

Working with Insect Cultures

Blowflies and Fleshflies

Calliphora sp., Sarcophaga bullata

In addition to blowflies and fleshflies, the order Diptera also includes mosquitoes, midges, and sawflies. All of these insects provide examples of complete metamorphosis.

You should receive your flies as pupae. When you receive them, place the pupae in a dry dish and put the dish in a screened cage; generally a cage 18" x 18" x 18" will provide enough room for 100 adults. Incubate the pupae at 25°C until the adult flies emerge. They should emerge within 5–14 days and continue to emerge for three days. When the adults begin to emerge, place one small bowl of sugar and one small bowl of water in the cage. The water should contain a small piece of sponge to prevent the flies from drowning.

Once all the adult flies have emerged, they will deposit eggs. Prepare a medium for the larvae by mixing one part sawdust with three parts dry dog food. Slowly add tap water to make a "mush". Put this mixture in a pan about 1½–2" deep and place a slice of scored raw beef liver on top. Once the medium has been prepared, place the pan in the adult cage. Add water to the medium daily to keep it damp, but not wet. In several days white larvae should be visible on the liver, especially the underside.

After about one week, remove the medium pan with the larvae. Line the bottom of a larger container with paper towels. A plastic dishpan works well. On top of the paper towels add a jar lid for a spacer, then place the medium pan with the larvae on top of this and cover the container with a screen (*figure 1*). Continue to add raw liver as needed. In approximately six days the larvae will migrate over the sides of the medium pan and fall onto the paper towels, where they will develop into brown pupae in about four days. These pupae may be incubated immediately to produce a second adult generation or incubated at 4°C for up to eight weeks.

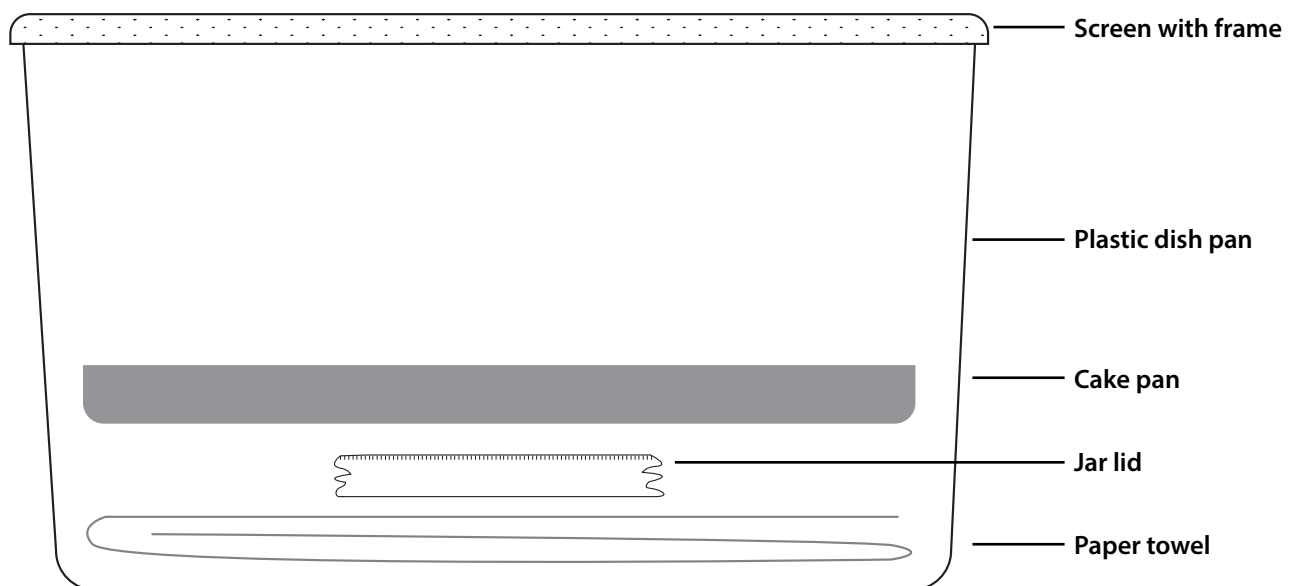


Figure 1

Butterflies and Moths

Lepidoptera

Butterflies and moths are in the insect order Lepidoptera ("scale-wing"). Lepidoptera are holometabolous insects like those from the order Diptera and have a life cycle that demonstrates complete metamorphosis.

