**Chapter 10: Phylum Arthropoda**

**Subphylum Trilobita**

The trilobites are an extinct group of arthropods that flourished during the Paleozoic Era from 570 – 245 million years ago. They were all aquatic. The trilobites get their name from the three lobes [one medial (**axial**), two lateral (**pleural**)] that are formed by two **longitudinal grooves** that divide the organism. A trilobite also has three body tagmata, the **cephalon** (head), **thorax**, and **pygidium**. The head contains a pair of large **compound eyes**, one pair of **antennae**, and three pairs of post-oral appendages involved in feeding.

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**Figure 10.1.** Labeled diagram of trilobite structures.

**Subphylum Chelicerata**

Characteristics:

1. Representatives possess **chelicerae** and **pedipalps** as mouthparts
2. Antennae and mandibles absent

**Class Merostomata**

* **Carapace** covers the **cephalothorax**
* **Abdomen** also covered with a dorsal plate
* **Telson** a long spine

**Order Xiphosura**

* + Horseshoe crabs (***Limulus*** sp.) are the only living representatives
  + Look for the small chelicerae on the ventral surface anterior to the first large appendages - preserved specimen and plastic mount
  + Possess one pair of chelicerae, one pair of pedipalps, four pairs of walking legs on cephalothorax, six pairs of appendages on abdomen
  + **Book gills** (respiratory surface) are associated with five of the abdominal appendages and are found under **gill opercula** on the ventral surface

**Class Arachnida**

* Two body regions: **cephalothorax** **(prosoma)** and **abdomen (opisthosoma)**
* Appendages: one pair of chelicerae, one pair of pedipalps, four pairs of **walking legs**

**Order Aranae**: Spiders

* + Chelicerae with terminal fangs, each with their own poison gland
  + Pedipalps in females are short and leg-like
  + Pedipalps in males have a terminal segment which looks like a boxing glove
  + Spinnerets are at the posterior end of the abdomen in both sexes
  + Look for the characteristic structures on *Loxoceles reclusa* (brown recluse), *Latrodectus mactans* (black widow), and *Rhechostica hentzi* (a tarantula).

**Order Scorpiones**: scorpions

* + Prosoma is wider than narrow, segmented abdomen
  + Abdomen has pre- (**mesosoma**) and post- (**metasoma**) sections
  + Abdomen terminates in a poison gland and stinger
  + Chelicerae are small projections from anterior end
  + Pedipalps are large pincers
  + Comblike pectines on pre-abdomen – tactile organs

**Order Acari**: ticks and mites

* + Prosoma and abdomen fused, with apparent loss of segmentation
  + **Chelicerae** project from front of body and carry a pair of articles that can be used for cutting. These articles have a

few recurved spines at the distal end. Mouthparts form a **capitulum**.

* + **Spiracles**: most terrestrial arthropods have external openings into the respiratory tubes (**tracheae**). Ticks possess one pair ventrally. They are obvious and located at the edge of the body in the region posterior to the last pair of legs.

**CLADE MANDIBULATA** (Subphyla Crustacea, Hexapoda, and Myriapoda)

Characteristic: possess mandibles

**CLADE PANCRUSTACEA** (Subphyla Crustacea and Hexapoda)

Characteristics:

1. Tripartite brain

2. Shared derived DNA sequences

3. All head appendages, except first antennae, used for feeding

sometime in life

**Subphylum Crustacea**

Characteristics:

1. Most organisms aquatic
2. **Two pairs of antennae** (**antennules** and **antennae**)
3. **Three pairs of feeding appendages on the head** (**mandibles**, **two pairs of** **maxillae**)
4. Two major body divisions (**cephalothorax, abdomen**)

The crustaceans are an amazingly diverse group of animals that inhabit most environments on Earth. In aquatic habitats, they are the dominant organisms in terms of abundance and diversity. The variety of body forms is truly staggering. Myriad microscopic forms such as ostracods and copepods swarm in planktonic communities, barnacles cover aquatic substrates, and large decapods cover the sea floors. Despite all this variation, crustaceans show a remarkable consistency in body plans. All crustaceans have five appendages on the head (indicating a fusion of five segments), two pre-oral and three post-oral. A crustacean has a two major body segments, the cephalothorax and the abdomen. Often, a **carapace** covers the cephalothorax.

