Invertebrate Diversity -- Teacher Preparation Notes

Dr. Jennifer Doherty and Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania, 2011[1]

Teaching Points

- introduce students to some of the variety of animal form and function, including varied methods of locomotion
- relate form to function, including the advantages of bilateral symmetry and cephalization
- distinction between similarities due to shared evolutionary history (animals in the same phylum) and similarities related to having a similar lifestyle (burrowing animals)

Equipment and Supplies for 6-10 students:

Containers to display the invertebrates in:

- 2-3 medium sized containers such as Gladware's Soup & Salad size (3 cups)
- 1 large sized container as large or larger than Ziploc's large Rectangular Container (9.5 cups) to allow room for crayfish movement
- 1 gallon sized plastic bag
- 1 plastic tray or plate

Magnifying glasses or hand lenses (4-6) and, if available, dissecting microscopes
Rulers (1-2)
Dechlorinated tap water[2]
Gloves for each student (optional; if you do not have students use gloves, make sure they wash their hands after handling the animals.)

Purchase from local pet store
(e.g. World Wide Aquarium & Pets, 7043 Ridge Ave, Philadelphia, PA 19128, Roxborough)
(approximate prices)

Crayfish (1-2)	$1.79 for 2
Crickets (5)	$0.10-0.20 each
Mealworms (5)	$0.10-0.20 each
Earthworms (5)	$2.59 for 24

This set of animals is enough for approximately 10 students. You can reuse the animals all day but, depending on how many classes you teach, you may want to buy replicate sets to ensure freshness and mobility for each class.

For each 6-10 students, set up 2 stations

1. Place 5 mealworms in a medium container. Place 5 earthworms on a damp paper towel on the tray or plate. Have 1 or 2 rulers available at this station and, if available, a dissecting microscope. When the students are not actively observing the **earthworms** it is very important to keep them **moist** by covering them with a wet paper towel.
2. Place 1-2 crayfish in a large uncovered container filled with dechlorinated tap water. Keep the crayfish separated overnight so they will not injure each other. Set out five crickets in 1-2 containers. Crickets are best viewed in a plastic bag that is expanded to full volume (either the bag they come in from the pet store or a plastic storage bag). However, you cannot keep them in a sealed bag overnight and must store them in a different covered container with a screen on top. Alternatively, you can display the crickets in a plastic container. Poke air holes in the bottom of 1-2 medium containers, place the crickets in the containers, put on the lid, and place it upside down. Be careful the crickets don't jump away during transfer.

Have several hand lens or magnifying glasses available at each station.

---

[1] These teacher preparation notes and the related student handout are available at http://serendipstudio.org/sci_edu/waldron/.

[2] You can dechlorinate tap water by leaving it out in the open containers overnight or by adding a commercial dechlorinator used for aquarium water. Alternatively, you can ask for extra from the pet store.

Teaching Suggestions and Biology Background

Before beginning this activity, students should be familiar with basic concepts such as phylum, class, bilateral and radial symmetry. If you have a 40-50 minute lab period, you may want to plan to discuss the Follow-Up Questions in the next class period, so students will have plenty of time to observe the animals.

You may want to use the introductory section (page 1 of the student handout) as part of a lecture/discussion for the class period before the lab activity. This could include an introduction to the annelid, arthropod and chordate phyla, as well as major subphyla like the Crustacea, and examples of other animals included in these phyla, subphyla and classes.

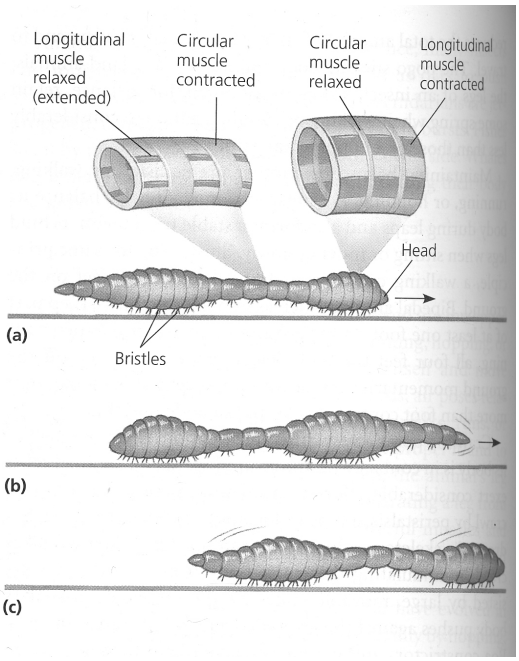
Characteristics of Observed Invertebrates

Name	Earthworm	Mealworm	Cricket	Crayfish
External anatomy	segmentation visible, clitellum*	legs, small antennae, very small eyes, segmentation visible	legs, wings, eyes, antennae, segmentation visible in abdomen	legs, claws (chelipeds), eyes, antennae, segmentation especially visible in abdomen
How does the animal move?	hydrostatic skeleton; alternating shortening and elongation of different segments	walks on legs on the front of the body	legs and wings (walking, jumping and flying)	swims backwards with tail, walks forward on legs

*The clitellum secretes material that makes the cocoon which surrounds the eggs and fertilizing sperm when they are released by the hermaphroditic earthworm after copulation.