It is also possible to collect adults from nature and induce the gravid females to oviposit or just collect the eggs in the field. If you do collect your own specimens, be sure to note the kind of plant where the animal or eggs were found. You will need to make sure that you have the appropriate fresh plant material for the larvae to eat when the eggs hatch.

Keep the eggs in a petri dish until they hatch. After the larvae hatch, they should be transferred to a larger container, and, as they grow, they should be moved to increasingly larger containers to prevent overcrowding. The bottom of the container should be covered with a substrate of loose soil for moths that pupate below ground. Sticks should also be placed in the container for other species that pupate above ground and for the adults to sit on as they dry their wings. Clean the container as needed to prevent the buildup of frasse (caterpillar excrement). Fresh plant material should be provided daily. It is important to choose plant material specific for the species. Reference books can help you determine the appropriate plants to choose for each species.

Cockroaches

Periplaneta americana

The cockroach is from the order Blattaria and is a typical example of simple metamorphosis. It is also widely used in experiments on physiology and testing insecticides.

Cockroaches are best reared in an aquarium or a terrarium that is covered with a tight-fitting screen. The container should be kept at room temperature in the dark or in a darkened area of the room. Stack several boards separated by $\frac{1}{4}$ – $\frac{1}{2}$ " spacers, to make a series of "apartments" where the roaches can congregate. Place a band of petroleum jelly around the top of the container to prevent the roaches from climbing to the top. Replace the petroleum jelly occasionally. Cleaning is rarely necessary and should be done only as necessary.

Keep the roaches supplied with water and food (dog biscuits work well) at all times. Supplement the dog biscuits with pieces of potatoes, apples, lettuce, and stale bread on a weekly basis.

Under these conditions, the colony will reproduce and survive indefinitely. Other cockroach species, such as our giant hissing cockroach may also be cultured in a similar manner. See the specific culture instructions included with each culture for more information.

Confused Flour Beetles

Tribolium confusum

The confused flour beetle is in the order Coleoptera and is from the family Tenebrionidae. It is mainly used to demonstrate complete metamorphosis. *T. confusum* can be a serious pest of stored food products so you should take the necessary precautions to prevent their escape.

Place the beetles in glass jars or culture dishes and add whole wheat flour, white flour, or cornmeal as a culture medium. It is not necessary to add water to any of the chosen media.

Transfer the beetles to a different container with fresh medium periodically to avoid overcrowding. When transferring the beetles, keep in mind that they emit a disagreeable odor when disturbed, so using an aspirator is not recommended. Instead, transfer the beetles with forceps or a camel's hair brush.

Tribolium beetles take about six weeks to develop from egg to adult at 27°C and 40% humidity. Adults generally live between six and twelve months, but may live as long as three years.

Crickets

Gryllus or *Acheta* sp.

Crickets, along with grasshoppers and katydids, are from the order Orthoptera and exhibit simple metamorphosis.

Crickets are easy to raise, they can simply be placed in an aquarium or glass jar. If the container is higher than eight or nine inches a cover is not necessary, although shallower containers should be covered to prevent escape. A single pair of crickets require only a 1 L jar, but larger accommodations should be supplied for colonies.

Cover the bottom of the container with approximately 1" of damp sand. The damp sand will provide enough water for small crickets, but adults and larger juvenile crickets should have a small watch glass or similar container filled with water as well. Add a sponge to the water container to prevent drowning. You may wish to keep the smaller, immature crickets in a separate container, since they may still drown in the water container.