**CLADE OLIGOSTRACA**

**Class Ostracoda** (Often planktonic)

* Body completely enclosed by a bivalve carapace
* Thoracic appendages reduced

**CLADE VERICRUSTACEA**

**Class Branchiopoda** (Planktonic)

* Examples: fairly shrimp, brine shrimp, water fleas
* Coxa of trunk appendages host gills, appear “leaf-like” - **phyllopodia**

**Order Diplostraca**: water fleas (***Daphnia***)

* + Head and trunk compose two body regions
  + Carapace covers trunk but not head
  + Biramous antennae

**Order** **Anostraca**: fairy and brine shrimp

* + No carapace
  + Uniramous antennae

**Class Copepoda** (planktonic)

* No carapace, elongate
* Antennules uniramous, antennae uni- or biramous
* Females carry eggs on large, paddle-like appendages

**Class Thecostraca**: barnacles

* Body enclosed in a shell of calcareous plates
* Attached to a substrate as adults

**Class Malacostraca**

* Trunk of fourteen segments:
  + Thorax: first eight segments
  + Abdomen: last six segments
  + Head with five segments
  + All segments bear appendages

**Order Isopoda**: pill bugs (sow bugs, wood lice)

* + Antennules uniramous
  + One pair of maxillipeds
  + Gills abdominal
  + Many are terrestrial
  + Dorsoventrally flattened with no carapace

**Order Amphipoda**: amphipods

* + Antennules often biramous
  + Eyes sessile and lateral
  + Body laterally compressed with no carapace
  + Gills thoracic
  + One pair of maxillipeds

**Order Decapoda**: shrimp, crayfish, lobsters, crabs

* + Three pairs of maxillipeds
  + Five pairs (ten) legs for walking
  + Second maxilla used to create water current for respiration
  + One pair of compound eyes
  + All thoracic segments fused with and covered by carapace

Serial Homology

The appendages of crustaceans illustrate very well the principle of serial homology. The ancestral crustacean probably had appendages on every segment in a primitive biramous condition. Each appendage possessed a basal **protopod** of one or more segments. Distally on the protopod there existed a lateral **exopod** and a medial **endopod**. Each of these structures could consist of more than one segment. These appendages and their evolutionary successors are called **biramous** (doubly branched) **appendages** (Fig. 10.2).



**Figure 10.2.** Labeled diagram of a basic biramous appendage.

There has been substantial modification of the ancestral biramous appendage in the directions of increasing or decreasing the segmentation, emphasizing or deemphasizing the endopod and exopod, and increasing and decreasing the overall size of the appendage. In addition, radical morphological alterations have occurred, making it difficult to accept the common nature and origin of the most extreme examples. Since we have a repetition of this appendage pattern from the same portion of each segment, the name **serial homology** is used.

Remove the 19 appendages from a crayfish as directed. See Table 10.1 for the functions of each of the appendages, and follow this presentation as you look at the appendages. At the conclusion of your study, you should be able to name the appendages in order, **be able to identify them individually when they have been removed from the body of the crayfish**, and **know the function of each appendage**. You can discern the function of some of the appendages by their appearance. The function of others is best illustrated by watching them in action.

**Crayfish Taxonomy**

Phylum Arthropoda

CLADE MANDIBULATA

CLADE PANCRUSTACEA

Subphylum Crustacea

CLADE VERICRUSTACEA

Class Malacostraca

Order Decapoda

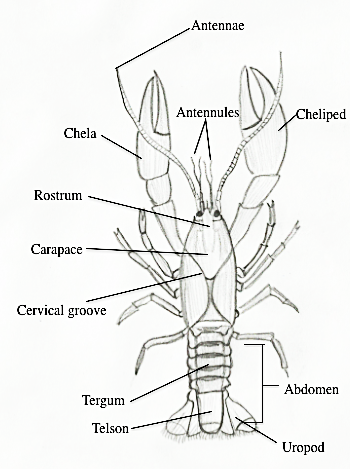
Genus ***Procambarus***

**Crayfish Morphology**

External Anatomy

Before removing the appendages from your crayfish, you should locate the main external features of your specimen. Refer to Figures 10.3 and 10.4. You should be able to identifyall the labeled structures.

