Chapter 10

Arthropoda

10.1 Objectives

- To observe the wide variety of Arthropods.
- To observe and compare the external and internal anatomy of various arthropods including a crab, crayfish, and cricket.
- To observe the external anatomy of various arthropods including a millipede, spider, and horseshoe crab.
- To observe a variety of live arthropods from both terretrial and aquatic environments.

10.2 Description

Arthropoda is the largest and most diverse animal phylum. It includes the trilobites, chelicerates, insects, and crustaceans. Arthropods have an exoskeleton that is molted periodically to accommodate growth. The body is segmented and the segments bear paired jointed appendages.

10.3 Classification

Phylum **Arthropoda**
- Subphylum **Trilobitomorpha**(trilobites)
- Subphylum **Cheliceriformes**
  - Class **Chelicerata**
    - Subclass **Merostomata** (horseshoe crabs)
    - Subclass **Arachnida** (spiders, scorpions)
  - Class **Pycnogonida** (sea spiders)
- Subphylum **Myriapoda**
  - Class **Chilopoda** (centipedes)
  - Class **Diplopoda** (millipedess)
- Subphylum **Hexapoda**
  - Class **Insecta**
- Subphylum **Crustacea**
  - Class **Branchiopoda** (brine shrimp)
  - Class **Maxiillopoda**
    - Subclass **Copepoda** (copepods)
    - Subclass **Thecostraca** (barnacles)
  - Class **Malacostraca** (sea spiders)
    - Subclass **Eumalacostraca**
      - Order **Decopoda** (crabs, shrimp)
      - Order **Isopoda** (pill bugs)
      - Order **Amphipoda** (sandhoppers)
      - Order **Euphausiacea** (krill)

10.4 Subphylum Crustacea

Crustaceans are mainly aquatic anumals which posses **mandibles**, two pairs of **antennae**, and **biramous appendages**. The cuticle is usually hard due to calcification. The evolutionary tendancy is from more primitive forms with many segments and unspecialized appendages to more advanced forms with fused segments and specialized appendages.

10.4.1 Crab dissection

- External Anatomy[1].

  Examine your crab and note that, unlike more primitive decapods such as shrimps and crayfish, the body is very wide and is dorsoventrally flattened. Most of the body is head and thorax which are covered dorsally by a large hard carapace. The reduced abdomen is folded beneath the thorax and is not visible dorsally

  On the ventral surface locate the abdomen folded beneath the thorax. The abdomen is sometimes called the pleon and its appendages are pleopods. In true crabs (such as *Callinectes* and *Cancer*) the abdomen is a small segmented structure whose shape varies with sex and maturity. In mature females it is broad with convex sides and covers most of the posterior ventral surface of the thorax. In immature females the abdomen a nearly equilateral triangle whereas the abdomen of males is narrow with a broad base. Determine the sex of your specimen.

[1]The directions for the following dissection are modified from a dissection on Richard Fox's wonderful website. They are for the blue crab *Callinectes sapidus* but also work well for our Dungeness crab *Cancer magister*.

Extend the abdomen so it is no longer folded but points posteriorly from the thorax. The transparent, membranous intestine runs along the ventral midline of the abdomen and terminates at the anus on the telson. It may be filled with dark feces in which case it is easier to see.

On the ventral surface of the thorax there is a median, longitudinal groove hidden by the abdomen. The abdomen of the male occupies this groove. Male gonopores are located at the tip of the inconspicuous penis on the last leg and will be seen later.

Identify the external anatomy of your crab using Figs. 10.1 and 10.2.

Study the appendages without removing them from the animal. The basic crustacean appendage is biramous, meaning they have two extensions. Extend the abdomen again, look at its ventral surface, and find the abdominal appendages, or pleopods. Males have only two pairs of pleopods and they are located anteriorly on the abdomen, on segments 1 and 2. Both function in the transfer of sperm to the female during copulation. The long, curved, tubular first pleopod is the gonopod. It, not the penis, is the organ used to deliver spermatophores to the female gonopore. The second pleopod is much shorter and functions as a piston to push spermatophores through the hollow core of the gonopod.

