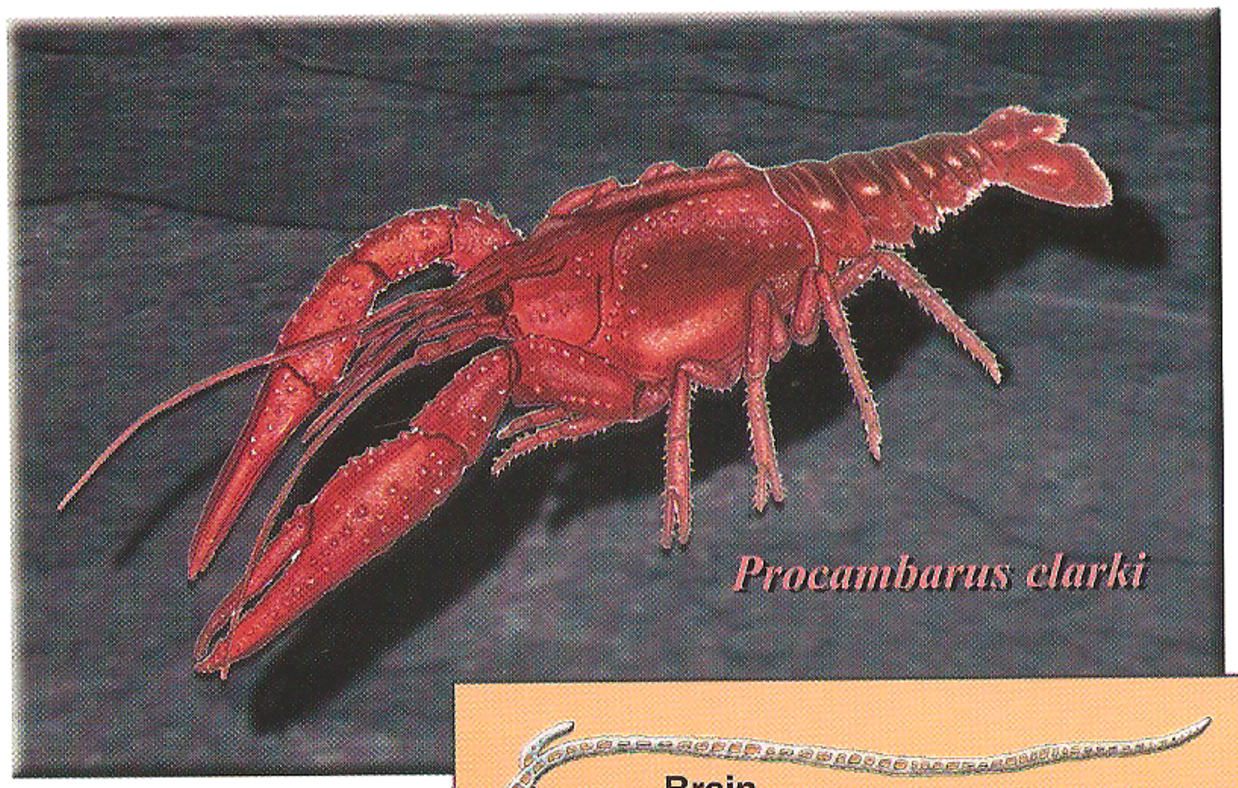
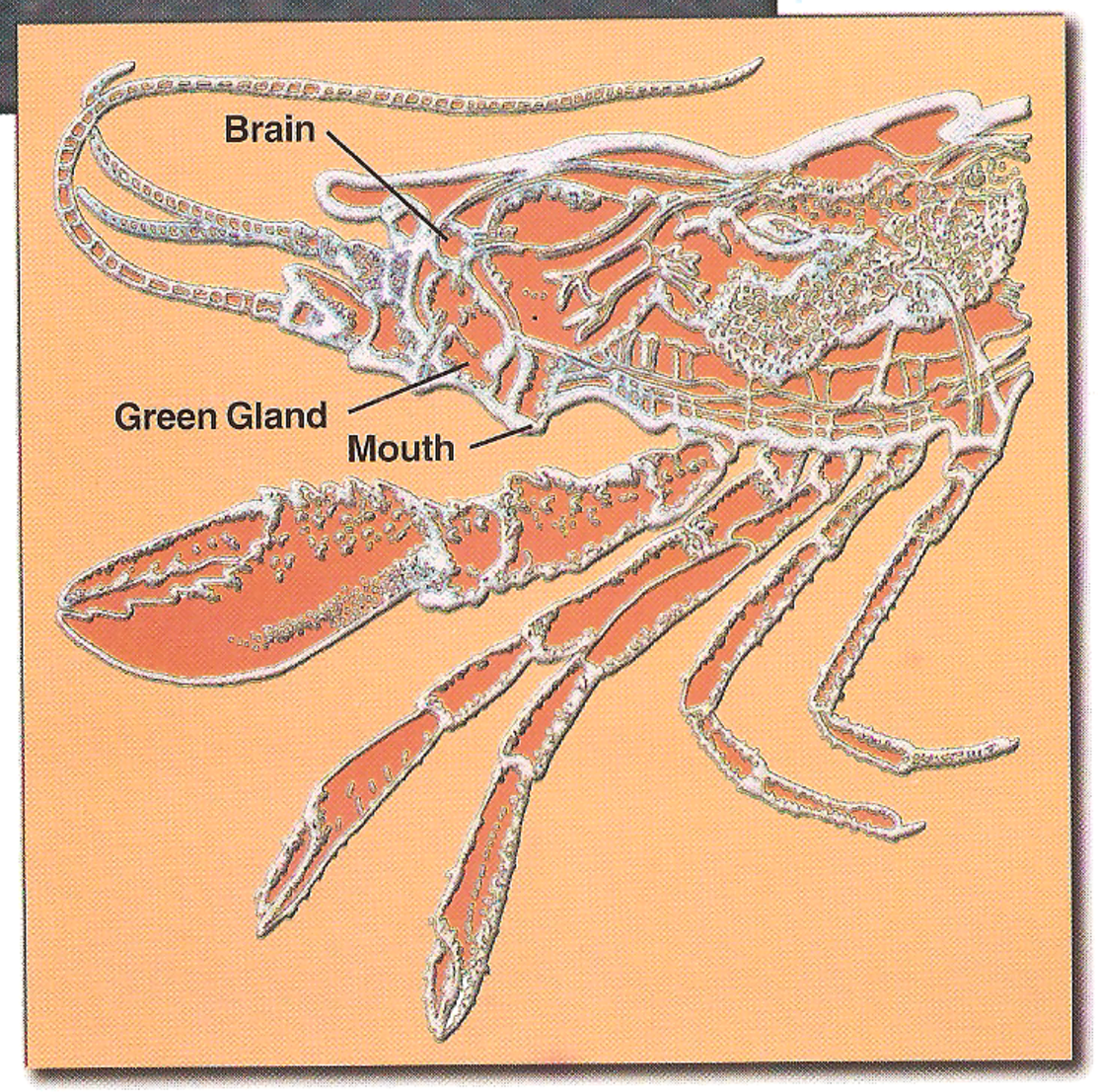
An Illustrated Dissection Guide To The... *Crayfish*