  
**Figure 10.3.** Labeled diagram of theexternal anatomy, including all biramous appendages, of the crayfish. Ventral view.



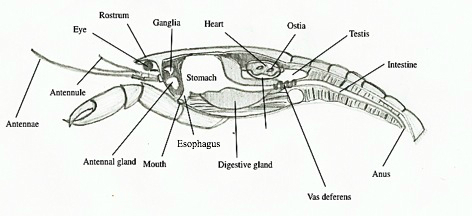
**Figure 10.4.** Labeled diagram of theexternal anatomy of the crayfish. Dorsal view.

**Table 10.1.** Names andfunctions of the crayfish appendages.

|  |  |
| --- | --- |
| **Appendage** | **Function** |
| First antenna (antennule) | Touch, taste, equilibrium |
| Second antenna (antenna) | Touch, taste |
| Mandible | Crushing food |
| First maxilla | Food handling |
| Second maxilla (bailer) | Drawing currents of water into gills |
| First maxilliped | Touch, taste, food handling |
| Second maxilliped | Touch, taste, food handling |
| Third maxilliped | Touch, taste, food handling |
| First walking leg (cheliped) | Offense and defense |
| Second walking leg | Walking and prehension |
| Third walking leg | Walking and prehension |
| Fourth walking leg | Walking |
| Fifth walking leg | Walking |
| First swimmeret | In male, transferring sperm to female |
| Second swimmeret (male) | Modified for transfer of sperm to female |
| Second swimmeret (female) | Creating water currents; carrying eggs and young |
| Third, fourth, and fifth swimmerets | Creating water currents; in females carrying eggs and young |
| Uropod | Swimming; egg protection in female |

Internal Anatomy

As the appendages are removed, internal parts are sometimes also removed (gills, mandibular muscle). You may find it helpful to obtain a new crayfish to dissect for the internal anatomy. In the process, you will locate parts of the digestive (**flow** – Fig. 10.6), nervous, circulatory (**flow** – Fig. 10.7), muscular, and excretory systems (**flow** – Fig. 10.8), though some may be hard to find and not visible on your particular specimen. Refer to the crayfish model and Figure 10.5 to identify the **antennal gland**, **mouth, esophagus, cardiac** **stomach, pyloric stomach, gastric mill,** **intestine**, **anus,** **digestive gland**, **ovary**, **testis**, **heart**, **ostia,** **vas deferens**, **oviduct**, **brain**, **anterior and posterior gastric muscles, mandibular muscle, abdominal extensor and flexor muscles,** and **ventral nerve cord**.



**Figure 10.5.** Labeled diagram of the internal anatomy of a crayfish.

Mouth 🡪 Esophagus 🡪 Cardiac Stomach 🡪 Pyloric Stomach 🡪 Intestine

🡪 Anus

**Figure 10.6.** Word diagram of flow through the crayfish digestive system.

Heart\* 🡪 Arteries 🡪 Tissue sinuses 🡪 Sternal sinus 🡪 Afferent sinus

channels 🡪 Gills\* 🡪 Efferent sinus channels 🡪 Pericardial sinus\* 🡪

Ostia\* 🡪 Heart\*

**Figure 10.7.** Word diagram of flow through the crayfish open circulatory system (\*visible in the dissection).

End sac 🡪 Labyrinth 🡪 Excretory Tubule 🡪 Bladder\* 🡪 Duct 🡪

Renal Pore

**Figure 10.8.** Word diagram of flow through the crayfish excretory system

(\*visible in the dissection).

Compound Eyes

Many crustaceans and insects both have a pair of photoreceptors called compound eyes. Their eyes are made up of rod-like elements called ommatidia. The crayfish has such an eye. *If you wish to do so,* remove a crayfish eye, and cut through the middle of it from the surface of the eye to the stalk. Observe the cut surface under the dissecting microscope. You should be able to see the individual elements or **ommatidia**.

Tease out several ommatidia, and observe under the compound microscope. Distally, there is a lens complex that is utilized for focusing the light on the sensory element at the base of the ommatidium. At the base of the ommatidium, there are pigment cells that have the capacity to disperse the pigment up along the sides of the ommatidium in bright light and withdraw it to the base in dim light. In dim light, this capacity to disperse the pigment results in the movement of light from one ommatidium to another, thus reinforcing the image.