Keeping milkweed bugs in the classroom

Grades K-12

Updated December 23, 2014

Summary

Large milkweed bugs, *Oncopeltus fasciatus*, are fast-growing, readily available insects that can easily be kept in the classroom for observation or experimentation. This document will tell you how to keep these insects and provide some ideas for classroom activities.

Learning goals

The specific learning goals may vary by grade level. But at a minimum, after keeping live bugs in the classroom, students should be able to

- Appreciate insects as animals with complex behaviors
- Understand the life cycle of a typical insect by identifying eggs, juveniles and adults.
- Think about what captive bugs could teach us about the lives of bugs in the wild.

Background information

Oncopeltus fasciatus are seed bugs (order Heteroptera; family Lygaeidae). Species of the genus *Oncopeltus* are common in the Caribbean, Central and northern South America. *Oncopeltus fasciatus* lives in the southern and temperate US, and individuals may colonize colder northern states in the summer. Some may over-wintered in diapause as adults. In the wild, they live and feed on milkweed (*Asclepias* sp.), and the bugs gain distasteful, toxic compounds called cardenolides from the plant. Their bright red/orange and black colors are aposematic, advertising their toxicity to would-be predators. To enhance this effect the bugs congregate in semi-social groups.

Heteroptera, like *Oncopeltus*, are hemimetabolous, meaning that there is no dramatic metamorphosis, as in other insects like beetles, moths, bees and flies. Instead, juveniles (also called nymphs) resemble adults in their overall body plan, but lack wings or genitalia. There are five juvenile instars (stages separated by molts of the cuticle) before adulthood. Each instar can be distinguished by its relative size and pattern of pigmentation (see below). *Oncopeltus* are a pale orange after molting. Within hours, the cuticle hardens and the underlying cells produce new pigment. Milkweed bugs spend about 3-10 days in each juvenile instar, reaching adulthood about 5-6 weeks after hatching. The adult wings cover the abdomen and have a pattern of black and orange/red pigmentation. Adults will often be seen attached end to end. This is a "mate guarding" behavior by which males prevent females from seeking new mates after copulation.

All true bugs have a long beak (also referred to as a rostrum, proboscis or mouthparts), which is used to pierce seeds, inject saliva, and withdraw liquefied food. Bugs have a large number of symbiotic gut microbes that help them extract nutrients from the seed extract. In the wild they may also feed on vascular fluids of the host plant, especially at new growth.

Milkweed bugs grow very well in the lab. To maintain a large culture they typically require attention every 7-14 days. Bugs kept in petri dishes should be tended every 1-3 days. The lab strain of *Oncopeltus* has been bred since the 1970s to feed on shelled sunflower seeds and to lay their eggs in cotton balls.

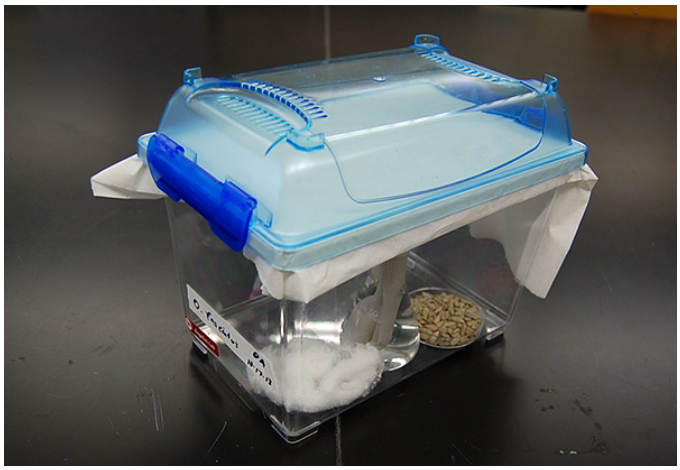
Materials

Milkweed bugs can be raised in any container with a tight-fitting lid. They are available from educational supply companies or may be caught in the wild throughout the temperate US. Below is a list of materials for their habitat. Supplies and catalog numbers are provided for some items along with possible house-hold stand-ins.