by
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An Illustrated Guide to the Dissection of the *Crayfish*

Introduction

Crayfish belong to the order Decapoda in the phylum Arthropoda, the largest animal phylum in diversity and number of species. The phylum Arthropoda can be divided into four large groups or subphyla: the Chelicerata (including the spiders, horseshoe crabs, scorpions), the Trilobita (trilobites all extinct), the Uniramia (insects, millipedes, centipedes, etc.), and the Crustacea. The subphylum Crustacea contains crayfish, lobsters, crabs, and shrimp. These organisms each possess a body covered by a chitinous exoskeleton strengthened with calcium salts, gills, two pairs of antennae, a pair of maxillae and mandibles.

There does not at first glance appear to be much similarity between a crayfish and a worm. But, in fact, the Arthropoda are closely related to the Annelida (the phylum that includes the earthworm) and these two phyla share the following important features:

1. Both groups are metameric (their bodies are segmented) although in some arthropod groups such as ticks the metamerism is greatly reduced.

2. The brain is located cranially and dorsally, but is followed by a ventral nerve cord with a ganglionic swelling in each segment.

3. Primitive arthropods show paired appendages for each segment which can be compared with the paired parapodia (or setae in the earthworm) of each metamere in the Annelids.

Despite these similar characteristics there are distinct differences between the phyla. Arthropods are characterized by having a hard, protective body covering: the exoskeleton. Coinciding with the evolution of this skeleton, the muscles for movement had to change. The locomotory muscles evolved from a simple body musculature like that of the earthworm (composed of only longitudinal and radial muscles) to a complex series of specialized muscles to control the limbs and tail. The circulatory system has changed from the Annelid's closed type to an open circulatory system where the hemolymph (blood) is forced away from the heart in arteries, but flows back to the heart through open venous cavities or sinuses. The heart in Arthropods has evolved from the five dorsal aortic arches of the Annelids to a single distinct dorsal heart. For a more detailed discussion of the relationships between the two phyla, the student should refer to an invertebrate text such as Barnes, 1980.

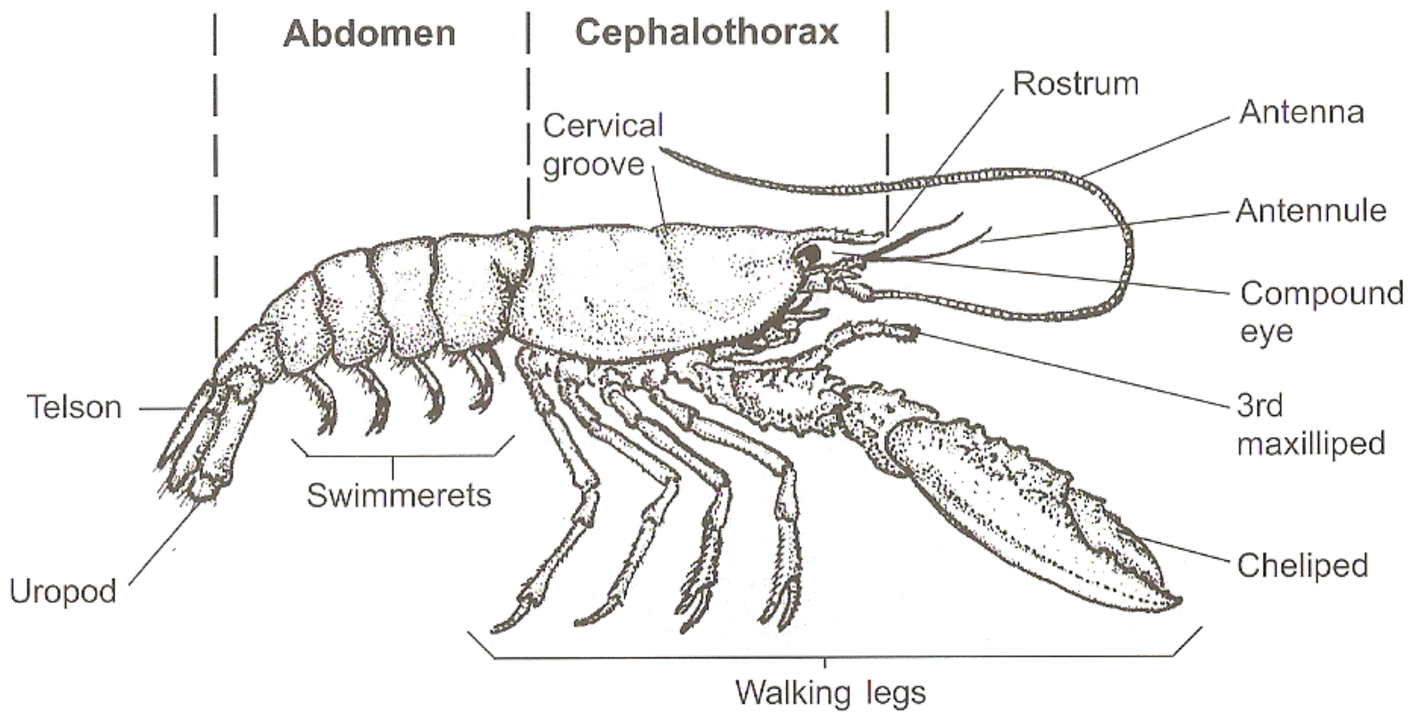

Figure 1. External features

Dissecting the crayfish involves an inspection of the external features, followed by the careful removal of the exoskeleton to gain access to the internal structures. To do this properly, without damaging the internal organs one should work with good dissection scissors, forceps, a dull probe, a sharp probe, and several dissection pins. Take your time and be careful. Precision and care in preparation are the difference between a neat, tidy dissection, and an unrecognizable mess. In order to keep your specimen from drying and to keep the tissues pliable, it is recommended that the specimen be sprayed with Delta-Sol. This nontoxic, odorless preservative prevents mold and does not have any of the irritating odors possessed by formalin and other common preservatives.