The five pairs of pereopods, or walking legs, of the posterior thorax lack exopods and are uniramous. In males the gonopore is located at the tip of a long, thin, limp, transparent, colorless penis on the proximal edge of the coxa of the fifth pereo-

pod. (The penis of *Cancer* is a short, blunt papilla). The penis fits into the groove of the gonopod to which it delivers sperm.

Pereopods can be voluntarily autotomized (=self cut) to escape predation, reduce blood loss from a wound, or in response to physiological stress. Pereopods 2-5 are similar to each other. Pereopod 1 is the cheliped and the pincer at its distal end is the chela. The cheliped is much more robust than the other pereopods and is constructed so that the dactyl is a movable finger that opposes an immovable finger. Note the teeth on the fingers.

The large opening in the carapace dorsal to the coxa of the cheliped is the inhalant aperture leading into the branchial chamber where the gills are located.

The maxillipeds, which are the appendages of the first three thoracic segments, function as mouthparts. Unlike other thoracic appendages, they are biramous. The maxillipeds and other mouthparts overlie each other so only maxilliped 3 can be seen at present.

The two pairs of antennae are small and may go unnoticed if they are folded out of sight under the anterior edge of the carapace. The lateral pair are the second antennae. In crabs they lack exopods and are uniramous.

The two short, thick eyestalks, which are not segmental appendages, are located on the anterior edge of the head in the orbits. A large compound eye, located at the end of each eyestalk is composed of hundreds of independent photoreceptive units, or ommatidia. The external manifestation of each ommatidium is its cuticular lens.

- Internal Anatomy

  Turn the crab so its dorsal side is 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 on its dorsal surface. Be careful that you cut only the heavy calcified exoskeleton and not the organs beneath it. Keep your scissors about 5mm from the edge of the carapace and cut completely around it. Use a scalpel to separate it from the underlying tissues. Carefully remove the carapace, in pieces if necessary, without disturbing the underlying tissues.

  The thin, dark body wall, which is little more than the epidermis, lies immediately beneath the carapace and as much of it as possible should be removed with the carapace. The exoskeleton and epidermis alone are the body wall, as there is no musculature, connective tissue, or peritoneum in it. Notice two small, digitiform, calcareous processes on the inner surface of the carapace almost exactly in its center. These are apodemes for the origin of muscles running to the gut. These muscles must be disconnected as you remove the carapace.

  The hemocoel is the large space in which the viscera lie. The coelom is present only as small spaces associated with the gonads and nephridia.

  Carefully remove most of the remaining epidermis (i.e. body wall) without damaging the underlying tissues. It may help to flood its surface with water to facilitate its removal. This is a tedious task but must be

done with care as some of the crab's organs adhere tightly to it.

Refer to Fig. 10.3 to identify the internal structures of your crab.

The stomach is a large, bulging, transparent, thin-walled sac lying dorsally on the midline in the anterior thorax. It is the most conspicuous part of the gut. It is an exceptionally complex structure whose walls bear some 40 calcareous ossicles and 80 muscles. It is divided into a large, dorsal anterior chamber (or cardiac stomach) and a smaller, ventral posterior chamber (or pyloric stomach). The digestive glands are large, soft, amorphous, yellow or greenish organs occupying the periphery of the dorsal thorax. (The digestive glands of textitCancer are gray-brown and consist of abundant small, fingerlike papillae.) The glands secrete hydrolytic enzymes, absorb the products of hydrolysis, and store food reserves.

The respiratory system consists of the gills located in the two lateral branchial chambers. These chambers occupy the pointed lateral sides of the body. The thin transparent body wall lying over the gills is a chitinous membrane investing the dorsal surface of the branchial chamber. It is almost invisible but it is all that separates the branchial chamber (which is filled with seawater) from the hemocoel (which is filled with blood). Remove this thin, transparent sheet from the gills. The branchial chamber is now open and the gills are exposed for study. There are eight gills on each side of the body but two of them are small and easily overlooked. The gills divide the branchial chamber into dorsal and ventral regions. Water flows in the inhalant aperture to the ventral region, then across the gill filaments into the dorsal region. It then exits via the exhalant aperture.