item	vendor information	or try this...
cage	Clear-View Plastic Terrarium, Small (Carolina Biological cat# 674339A, $5.50 each)	any small aquarium, terrarium, or a large, clear jar with a lid
paper cover	Kimwipes Cleaning Tissue, 15 x 17", Box of 140 (Carolina Biological cat# 633951, $11.50)	any paper towel wide enough to cover you cage, but without holes larger than about 1 mm.
water flask	Erlenmeyer Flasks, 50 mL, (Carolina Biological, Pack of 12, cat# 731027, $30.55)	a salt/pepper shaker or old plastic film canister
water	Spring water is best	tap water is okay if it's potable
seed dish	Petri Dishes, Polystyrene, Disposable, 60 x 15 mm, (Carolina Biological, Pack of 20, $6.35)	old milk jug caps
sunflower seeds	Feed the bugs organic, unsalted, shelled sunflowers. You may also feed the bugs milkweed seeds.	If those aren't available, any unsalted, shelled sunflower or pumpkin seeds may work.
cotton balls	Any cotton balls will do!	
brush	A fan-shaped paintbrush to move bugs around	In a pinch, a torn piece of paper works just as well

Procedure

- A **standard mass-rearing cage** consists of a large plastic terrarium containing a water flask, seed dish and cotton balls, covered by a large paper towel (or KimWipe) and the terrarium lid. Cage cleaning should happen when the bugs cover the walls with bug poo. Dense cultures should be split up into multiple cages.



- The **water flask** is typically a 50-ml Erlenmeyer flask filled with *spring* water (not tap or distilled!) and a folded paper towel wick that is roughly 1 cm wide, at least 0.25 cm thick, and 5 cm long (from the bottom of the flask to about 2 cm above the rim). The rim should be loosely packed with half a cotton ball. New, clean water flasks should be provided weekly.
- The **seed dish** is half a Petri dish of 3-10 cm diameter containing a single layer of sunflower seeds. The seeds will grow mold, so adding extra seeds will not extend the useful time span of the seed dish. Seeds should be replaced when visibly moldy.



- **Cotton balls** are a place for milkweed bugs to lay eggs. The balls should be teased apart slightly to allow females easier access. A good size for the cotton ball is about the size of a chicken egg. Only adults will need cotton, and juveniles can be kept without it.
- The cage must be **covered** by a single-ply, extra-large KimWipe, folded in half. Paper towels may also work. There are usually small holes in a KimWipe, so it's important that two layers cover the cage. The lid of the cage just keeps the KimWipe in place!
- **Temperature** for milkweed bugs can vary widely. We generally keep them at room temperature, 20-24˚C.
- **How many cages to keep?** If experiments will be consuming bugs, having more cages on hand (before experiments begin) is good way to prevent the stock from becoming depleted to levels where experiments may be delayed by lack of bugs!

- **Mold is bad.** It competes with the bugs for food. Juveniles may become tangled in hyphae and loose limbs when molting or die. Some molds will infect and kill bugs posing a serious potential threat to the health of the entire lab population. Therefore, cages with any dead, moldy bugs should be washed with soap and a mild bleach solution.

- **Bug wrangling** is best done by two students working as a team: one for "defense" and one for "offense." When moving bugs to a new cage:
  1. Set up the new cage with seeds, water and cotton.
  2. Place the old and new cages besides one another.
     - To start a "new" cage, just move the cotton and its eggs from the old cage to the new one. However, if you need to transfer juveniles or adults, continue…
  3. Move the old paper towel cover with any bugs on it to the new cage. Give the surface of the paper a sharp flick with your index finger to kick off any bugs.
  4. Defense! Watch out for bugs climbing up and out of the cage. Using a tortilla chip-sized piece of paper towel or a fan-brush, knock climbers back, or sweep them from the old cage to the new one.
     - Cages with lots of tiny juveniles can be very hard to manage. Therefore, it's best to avoid allowing a large number of eggs to hatch in a filthy cage.
     - Be gentle! An occasional squashed bug is not terrible, but be especially careful with bugs that are part of an experiment.
       - In general, the less you handle a bug, the better for its health.
       - Never use metal forceps to move a live bug.
       - Using a brush or paper towel piece, sweep the body in brief contact.