External Features *(Figure 1)*

The body of the Crayfish is covered by an exoskeleton secreted by the epidermis. The exoskeleton is composed of chitin, a nitrogenous polysaccharide bound with protein and hardened with mineral salts. The exoskeleton must be shed or ecdysed as it is outgrown. After shedding its exoskeleton the crayfish is vulnerable to predators for a time while the new exoskeleton hardens. The body can be divided into two major functional sections or tagmata: the cephalothorax and the abdomen.

The portion of the exoskeleton covering the cephalothorax is the carapace. The carapace is composed of numerous fused plates. The cervical groove marks the line of fusion between the head and the thorax. By gently lifting the edges of the carapace behind the cervical groove, the gill chambers can be opened and the gills may be seen. The most anterior portion of the cephalothorax is the rostrum. Just below the rostrum are the two pairs of antennae, and a pair of well-developed compound eyes on the ends of movable eyestalks. There are three pairs of small mouthparts originating from the head (the mandible and two pairs of maxillae). There are three more sets of mouthparts, the maxillipeds that arise from the thorax in the region nearest the mouth. These small appendages function as touch sensors and help to hold and manipulate food.

The crayfish has five pairs of walking legs or pereiopods (hence, the order name Decapoda). The gills are connected to the basal portions of these legs. The first pair of walking legs is highly modified with enlarged claws (chelae) for grasping food, defense, offense, and displaying, and is known as the chelipeds. The remaining four pairs are used for walking and food handling.

Contained within the cephalothorax are the nervous, circulatory, digestive, excretory, and reproductive organs. At the base of each antenna on the ventral side is a pore. This is the renal opening, through which nitrogenous waste is expelled. If your specimen is a male, the genital pores, through which sperm is released, will be found medial to the bases of the fifth legs. The genital pores of the female, through which the eggs are released, are located medial to bases of the third legs. In females, the seminal receptacle is on the ventral midline anterior to the last pair of legs. This is where the sperm is stored between copulation (usually in the fall) and fertilization (usually in the spring).

The abdomen is a segmented, muscular tail that functions mainly as a locomotory structure. On the underside of the abdomen are the swimmerets, or pleopods. These are simple biramous appendages that are used in slow swimming, and to create a current of water over the gills. These appendages are also used for holding the eggs and young in females. In males, the first pair of swimmerets is modified for sperm transfer to the female during copulation. At the very end of the abdomen is the telson, bordered on both sides by a pair of uropods. The anus opens on the ventral surface of the telson.

Beginning the Dissection

Place your crayfish in a dissecting pan and carefully remove the carapace as follows:

Carefully insert your scissors under the lower, caudal edge of the carapace and cut dorsally until you have reached the top of the underlying gills lifting the carapace gently with forceps as you go.

Make an anterior cut in the carapace about 1.5 cm to one side of the medial line. Cut forward to within about 1 cm of the eye. Repeat this procedure on the other side.

Carefully remove the strip of exoskeleton that you have formed moving from the tail toward the head. Be careful not to damage the underlying tissues. Use your probe or scalpel to help loosen any epidermal or muscle tissue that sticks to the portion being removed. Extend your cuts up so that they join between the eyes.

Finish removing the dorsal section of the carapace. It is especially critical to be careful in the head region as there are many muscles connected to the carapace here. The sides of the carapace, if they have not already fallen off, should now be easily removable with a gentle pull of the forceps or some small cuts. At this point, you should see the dorsal epidermis and the exposed gills. Repeat this procedure one segment at a time on the abdominal segments.