The soft, white or gray heart lies on the midline posterior to the stomach. The heart has three pairs of large ostia, two dorsal and one lateral, through which blood enters the heart. The blood, or hemolymph, contains the respiratory pigment hemocyanin, which is colorless when deoxygenated and pale blue when oxygenated.

The male reproductive system starts with two long, paired, indistinct, white or grayish, testes which lie dorsally in the anterior body where they may be difficult to distinguish from the digestive glands beneath them. Each testis is a translucent convoluted tube that begins laterally near the base of the lateral spine and extends anteriorly and medially. It lies on top of the digestive gland and runs parallel to the anterolateral border of the carapace. Near the midline it becomes the complex, coiled and looped vas deferens of many regions and colors (white, pink, greenish). The proximal region is a slender coiled tube wound into a white globular mass. The middle region of the vas deferens is large, pink, and glandular in mature individuals. In mature specimens this is the easiest part of the male system to see. The distal position of the vas deferens extends to the penis.

The excretory system consists of two soft, grayish or pale greenish-white antennal glands located inside the anterior wall of the cephalothorax behind the second antenna. They may be difficult to find. These antennal glands are very effective

osmoregulatory organs and blue crabs are tolerant of a wide range of salinities. The glands play little or no role in nitrogen excretion, most of which occurs across the surfaces of the gills.