        - Don't drag a bug along a surface.
        - You can flip a bug over and it will flail to grab onto anything you offer it. This can be a safe way to get a single bug.
    5. Lift up the old water and seed dish, and sweep bugs from them into the new cage.
    6. Hold the old cage side ways. As bugs "run away" towards the bottom edge, sweep them into the new cage.
    7. Milkweed bugs are prolific enough that it usually isn't necessary to save every last one. When the new cage contains several dozen bugs, any stragglers can be euthanized by placing the old cage in a freezer overnight.

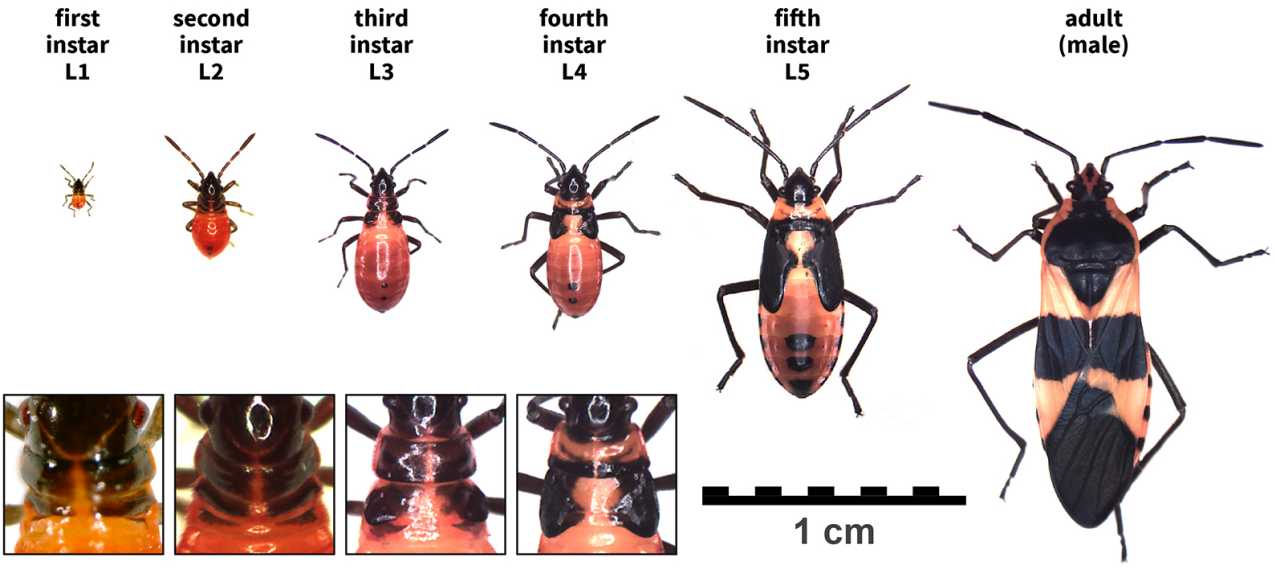
- **Individual bugs** can be raised in 6- or 10-cm Petri dishes. This set-up can be used to observe the development of 1-5 bugs or for mating pairs.
    - **Water**: start with a paper towel folded up like the wick for a water flask. Cut off a roughly 1-cm^2 piece and add it to the Petri dish. Soak this with spring water.
    - **Seeds**: Add 5-6 sunflower seeds. The seeds must be kept away from water or they will mold quickly. In a small dish, a bead of hot glue can separate the two. Larger deep dishes (10 x 2.5 cm), can allow the seeds to be placed in the lid or base of a smaller (4-cm) dish which will significantly slow mold growth.
    - **Egg carton**: very young juveniles may benefit from a small piece (2 cm^2) of paper egg carton folded diagonally. This gives them a place to shelter, which may reduce stress, and provides a good place to molt. (This is crucial for soapberry bugs!)
    - Don't tape the culture dishes shut. Peeling the tape off is a pain.
    - Store multiple dishes in a Tupperware container or terrarium with a snap-on lid. Be sure it is not airtight. This will prevent mice from disturbing dishes to eat the sunflower seeds. (It has happened!)