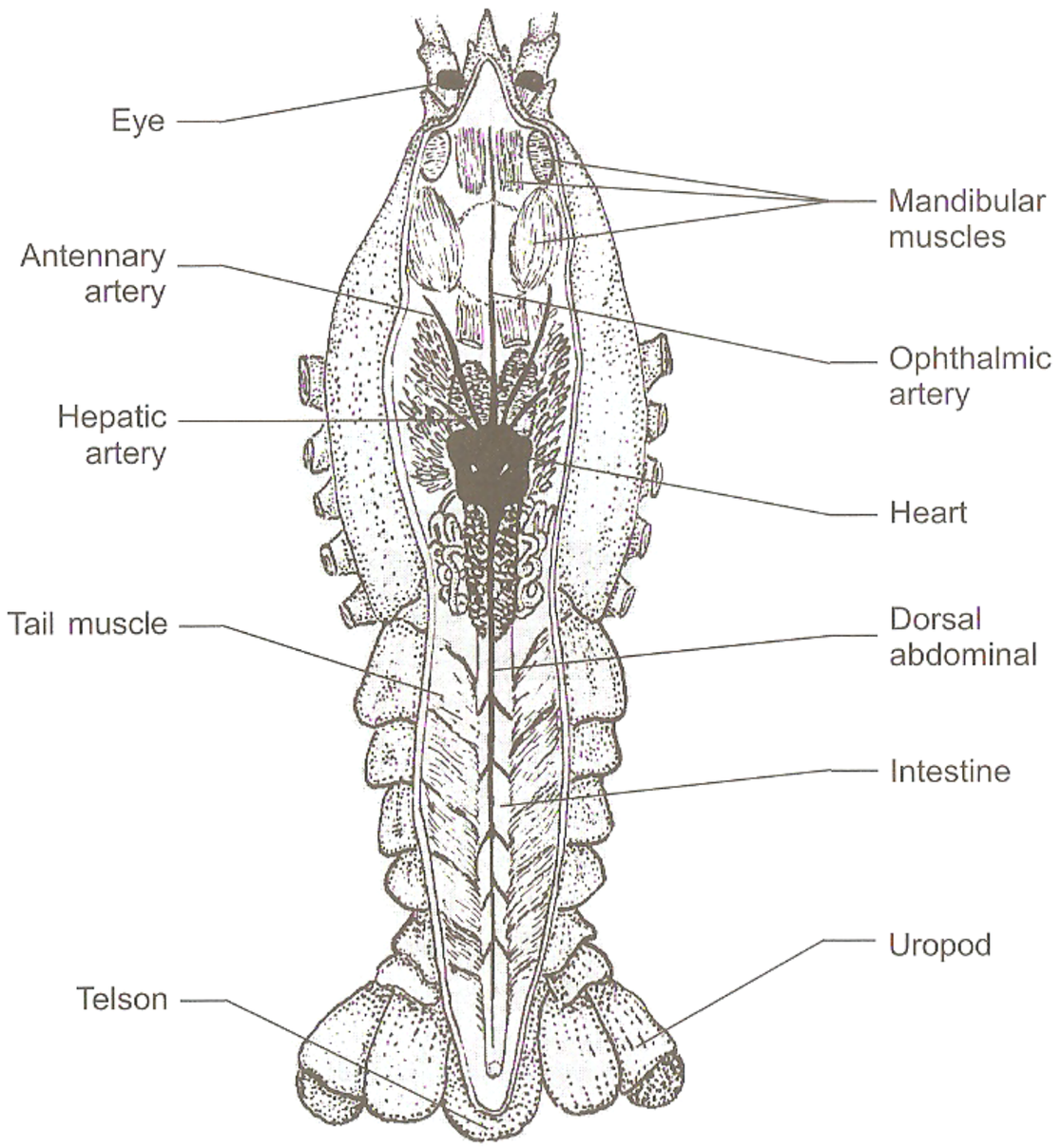

Figure 2. Dorsal view of internal organs.

The thin tissue covering the internal organs is the epidermis. This tissue produces the exoskeleton. Near the caudal edge of the cephalothorax, you should see a darker, pinkish portion of the epidermis. This stained area covers the pericardial sinus, which contains the heart. Carefully remove the epidermis to expose the underlying organs

At this point, you should be able to see the stomach near the head. All around the stomach are muscles. Those anterior to the stomach are the anterior gastric muscles. Those behind it are the posterior gastric muscles. The gastric muscles connect the stomach to the carapace and power the gastric mill. Those lateral to the stomach are the mandibular muscles. Extending laterally and caudally from the stomach are the two lobes of the digestive gland, or hepatopancreas. These lobes should extend the full length of the thorax. The digestive gland is the largest gland in the body.

