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Insects You Can Rear

AQUATIC INSECTS

The techniques for rearing aquatic insects are a little different than those for terrestrial insects. You can use any watertight container for rearing aquatic insects, but if you use a glass jar or aquarium you'll be able to see the insect easier. Fishbowls, aquariums and widemouthed (gallon-sized) jars all work well. Spread a 1-inch layer of sand or gravel in the bottom of the container, fill it with dechlorinated water and plant a few aquatic plants in the sand. You can use a variety of plants, from a pond or stream, or from a pet store. The plants provide food and hiding places, and give off the oxygen the insects need. Don't worry too much about algal growth, because the insects can eat algae, too. If the algae gets out of hand, a few snails will perform the necessary housekeeping chores.

Aquatic insects can be collected from any pond, river, stream, roadside ditch or woodland pool. A large variety of them are easily maintained in aquariums and different kinds can be kept in the same container. Collect the insects with an aquatic dip net and transport them in a loosely covered container.

Many aquatic insects are predaceous, which means they feed on other insects or microscopic water animals. If you fill the aquarium with pond water instead of tap water, your insects will get enough to eat. Tadpoles, minnows and guppies serve as food sources for giant water bugs and predaceous diving beetles (and their larvae, known as "water tigers"). Mosquito larvae will eat finely crushed dog biscuits. The tiniest pinch of crushed dog food is enough to feed many mosquito larvae.

HOUSE AND FIELD CRICKETS

Both the black field cricket (*Gryllus* species) and the tan house cricket *(Acheta domestica)* can be reared successfully. Many people rear the house cricket because they can be readily purchased from pet supply houses and "cricket farms."

Habitat requirements. Prepare a suitable cage for your crickets. The cage can be a large glass jar (with a screen or cloth covering) or a screen cage. If you use glass containers it helps to treat the inside, upper portion of the jar with a very thin layer of mineral oil, petroleum jelly or furniture wax to keep the crickets from escaping. Spread 3 or 4 inches of dry, clean sand in the bottom of each cage.

Place a small plastic or glass container of moist sand in the cage so that the top edge is about ½ inch above the dry sand. This container is the egg laying site, and must be kept moist but not wet at all times. Some cricket farmers prefer to have separate egg laying containers. They fill coffee cans with damp sand and then place 20 to 30 adult crickets (half males and half females) in each can. The female cricket is readily distinguished by her long ovipositor (egg laying organ). After moistening the sand for the first time, don't moisten it again for 3 months. The young crickets (nymphs) must have dry sand to remain disease-free.

The small container of moist sand, or the separate egg laying containers, must be kept warm (80 to 90°F) during the incubation period. Eggs will begin to hatch within 3 weeks after they've been laid. The newly hatched nymphs are very tiny and blend in with the sand. You'll need to look very carefully to see them.

Very young nymphs require soft food. You can feed them slices of banana or apple, or powdered dog food laid on pieces of lettuce. Poultry laying mash also works very well.

Place the food in a shallow container with excelsior or hay around it so the crickets have easy access to the food. Placing the food in a dish allows for easier housekeeping. The cage must be kept free of unused food and dead crickets to prevent mold or disease.

Adult crickets will do well on crushed dog nuggets or poultry laying mash. If you wish, you can supplement their diet with bits of banana, apple, lettuce, or other pulpy fruits or vegetables.

Crickets must have a constant supply of drinking water. Indeed, the water supply is more important than a constant supply of food. You can make a drinking fountain by placing an inverted jar in a shallow dish (fig. 3, page 7). Clean the fountain and replace the absorbent material every month, or as needed.

You must provide places for your crickets to hide. Paper or foam egg cartons work very well. You can also use folded corrugated cardboard, excelsior or hay. Young cricket nymphs must be kept separate from the adults until they are one-third to one-half grown, or they are likely to be eaten! After they have reached the required size, they may be safely put in with the adults.

Life cycle. The length of time crickets take to complete their development depends on several factors: temperature, moisture, freedom (amount of space), and the presence or absence of disease-causing organisms, predators or parasites.

If all other conditions are favorable, the developmental time is most directly regulated by temperature. Nymphs held at 90°F may require only 30 to 35 days to complete development, while those held at 80°F may require up to 65 days to mature. Four hundred crickets can be reared every 3 months in a container as small as 24 inches in diameter. A smaller container will result in fewer crickets being produced.

BLABERUS COCKROACHES

The *Blaberus* cockroach is a giant among roaches, measuring up to 3 inches long and 1½ inches wide (depending on the species). These roaches are not native to Michigan; they are found in Florida, the Carribbean, and Central and South America. These insects are easy to rear and observe, and are well-suited to experimentation.