- **Euthanize** bugs when cultures become too crowded or when you have more cages than needed for maintenance of the stock. You should also euthanize bugs used in experiments after you have collected all the data and specimens necessary.
    - Bugs that you don't need to keep should be killed by freezing them overnight at -20˚C. (Remember, in the wild they would either die slowly from disease, be crushed in the jaws of a predator, or freeze.)
    - If you need to keep an entire bug as a voucher or specimen from an experiment, preserve it depending on the needs of the experiment:
        - 70% ethanol for preservation of anatomical structure (store at room temp.)
        - 100% ethanol for preservation of DNA (store at 4˚C)
    - Never release lab insects into the wild!

Ideas for Student activities

Milkweed bugs are a convenient animal with which to illustrate many basic biological principles. They can also be used in experiments to explore many biological questions. Here are a few suggestions.

- **Life cycles** - Milkweed bug nymphs hatch from eggs and grow through a series of 5 juvenile stages (instars) without a true metamorphosis. The stages can be distinguished by their body size and the shape of their black wing pads. Questions students can explore:
    - How do the numbers of bugs in each stage change over time?
    - Do these numbers depend on the quantity or quality of their food?
    - What happens if the cage has a varying number of males and females?
- **Toxicity resistance** - Milkweed bugs from Carolina Biological have been in captive for more than 40 years, where they have been bred to eat sunflower seeds. Can they still survive on toxic milkweed and its seeds? Do they grow more or less on each food? If you have wild bugs in your area, can they survive on sunflower seeds? Bugs have previously been bred to feed on pumpkin seeds too. How does growth on pumpkin seed compare?
- **Insects anatomy** - Bugs can be used to illustrate basic insect anatomy
    - What anatomical changes occur in the transition from juvenile to adult stages? There are many! But how do bugs compare to beetles or butterflies as they become adults?
    - Compare the anatomy of bugs to beetles, butterflies, or true flies.
- **Adaptation** - Explore features of the milkweed bugs that adapt them to their host plant. Compare *Oncopeltus fasciatus* to other bugs, such as the small milkweed bug, *Lygaeus kalmii*, box elder bug *Boisea trivitatta*, soapberry bug *Jadera haematoloma*, cotton stainer *Dysdercus* sp., or stink bugs such as *Halyomorpha*. More distantly related insects will differ in more features.
    - What features of the milkweed bug adapt it to its environment, compared to the others?
    - What features are shared among all these bugs or insects?
      For larger insect groups (and other animals) you can find the time since species shared a common ancestor at http://www.timetree.org/.
- **Behavior** - Observe 10 bugs for 10 minutes. What are doing? How does their behavior vary with stage? What factors influence bug behavior? Light? Heat? The number of hours of light/dark per day? How many other bugs are in the cage? The sort of food they being fed? What other influences can you think of to explore?



Distinguishing male and female milkweed bugs

The sex of milkweed bugs is determined by chromosomes, just as with humans. Females have two X chromosomes, while males have one X chromosome and one smaller Y chromosome. Seven pairs of chromosomes are shared by both sexes. Male and female milkweed bugs can be distinguished as adults and fifth instars.

Adult males are smaller than females and have a "genital capsule" at the posterior end. This capsule contains the male copulatory organ, however the testes are actually inside the anterior of the abdomen. Females are typically larger than males and can be most easily identified by a posterior-pointing edge on one of the plates (sternite) on the abdomen. The female sternal process is also visible in fifth instar females. At the posterior, females also have a large retractable structure for laying eggs, called an ovipositor. However, females will typically keep the ovipositor tucked in.