Just behind the stomach, within the pericardial sinus, is a small, angular, saddle-shaped heart. Extending from the heart are five major arteries. These are the Opthalmic (1), Antennary (2), Dorsal Abdominal (1), Hepatic (2), and Sternal (1 not shown) arteries. The opthalmic artery arises from the medial portion of the cranial end of the heart. It proceeds

straight toward the head and supplies the head and esophagus. Arising from either side of the opthalmic artery and extending anteriorly to the green glands are the antennary arteries. These supply the stomach, green glands, antennae, and lateral portions of the head. The dorsal abdominal artery is a large artery extending caudally from the heart. It supplies the intestine and the tail muscles. The hepatic arteries branch from the ventral surface of the heart and supply the hepatopancreas. The sternal artery extends from the ventral side to the ventral nerve cord where it branches. The anterior branch is the ventral thoracic artery and the caudal branch is the ventral abdominal artery. The ventral thoracic artery supplies the leg muscles and the ventral abdominal artery supplies the tail muscles. All of the arteries divide into smaller vessels and capillaries, but the crayfish has no veins to return the hemolymph to the heart. Instead, the hemolymph is returned to the heart through a series of open sinuses.

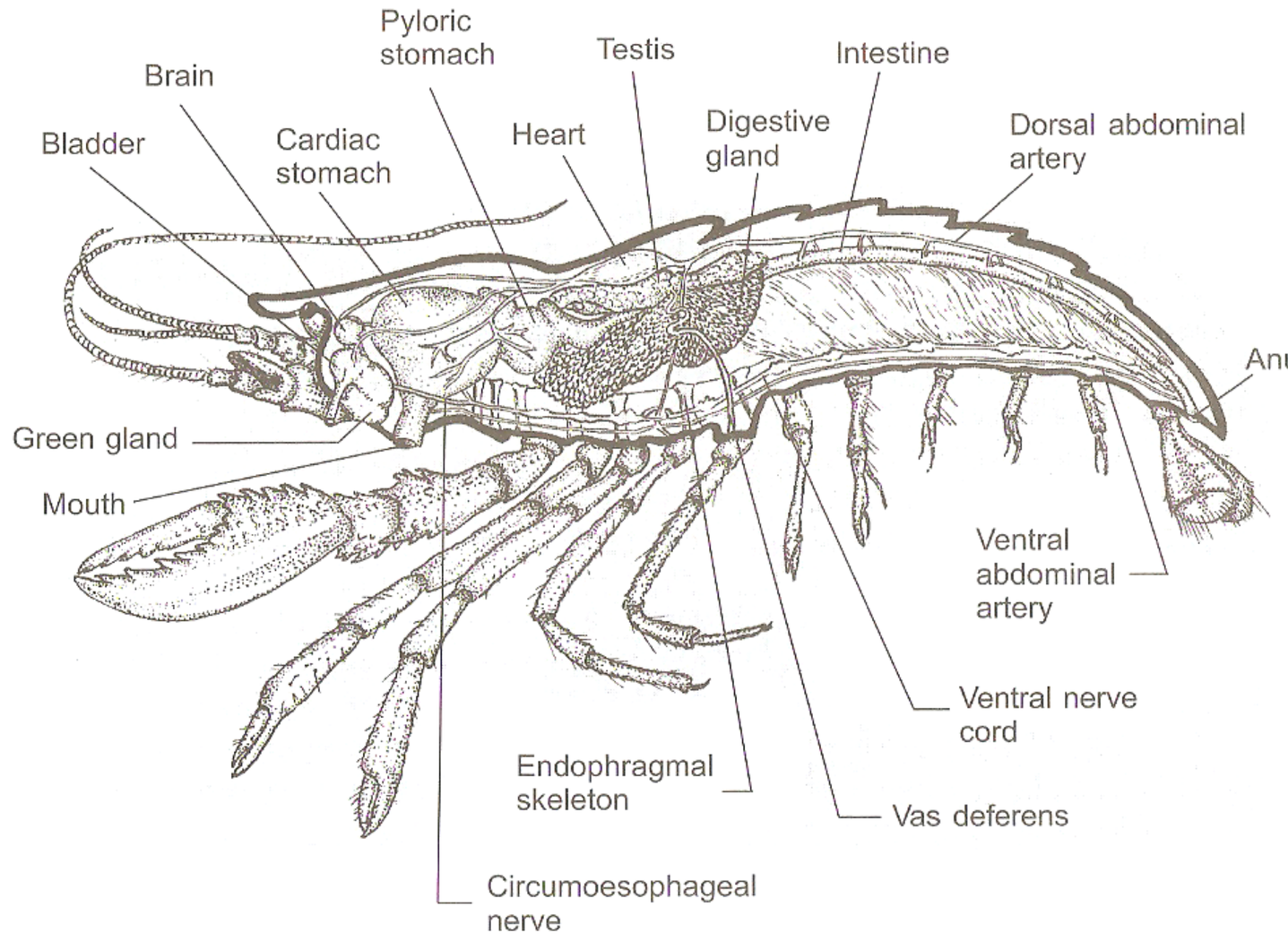

Figure 3. Lateral view of internal organs.

Continuing the Dissection

Lay your specimen on one side in the dissecting tray. Remove the gills. With scissors, cut away the body wall just above the appendage joints. Cut caudally from the first limb joint to the first abdominal segment. From this point, cut up dorsally to the dorsal cut. Cut the cranial end just behind the eye to the mouth. Carefully remove the exoskeleton pieces you have freed until you have exposed the internal organs as shown in *Figure 3.*

Identify the following: (to see most of these parts you may need to remove a large portion of the digestive gland).

Nervous System

Brain—Located just caudal to where the eyestalks join the body. This is a small, lobed, white organ, connected to the ventral nerve cord by the circumoesophageal nerves. These nerves extend together away from the brain, separating at the circumoesophageal commissure to go around the esophagus and then rejoining at the subesophageal ganglion to form the ventral nerve cord.