The following figure from Biology, 6th Edition, by Campbell and Reece may be helpful for clarifying student observations concerning **earthworm locomotion**.

FIGURE 49.27 Peristaltic locomotion in an earthworm. A hydrostatic skeleton, two sets of muscles (one elongating the body, the other shortening it), and bristles holding to the substrate enable an earthworm to crawl over moist ground or burrow through it. Contraction of longitudinal muscles thickens and shortens the worm, while contraction of circular muscles constricts and elongates it. **(a)** As the worm crawls forward, body segments at its head and in front of the tail are short and thick (longitudinal muscles contracted; circular muscles relaxed) and anchored to the ground by bristles. Behind the head and at the tail, segments are thin and elongated (circular muscles contracted; longitudinals relaxed). **(b)** The head has moved forward because circular muscles in the head segments have contracted. Segments behind the head and in front of the tail are now thick and anchored, thus preventing the worm from slipping backward. **(c)** The head segments are thick again and anchored in their new position. The rear segments have released their hold on the ground and have been pulled forward.



You can use the **comparison between earthworms and mealworms** to contrast phylogenetic categories with non-phylogenetic common usage categories such as worms (animals with one dimension much longer than the other two). A phylogenetic category, such as a phylum, groups animals that share a common evolutionary ancestor and therefore share similarities in their fundamental biology. Evolutionary relatedness is judged based on characteristics that often are not obvious from the outside, so animals that have very different external appearance may be grouped in the same phylum (including larval forms such as mealworms and caterpillars which are grouped with all other insects in the Arthropod phylum). In contrast, animals that look similar but have very different internal anatomy may be grouped in different phyla (e.g. flatworms, roundworms, and segmented worms).

All of the animals in this activity are **bilaterally symmetric**. Bilaterally symmetric animals typically have a concentration of sensory organs at the head end of the animal, which allows the animal to gather information about the environment it is moving toward. (The concentration of sensory organs and much of the nervous system at the head end is called cephalization.) In contrast, radial symmetry is observed in organisms like jellyfish or hydra which drift slowly through the environment or are sessile; radial symmetry is associated with sensory organs distributed around the circumference which receive sensory information from all directions.

Follow-up Questions 3-6 guide students in thinking about **similarities due to shared evolutionary history vs. similarities due to adaptations to similar environments**. If your students have studied homology and analogy, you may want to link this discussion to homology (similarities due to shared evolutionary ancestors) and analogy (similar form for similar function due to convergent evolution). With regard to Follow-up Questions 4 and 5, both the worm shape and the absence of substantial eyes are related to the burrowing lifestyle. Earthworms live underground and consume decaying organic material, and mealworms live surrounded by what they eat (e.g. grain or grain products).

You may want to contrast the type of development in mealworms/Darkling beetles (complete metamorphosis) vs. in crickets (incomplete metamorphosis). Complete **metamorphosis** is observed in insects where the larval stages look completely different from the adult (e.g. mealworms or caterpillars) and the transformation from the largest larva to adult occurs in a pupa; the larval stages are specialized for eating and growing and the adult stage is specialized for dispersal and reproduction. Incomplete metamorphosis is observed in insects like crickets where the young resemble the adults, although they lack wings; each molt produces a larger insect with more nearly adult body proportions, and the final molt produces an insect with wings and mature reproductive organs.

For **additional information** on the anatomy, biology and care of these animals see the following websites:

Earthworm (e.g. *Lumbricus terrestris*)
http://web.archive.org/web/20031209012204/http://www.icewatch.ca/english/wormwatch/resources/anatomy.html
http://www.carolina.com/category/teacher+resources/care-guides/earthworms+and+redworms.do

Mealworm, larvae of *Tenebrio molliter*
http://www.enchantedlearning.com/subjects/insects/beetles/mealworm/
http://insected.arizona.edu/home.htm (click on "Using live insects in elementary classrooms", then click on Information or Rearing sheets)
http://www.carolina.com/category/teacher+resources/care-guides/mealworms.do

Cricket, *Acheta domestica*
http://www.enchantedlearning.com/subjects/insects/orthoptera/Cricket.shtml
http://insected.arizona.edu/home.htm
http://www.carolina.com/category/teacher+resources/care-guides/crickets.do

Crayfish (e.g. *Procambarus* or *Orconectes* species)
http://www.enchantedlearning.com/subjects/invertebrates/crustacean/Crayfishprintout.shtml
http://www.carolina.com/category/teacher+resources/care-guides/crayfish.do
http://www.carolina.com/category/teacher+resources/classroom+activities/crayfish+in+the+classroom+article.do

Unless you are very familiar with these organisms, we recommend that you have access to these sources or an invertebrate zoology textbook during the activity to help you answer student questions. Also, the figures from these sources can help students to interpret observed characteristics.