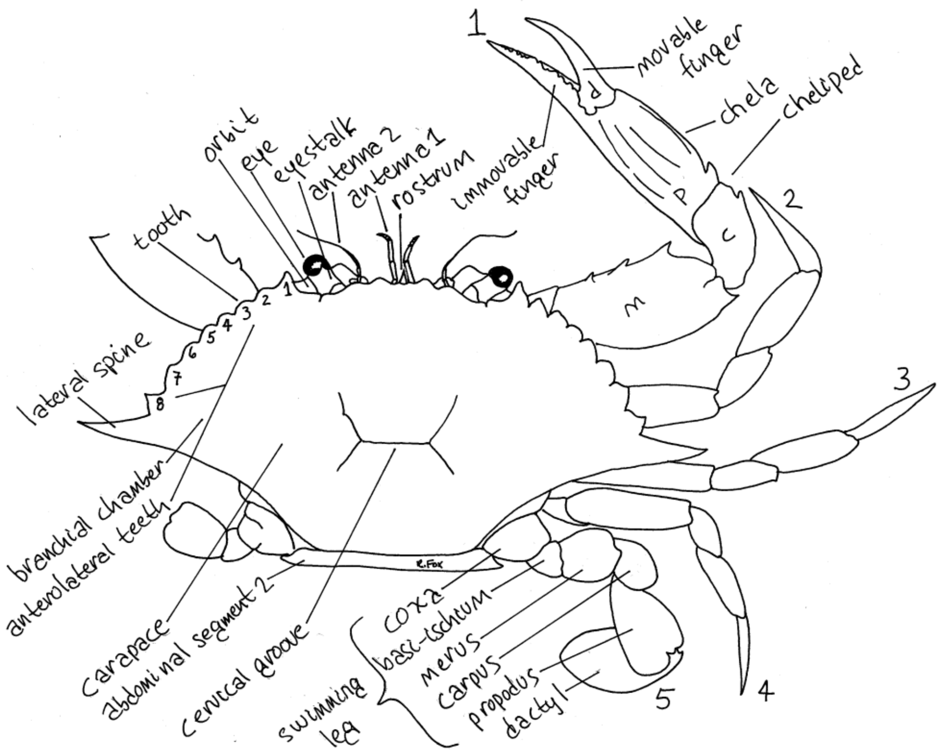


Figure 1. Dorsal view of the blue crab, *Callinectes sapidus*. The pereopods are numbered 1-5; those on the left side are omitted. m = merus, c = carpus, p = propodus, d = dactyl.

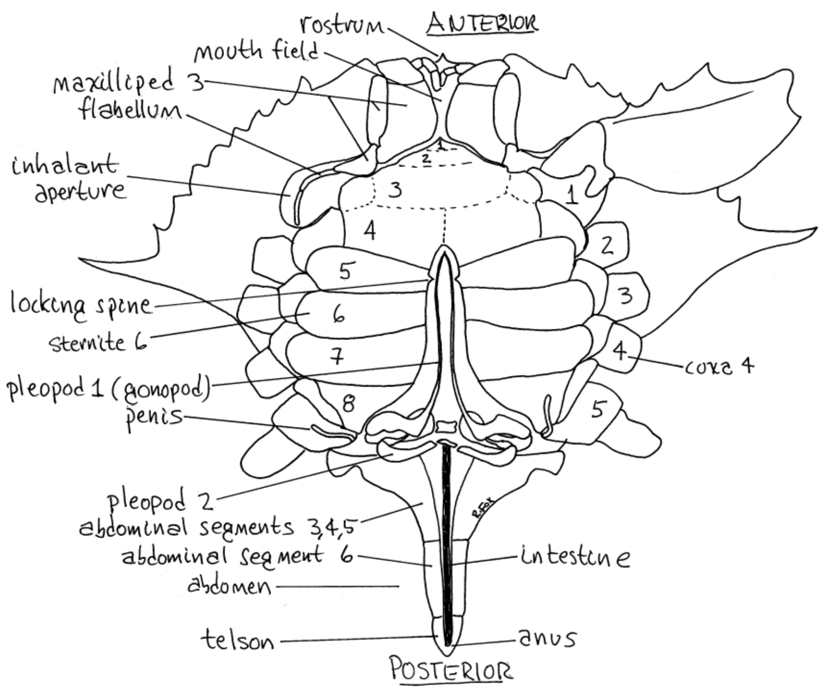


Figure 2. Ventral view of a male blue crab. The sternites of the thorax are numbered 1-8. Left coxae of pereopods are numbered 1-5. Abdomen is extended to reveal the abdominal appendages and penis.