Crickets should be given ground rolled oat paste made by adding a small amount of sugar, skim milk powder, and water to oatmeal. Spread the paste on sheets of paper and allow it to dry. Cut the paper into 1" squares and place one in the aquarium or jar every two or three days. They will also eat lettuce, grass, fruit, and almost any food that does not mold quickly.

Dermestid Beetles

Dermestidae

Most species in the order Coleoptera and family Dermestidae are scavengers that feed on a variety of organic matter. Often used for a variety of biological experiments, dermestid beetles are also used in skeleton preparation. The larvae will clean flesh and cartilage from a dried carcass, leaving the bones ready to be rinsed, degreased, bleached, and assembled. Despite their beneficial role as scavengers, the larvae can also be serious pests, destroying textiles, stored food, and museum collections. The adults feed on flowers and seldom cause damage, but it is still recommended to take precautions to prevent these beetles from escaping.

Place the dermestids in any container that can be sealed. Add dried protein such as dried meat, cereal, insects, or fish food as a culturing medium. While atmospheric humidity generally provides enough moisture for the beetles, you may also add a small piece of cotton or filter paper that has been dampened with water to the container. Clean the container by filtering the debris through a sieve that will retain the larvae.

The beetles will produce two or three generations in a year. You may start a new culture by transferring a portion of an existing culture to another culture container with fresh media or by transferring newly emerged adults to a new container for mating and egg production.

Dragonflies and Damselflies

Aeshnidae, Coenagrionidae

These common predaceous insects are members of the order Odonata and they exhibit simple metamorphosis. Immature stages are aquatic and do not resemble the adults as most insects do when developing through simple metamorphosis. The aquatic stages are called naiads, which are also voracious predators.

Dragonfly and damselfly naiads can be collected almost any time of the year and maintained indoors over the winter. Some species may remain naiads for several years before becoming adults. Adults will emerge in the spring.

The naiads can be kept in a small aquarium and require live food. Smaller naiads will feed on Daphnia and similar small crustaceans, while larger forms will eat other aquatic insects, mosquito larvae, and even small fish. An ideal culture setup for these aquatic predators is a five to ten gallon tank with plants such as Elodea and Vallisneria. At least one floating plant should be included to enable the insects to emerge from the water as they transform into adults. Add some tadpoles and pond snails, then introduce the dragonfly and damselfly naiads. Daphnia and mosquito larvae should be added every two or three days as needed for food. The aquarium should be covered with netting to prevent the adults from escaping into the classroom. Once the naiads have all emerged, you may capture the adults and release them outdoors.

Mealworms

Tenebrio

Mealworms are from the order Coleoptera and the family Tenebrionidae and are ideal as food for insectivorous animals, as well as subjects for various lab experiments.

Mealworms produce a single brood laying eggs from May through late October and producing larvae from fall through the following spring. A culture started in April will usually produce enough mealworms for use in experiments in the following school year.

Mealworms can be raised in containers such as a wooden box, a glass jar, an aquarium, or any other similar container. Place wheat bran or a similar wheat meal product in the bottom of the container to a depth of several inches. The wheat meal may be mixed with chick mash or hog meal. Cover the meal with a damp, but not wet, piece of burlap or paper towel, and then place an additional 1–2" of food on top of it. Add the mealworms and cover the container with a screen to keep the adult mealworms from escaping. Keep the container in a relatively dark corner of the room at an average temperature. Add slice of raw potato weekly to maintain the culture.

Milkweed Bugs

Oncopeltus fasciatus

Milkweed bugs are from the order Hemiptera and the family Lygaeidae. They can be used to illustrate simple metamorphosis and the morphology of a typical hemipteran.

O. fasciatus are clean and thus are easily maintained. First, establish a colony in petri dishes or glass culture dishes, then keep the colony in an aquarium. Line the container with paper towels to absorb excreta. Place a small ball of cotton or cheesecloth in the container to collect eggs. Eggs will be deposited in groups of ten to fifteen and as they incubate they will change color from yellow to deep orange. Because the adults and nymphs will feed on the eggs, the cotton containing the eggs should be removed daily.