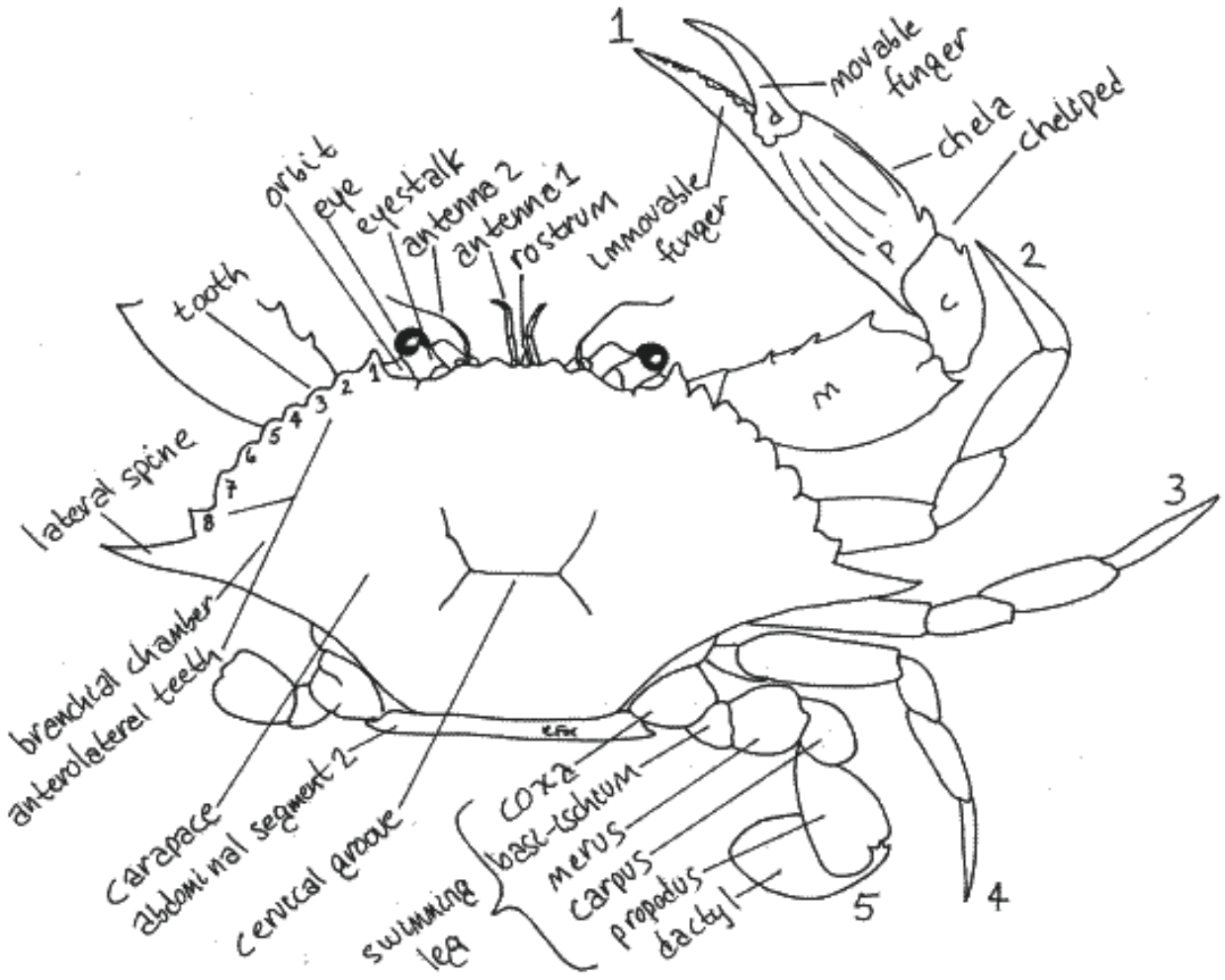

Figure 10.1: Dorsal view of the blue crab *Callinectes sapidus*.