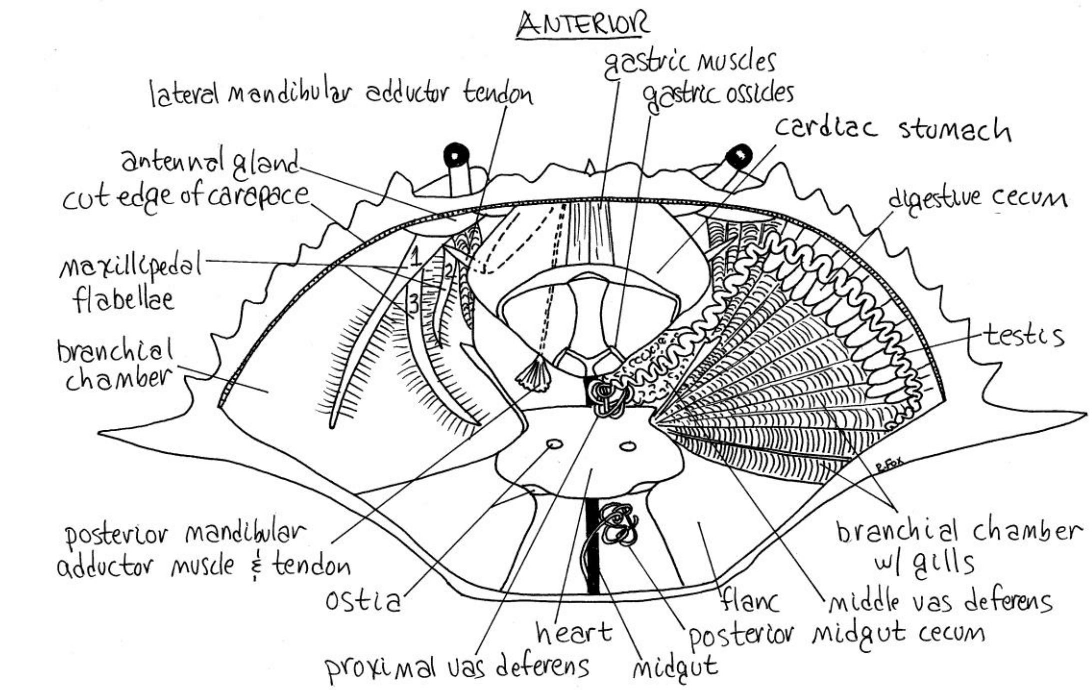


Figure 11. Dorsal dissection of a mature male crab. The digestive cecum, gonads, and gills have been removed from the left side.