Obtaining the insects. Since these roaches are not native to our area, you will probably have to purchase them from a biological supply house. Because *Blaberus* roaches are potential household pests, a USDA permit is required to have them mailed to you. The supply house will usually handle this for you. Sometimes you can obtain starter cultures from universities or insecticide manufacturers.

Habitat requirements. Any type of cage covered with ordinary window screen will work well for rearing these roaches. Even the smallest nymphs are too large to squeeze through the mesh. Some absorbent material, such as sand, should be placed in the bottom of the cage. The sand should be replaced every 4 to 6 months. Pour the used sand through a sieve to avoid throwing away any small nymphs. Keep in mind that these are tropical insects, and place the cage in a warm location. They seem to do best at about 80°F. Also, the roaches prefer subdued light, so don't keep them in an area with bright lights (don't use a light bulb to warm them unless absolutely necessary).

Any high-protein dry dog food can be a staple in your roaches' diets. Dog food can be fed directly from the package, no pulverizing is necessary. If you see evidence of "wing-nipping" (a tendency toward cannibalism), you can safely assume that your roaches' diet is protein deficient. Supplementing the roaches' diet with protein-rich foods such as powdered milk, meat scraps or fresh liver should eliminate this problem. The protein diet should also be supplemented with fresh fruits or vegetables such as lettuce, carrots, celery tops, apples or potatoes. The apples and potatoes are high in moisture and may eliminate the need for a separate supply of drinking water.

A constant supply of drinking water is important for the roaches' survival. As mentioned before, some fresh fruits and vegetables can actually be a water supply for these roaches. However, you will probably want to use a drinking fountain to ensure that the roaches have plenty of water.

Life cycle. The youngest *Blaberus* nymphs bear little resemblance to the adults. When they first appear, they are about ¼-inch long and quite flat. In some ways they resemble the fossil arthropods known as trilobites. The nymphs grow fairly rapidly through the seven or eight stages, each of which is separated by a molt. Wings appear after the last molt (when the roach becomes an adult). The average time required for development, from the first nymphal stage to adulthood, is a little less than 6 months.

Male and female adult *Blaberus* roaches look very much alike, but you can tell them apart if you look closely. To identify the sex of a *Blaberus* roach, grasp the roach with your thumb pressed against the ventral side of its thorax. Examine the underside of the last abdominal segment. In both sexes there will be a conspicuous pair of appendages (called cerci) projecting from the outer margins of the last segment. The males also have a second pair of appendages, called styli. The styli are much smaller than the cerci, and are located just inside the cerci. The styli are very small and are barely visible without magnification.

The female roach produces eggs capsules, also known as oothecae. One *Blaberus* ootheca is about ½ inch long and contains 20 or more compartments, each with an egg. Most other species of roaches deposit their egg capsules long before they are ready to hatch. This is not so in *Blaberus,* so the egg capsules are rarely seen. The females hold the egg capsule within their bodies, where they eventually hatch. Thus it appears that the female "gives birth" to 20 or more young nymphs.

MILKWEED BUGS

The large milkweed bug is ideal for your 4-H entomology project. It is brightly colored and easy to maintain. It requires little space, is easily observed, creates no offensive odor, is resistant to diseases and parasites, and has a fairly short life cycle. This species is widely distributed throughout the United States and can be readily collected during the proper season.

Obtaining the insects. Milkweed bugs are collected from their host plants, milkweeds (*Asclepias* species), which commonly grow in pastures and along roadsides. The plants are often 4 to 5 feet tall. Their stems and large, fleshy leaves contain a milky juice, or latex. The seeds are borne in pods which turn from green to brown as they mature. When the pods are fully ripe, they split open, releasing the seeds. A tuft of soft, silky hair (down) is attached to each seed and acts as a parachute, helping the mature seeds drift with the wind. In the Midwest the pods appear in August and September. Therefore, late summer and early fall are the best times to search for milkweed bugs.

The bugs begin to appear on milkweed plants as the maturing pods change from green to brown. The larger milkweed bug does not overwinter in Michigan and must reinvade the state each year from south of the Ohio River valley. Adults and older nymphs will be found feeding on milkweed pods and the seeds they contain. You will find more bugs on pods which have begun to split open. The bugs are easy to see because of their bright reddish-orange and black markings, and they are easy to collect by hand. Collect both adults and nymphs, and place them in your collecting container. You will also need to collect a lot of milkweed pods to feed your bugs over the next year.

Special strains of large milkweed bugs that are able to survive on unsalted sunflower kernels are now available through biological supply houses. The advantage of buying these bugs is that you don't have to collect milkweed seed to use as food.

Habitat requirements. The large milkweed bug adapts well to rearing in glass or plastic containers. Fish bowls or gallon jars covered with screening or cheesecloth are quite suitable.