Milkweed bugs feed on various species of milkweed, but prefer dried milkweed seeds. These can be scattered on the bottom of the container. Also provide the insects with water in a small vial with a cotton plug wick. Change the water and cotton plug every fourth day.

O. fasciatus develop from egg to maturity in approximately six to seven weeks. See the table for the time required for various stages of development. The markings on milkweed bugs make it easy to determine the sex. A female will have two black spots on the second abdominal segment, a band on the third segment, and two black spots on the fourth segment. The male, on the other hand, lacks the spots on the second segment, while the third and fourth segments have a solid black band instead of spots.

Development of <i>Oncopeltus</i> 27°C and 40% Humidity	
Stage	Number of Days
Eggs	5
Eggs to fifth instar nymph	19
Fifth instar to adult	9
Adult to egg production	7
Egg to sexual maturity	40

Mosquitoes

Culex, Anopheles

Mosquitoes are from the order Diptera and, as such, develop through complete metamorphosis. However, these insects have aquatic larvae. Mosquitoes are often used in medical studies, so there is an abundance of literature detailing various methods of rearing and maintaining mosquitoes in laboratories. The method detailed here should suffice for normal development of both *Culex* and *Anopheles*.

Begin a colony by collecting egg masses or larvae. Handle gravid females with extreme care. Place the eggs inside a cork ring and put the cork in a glass jar filled with water. The ring keeps the eggs from adhering to the sides of the jar.

The most convenient medium for rearing larvae is a wheat infusion. You can make a wheat infusion by boiling wheat grains for about five minutes. Add 250 grains of boiled wheat to 2 L of water in an enamel pan or glass jar. Allow bacteria to grow for approximately two or three days, then inoculate the culture with material from an older culture that supports a thriving population of flagellates and ciliates. To maintain an alkaline pH, add 1 g of calcium carbonate. This culture should be usable for two or three weeks. After another five to seven days, add the mosquito larvae. Supplement the wheat infusion diet with yeast by adding a small pinch daily. If scum develops on the surface, reduce the amount of yeast added, subdivide the culture, or move the smaller mosquito larvae to another culture.

When the larvae transform into pupae, remove them from the culture with a pipet and place them in a pan of clean water. Spread chaff, broken cork, or other similar material on the surface to keep the pupae separated and to provide the adults with a surface to emerge from the water. Change the water daily to prevent the formation of scum on the surface. Put the pan in a cage large enough to provide enough space for the adults to fly. To capture the adults, cover the perched mosquitoes with a vial.

Breeding adult mosquitoes is not a recommended procedure for the classroom because of the space and blood meal requirements.

Termites

Zootermopsis

Termites are relatively primitive insects from the order Isoptera that develop through simple metamorphosis. Termites from the genus *Zootermopsis* are native to the West Coast of the United States and are the host organisms for many protozoa such as *Trichonympha*, *Trichomonas*, *Streblomastix*, *Hexamastix*. The majority of these protozoa have a mutual relationship with the termite where each organism benefits from the relationship. In this particular relationship, the protozoa digest wood cellulose in order for the termites to absorb the nutrients.

Zootermopsis require relatively high humidity at ordinary room temperature, but can survive in a wide range of temperatures, although ideally temperatures should not exceed 20°C. Colonies should be maintained in a large culture dish with rotten wood as the culture medium. Keep the wood moist by adding a few drops of water every two or three days. Fungi are a necessary part of the diet, but be sure to prevent the overgrowth of mold. Only wood that does not appear to be heavily infected with fungus should be used for food. Cultures should also be kept in a dark area.

The culture contains nymphs and adults from two castes. Soldier termites have large heads and strong mandibles and are readily distinguished from the termites that have only reproductive functions. *Zootermopsis* do not have a worker caste, since the smaller nymphs perform the function of cleaning the nest. Some of the nymphs will develop into secondary reproductive forms, which are recognizable by their light brown color. To establish a permanent colony, separate these nymphs from the adults. Remove any dead termites immediately.