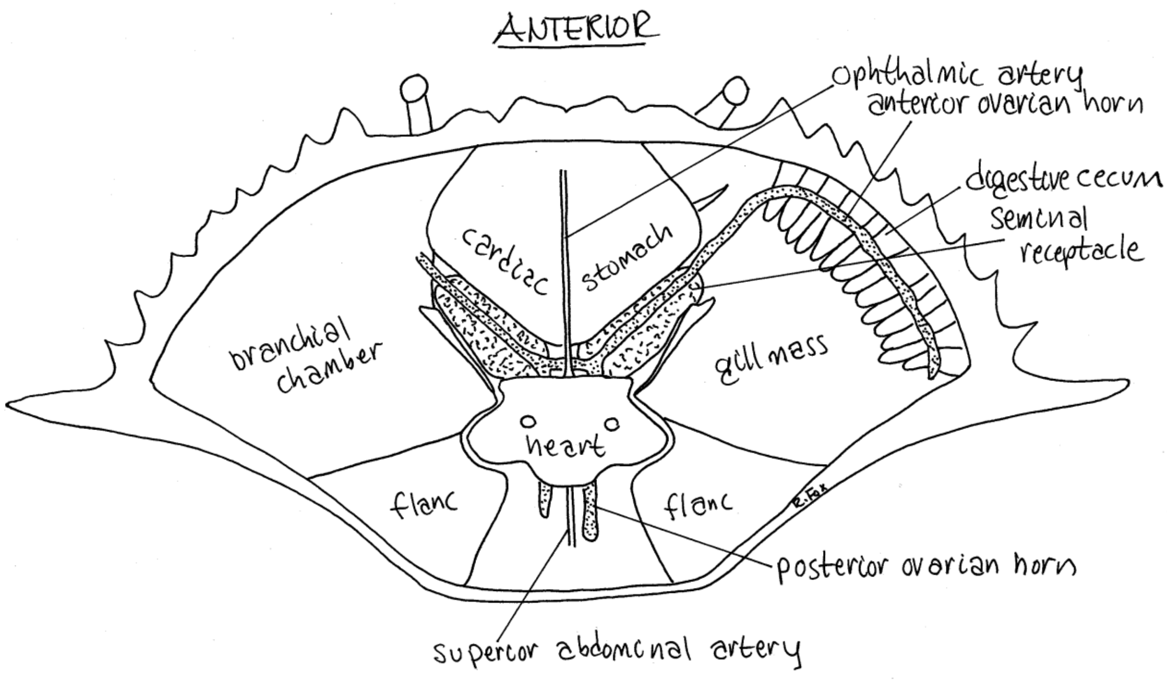


Fig 12. Dorsal dissection of fertilized but sexually undeveloped female. The seminal receptacle is filled with sperm but the ovary is small and undeveloped. Notice the "H" shape of the gonad.