Ventral Nerve Cord—This is the main nerve cord of the crayfish. Along its length are ganglia (swellings) from which arise nerves that extend away from the ventral cord to the limbs and organs. Each body segment or somite has it own ganglia, although some of these are fused. The brain is a fusion of three ganglia and the subesophageal ganglion is formed by the fusion of five pairs of ganglia. In order to view the entire nerve cord, it is necessary to cut away the endophragmal skeleton that is located below the intestinal tract in the cephalothorax. The endophragmal skeleton projects inward from the sternal plates and provides attachments for the limb muscles. Trace the nerve cord to the suboesophageal ganglion and the circumoesophageal commissure by which the nerve cord passes around the esophagus.

Excretory System

Green Gland—In the head region just below the antennae, and anterior to the digestive glands, are the green glands or antennal glands. These glands are green in fresh specimens but are usually yellowish in preserved specimens. The green gland is responsible for maintaining osmotic balance and for removing nitrogenous waste from the hemolymph.

Bladder—Just above the green gland is a thin-walled storage bladder that stores liquid waste filtered from the hemolymph. The waste is released via a duct under each antenna.

Digestive System

The stomach is composed of two parts: the large, strong anterior portion is the cardiac stomach, and the weaker, smaller, caudal portion is the pyloric stomach.

Cardiac Stomach—This contains the gastric mill. The gastric mill is composed of three chitinous teeth that grind the food. The gastric muscles control them.

Pyloric Stomach—The pyloric stomach is separated from the cardiac stomach by a constriction containing a filter that allows only fine food particles through. The enzymes from the digestive gland are mixed with the food in the pyloric stomach.

Digestive Gland—This functions as the crayfish's liver and pancreas. The digestive gland produces the enzymes needed to break down ingested food. The digestive gland is also the main site of absorption and food storage.

Intestine—The intestine is small and thin-walled. It travels caudally from the pyloric stomach, under the heart, along the dorsal surface of the tail, then ventrally to the anus. Some absorption takes place in the stomach and solid waste is transported as feces to be expelled from the anus.

Reproductive System

Sex Organs—Either the male testis or the female ovaries are located underneath the heart. **Figure 4** shows each of the organs. The testis release sperm, via the vas deferens, through a genital pore at the base of the last walking appendage. The eggs are released via the oviduct through a genital pore located at the base of the third walking leg.