The bugs are fully capable of flying, but in captivity they seem to prefer crawling around the container, and will readily climb the vertical glass or plastic walls. It's a good idea to ring the mouth of the container with a thin layer of mineral oil, petroleum jelly or furniture wax. This will keep the bugs from escaping when the cover is removed for housekeeping, etc. The bottom of the container should be lined with material for the bugs to crawl on; paper towels cut to the same dimensions as the container will work well. Keep the cage clean and avoid overcrowding.

Milkweed bugs require milkweed seeds for proper growth and development (unless of course, you are using a sunflower seed strain of the bug). Since milkweed seeds are not available commercially, you'll have to collect your own supply of pods and seeds. This is easily done when you collect your bugs. Pods which have recently split open are just right for collecting, but you can take green pods as well. After the pods are dry, separate the seeds from the pod and down. The dry seeds can be stored indefinitely at room temperature.

Generation after generation of milkweed bugs will develop on a diet of seeds (milkweed or sunflower, depending on the strain) and water. Used seeds should be discarded periodically.

Milkweed bugs need a water source. The most convenient way to water them is with a vial and wick fountain (fig. 4, page 7). Soiled wicks should be replaced frequently.

Small balls of cheesecloth are suitable sites for egg laying (oviposition). They can be easily removed and transferred to other containers for starting new colonies. The eggs will hatch right in the cheesecloth and the young nymphs will crawl out.

Life cycle. The oval, yellowish eggs are laid in clusters of 10 to 50. The newly laid eggs look very much like miniature jellybeans. The eggs hatch within 1 to 2 weeks when held at 70 to 80°F. They change from yellow to reddish orange during incubation.

Newly emerged nymphs are bright red and about the size of a pinhead. They crawl about actively looking for food almost immediately after hatching. The nymphs grow fairly quickly through their five nymphal stages (instars). Wingpads appear early in development.

Milkweed bugs reach adulthood after the fifth nymphal molt. Fully developed wings are characteristic of the adult stage. The male and female can be distinguished by examining the ventral abdominal surface (fig. 5). In the male, the second abdominal segment (counting from the end closest to the thorax) is unspotted, the third segment bears a wide black band and the fourth segment has a somewhat nar-

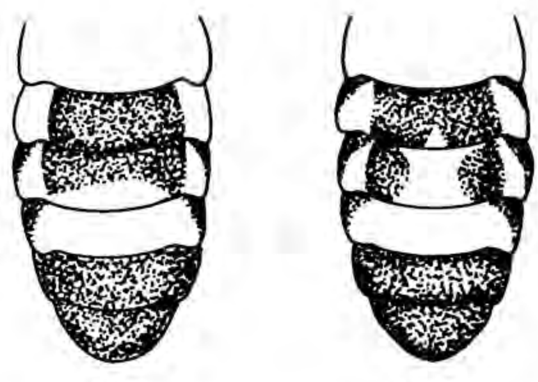

Figure 5. Underside of abdomen in adult male and female larger milkweed bugs.

row black band. The female's second abdominal segment has two black spots, the third segment has a wide black band (like the male) and the fourth has two black spots (instead of the narrow band like the male).

Large milkweed bugs mate in an end-to-end position. They couple at any hour of the day or night, and mating pairs may remain attached for 30 minutes or more. If the colony is kept at about 80°F, the eggs will develop to adulthood in about 25 to 30 days.

MEALWORMS

Mealworm larvae are excellent fish bait and can be used either alive or preserved. The yellow mealworm, *Tenebrio molitor,* is the species most frequently reared and used for bait. These beetle larvae are also used as food for exotic pets, such as lizards and tarantulas, and therefore can often be purchased in pet shops. They are also sold by bait dealers and biological supply companies.

Habitat requirements. Any large glass or plastic container will work for rearing mealworms. Your mealworms will live well in a mixture of either graham flour and meat scraps or wheat bran with a small amount of dry brewer's yeast. Wheat bran alone seems to be an inadequate staple diet; the larvae will grow larger if you add yeast. Place 3 to 6 inches of food in the container.

Maintaining an adequate moisture supply is essential for mealworm survival; too little or too much moisture is equally bad. If there is too little moisture available, the larvae will grow slowly and will be small. If there is too much moisture, the food becomes moldy and poisons the larvae. To maintain suitable moisture levels, place either a piece of cabbage, carrot or potato on top of the food. Replace it as needed. You also need to supply drinking water to the larvae; use a vial and wick fountain (fig. 4, page 7). Be sure to keep the fountain clean and don't let it leak large amounts of water.

When the larvae are nearly full-grown (about ¾ inch to 1 inch long), place corrugated paper, burlap cloth or crumpled paper towels in the container. Let the adult beetles emerge from these hiding places before disturbing them. Don't keep too many adults in one container. Crowding will eventually reduce the population, because the adults may begin to eat the eggs. Remove some of the adults when the colony has more than two or three adults per square inch. You can use these surplus adults to begin additional colonies, if you wish.