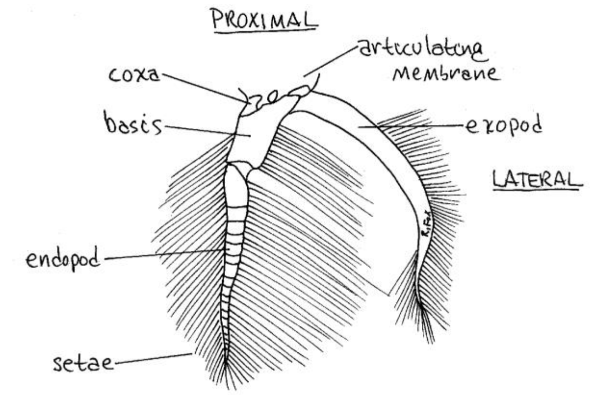


Fig 3. Pleopod of abdominal segment 5 of a female crab

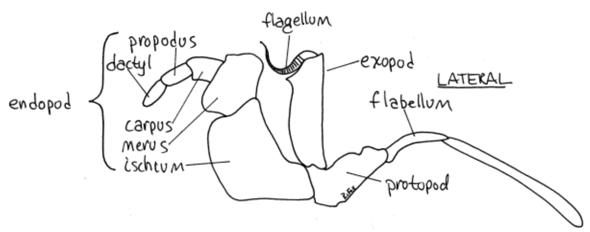


Fig. 4. The third maxilliped

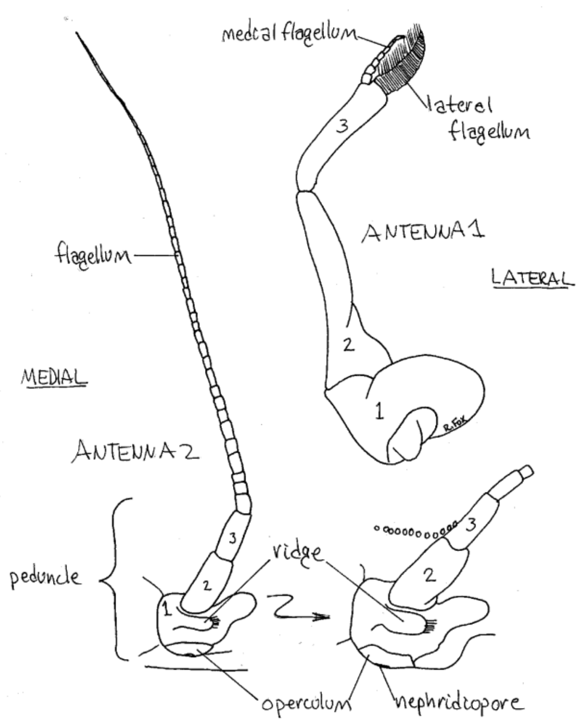


Figure 10. The first (right) and second (left) antenna of *Callinectes similis*. The peduncular articles of each are numbered. The inset is an enlargement of the base of antenna 2 showing the nephridiopore and its operculum.

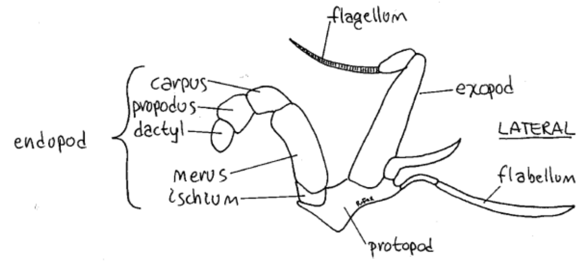


Fig. 5. The second maxilliped

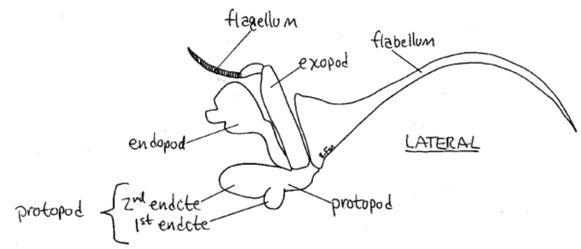


Fig. 6. The first maxilliped

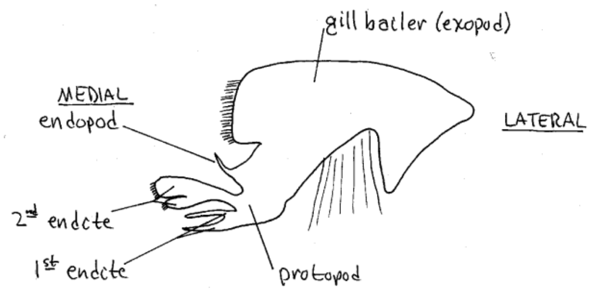


Fig. 7. The second maxilla

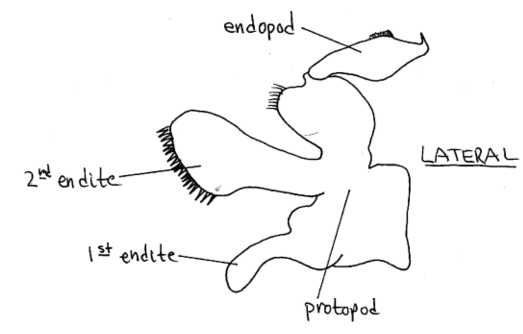


Fig. 8. The first maxilla

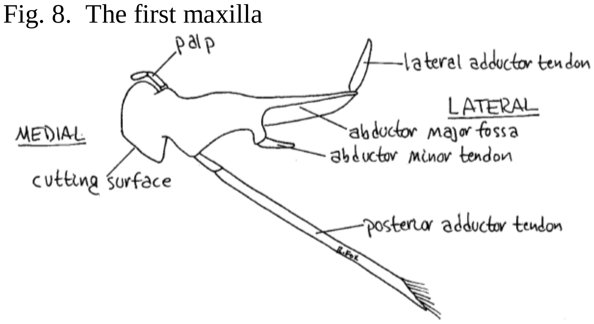


Fig. 9. The mandible