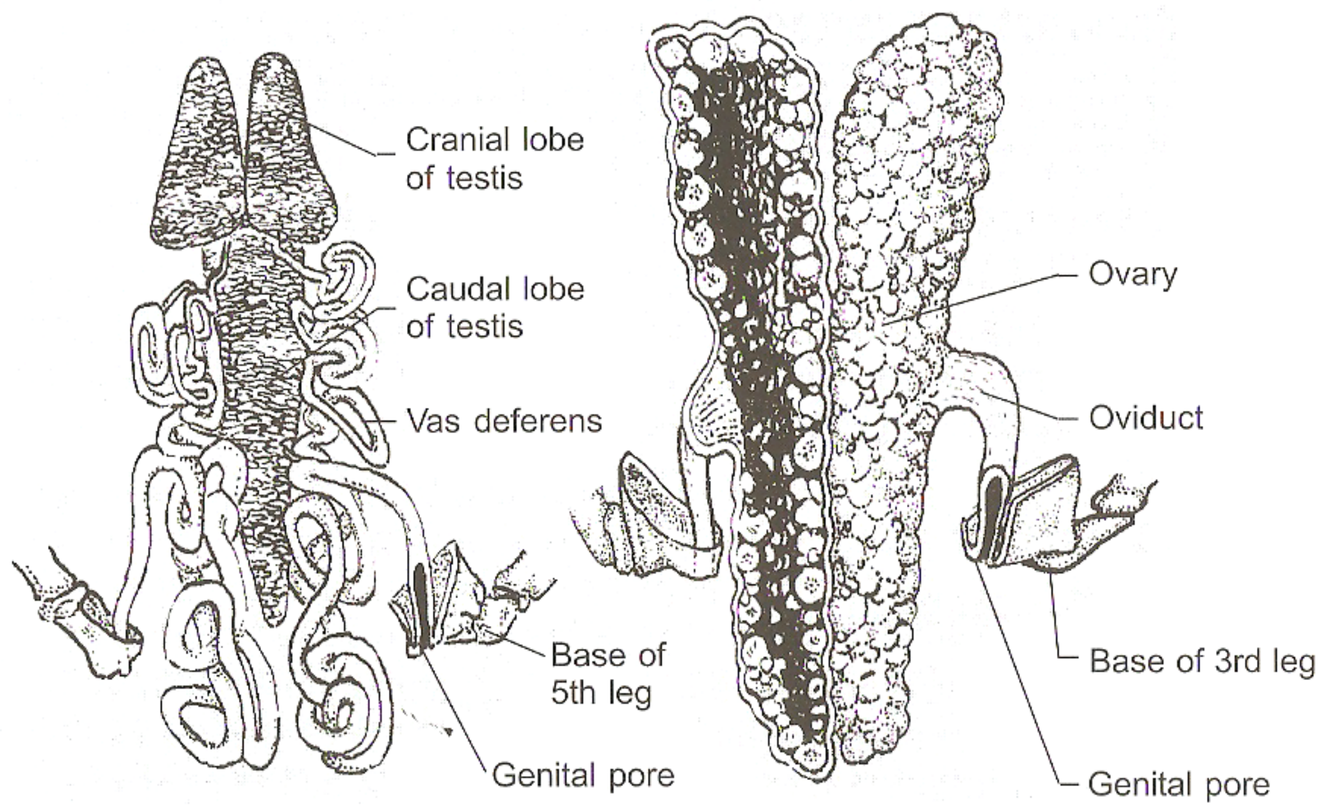

Figure 4. Reproductive organs of the crayfish.

Natural History

Crayfish are found in freshwater ponds, lakes, and streams, all across the globe. There are four genera of crayfish, Procambus, Orconectes, Cambarus, and Astacus. There are about 100 species in the United States, and probably around 300 species worldwide. In the United States Procambus sp. are the most common west of the Rocky Mountains, Orconectes sp. and Cambarus sp. are the most common in the East, and Astacus sp. in the south. In some areas, crayfish are considered agricultural pests, whereas in other areas, they are farmed as a food source. Crayfish are generally active just after sunset and just before sunrise. This form of activity schedule is termed crepuscular. During its active periods, the crayfish forages for food. This consists of snails, tadpoles, insects, aquatic and terrestrial plants, and decaying organic matter. Crayfish burrow into stream banks; the burrows often have entrances that open to the ground surface. Mating usually takes place in the fall. The female stores the male's sperm in a fold of cuticle (exoskeleton) between the last two pairs of walking legs called the seminal receptacle. The sperm is stored throughout winter and used to fertilize the eggs when they are laid the following spring. A single female can lay from 100 to 600 eggs. The female carries the eggs underneath her abdomen and aerates them with currents produced by her swimmerets. When the larval crayfish are mature enough, they are released into the water column, where they drift for a time until settling in an area suitable for further maturation.