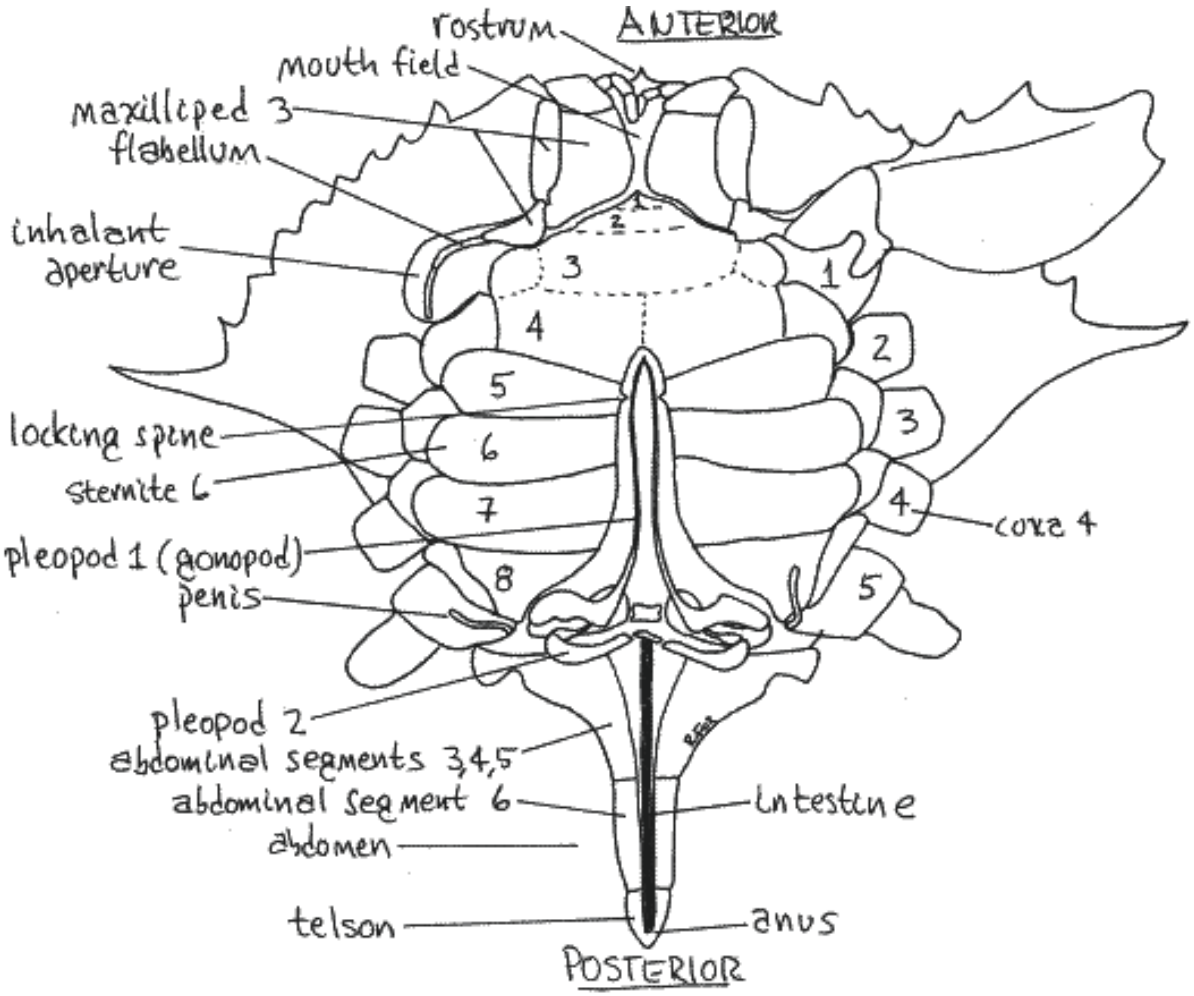

Figure 10.2: Ventral view of the blue crab *Callinectes sapidus*.

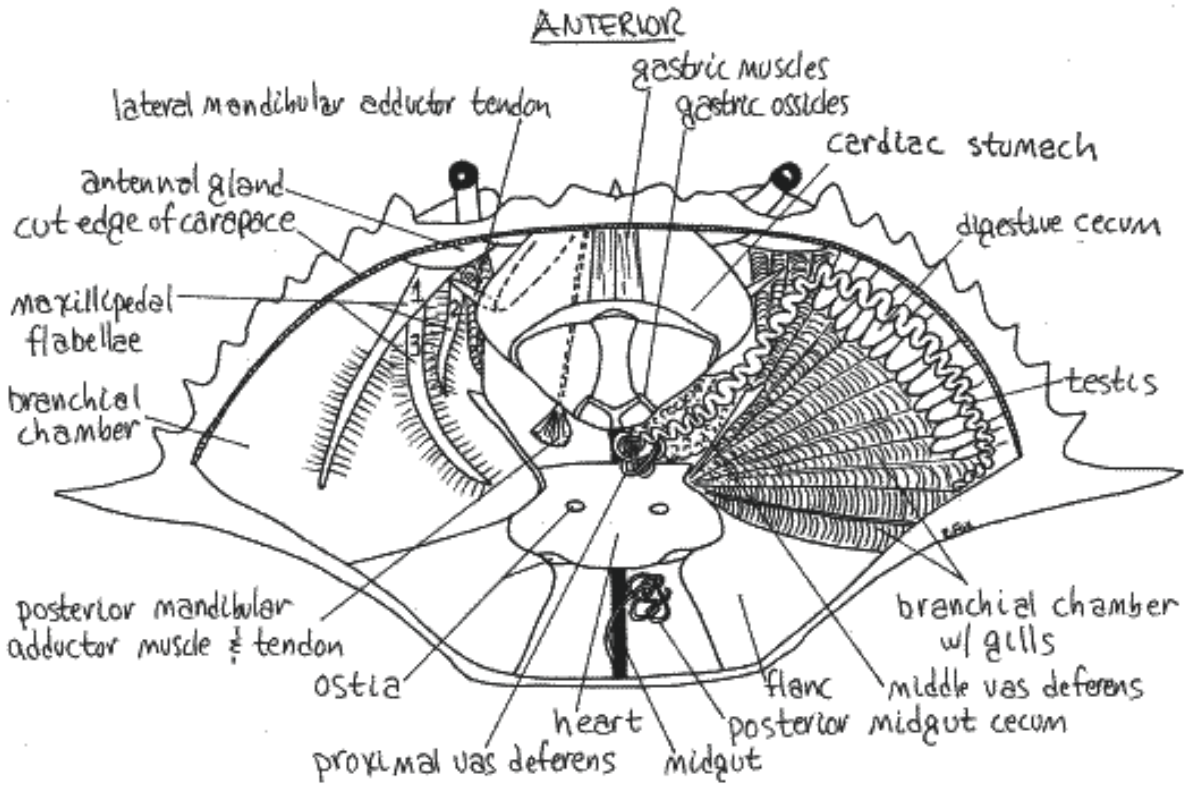

Figure 10.3: Dorsal dissection of a mature male blue crab. The digestive gland, onads, and gills have been removed from the left side.