Life cycle. Larval mealworms molt 9 to 20 times during their development. If your mealworms are well-fed, warm enough (about 80°F), not overcrowded, and are exposed to sufficiently humid conditions, they will complete their development in about 5 months. On the average, the adults live for 84 days. Each female lays about 275 eggs.

FLOUR BEETLES

Habitat requirements. Any medium to large glass or plastic container is suitable for rearing flour beetles. Fill the container with an inch or two of white flour, finely ground whole wheat flour or cornmeal. No water source is needed.

Avoid overcrowding your cultures. Periodically transfer some beetles to a fresh food medium. The beetles should be transferred with some care because they are fairly delicate. Avoid using an aspirator to transfer the beetles, because they emit a disagreeable odor when disturbed. A small brush, spoon or spatula works better.

Life cycle. Two species of flour beetles commonly infest stored food products. They are the confused flour beetle *(Tribolium confusum)* and the red flour beetle *(Tribolium castaneum).* The species are very similar in size and appearance, but they can be easily distinguished by the difference in their antennae. The red flour beetle has an abrupt, distinctly three-segmented antennal club, whereas the confused flour beetle has a gradually swollen antennal club.

Flour beetle eggs are very small (several would fit on the head of a pin). The whitish larvae are very active and burrow in the food medium. They pass through 6 to 11 instars, depending on the quality of their food and the temperature. You can determine the sex of the beetles as soon as they reach the pupal stage, but because they are so small you will need to use a low power microscope or a high power hand lens to do so. Examine the underside of the terminal abdominal segment. The females have a pair of small appendages. The males either have much smaller appendages or none at all.

Flour beetles average 3.4 mm in length. Although adults may live for up to 2 years, their average lifespan is only 6 months. The time it takes them to complete development, from oviposition to adult emergence, varies with the environmental conditions. At 80°F and 75 percent relative humidity, the process takes about 40 days.

WAX MOTH LARVAE (WAXWORMS)

The greater wax moth, *Galleria mellonella,* is a pest in honey bee combs, but certain growth characteristics make it suitable for rearing in mass cultures. You can make many valuable observations on the life cycle and biology of insects in your wax moth culture. Also, mature larvae can be harvested and used or sold for fish bait and pet food.

Obtaining the insects. Cultures can be started from any stage, but the usual procedure is to collect larvae from infested combs or to buy them from a biological supply company. Rear the larvae in a large glass or metal container (they can chew through wood and soft plastic).

Habitat requirements. In nature the larvae feed on the pollen, honey and beeswax in honey combs. When rearing waxworms in large numbers it is easier to prepare and use a manufactured diet. One such diet, which is inexpensive, easy to use and that produces favorable results, is made with granular dog food and honey. The food should be prepared as follows. Mix seven parts granular dog food and one part water, then add two parts honey. Mix the ingredients thoroughly and allow them to stand for at least a day before using. The dog food granules should be soft, but not sticky.

Wax moth cultures will be most successful if you provide them with fairly constant conditions of 90 to 95°F and 75 to 85 percent relative humidity. Add food to the container as the larvae eat it. A continuous cycle of larvae can be obtained by allowing female moths to deposit their eggs on the food in the container. Transfer some adult moths or a few larvae to a fresh container occasionally.

When mature larvae are ready to pupate, they will crawl into any available crevice or hollow to spin their cocoons. If you want to "harvest" waxworms, you can take advantage of this behavior by furnishing the culture with a pair of boards with a ¼-inch gap between them (nails or screws and a few washers can be used to hold the boards apart). Larvae will crawl into this space and can be collected daily. They can be counted and allowed to crawl into rolls of corrugated cardboard strips for holding.

Once the mature larvae have tunneled into the corrugated strips they can be placed in a cool storage area to halt further development. Do not place them in a refrigerator (it's too cold). At temperatures near 60°F the larvae won't pupate for 2 or 3 months.

Life cycle. Under the best temperature and humidity conditions, the life cycle (egg hatch to adulthood) of the greater wax moth takes about a month. If conditions are not favorable, development may take much longer. The larvae pass through seven instars. They feed actively in all instars but grow the most in the final two. The mature larvae spin cocoons and pupate. The adults emerge from these cocoons within a week or two.

BUTTERFLIES AND MOTHS

Obtaining the insects. You can start a moth or butterfly rearing program at any stage in the life cycle of these insects. Eggs and pupae (cocoons) can be purchased from biological supply companies or Lepidoptera breeders. Larvae can be collected in the field if you know where to look. Also, females can be used to attract and capture males, and then

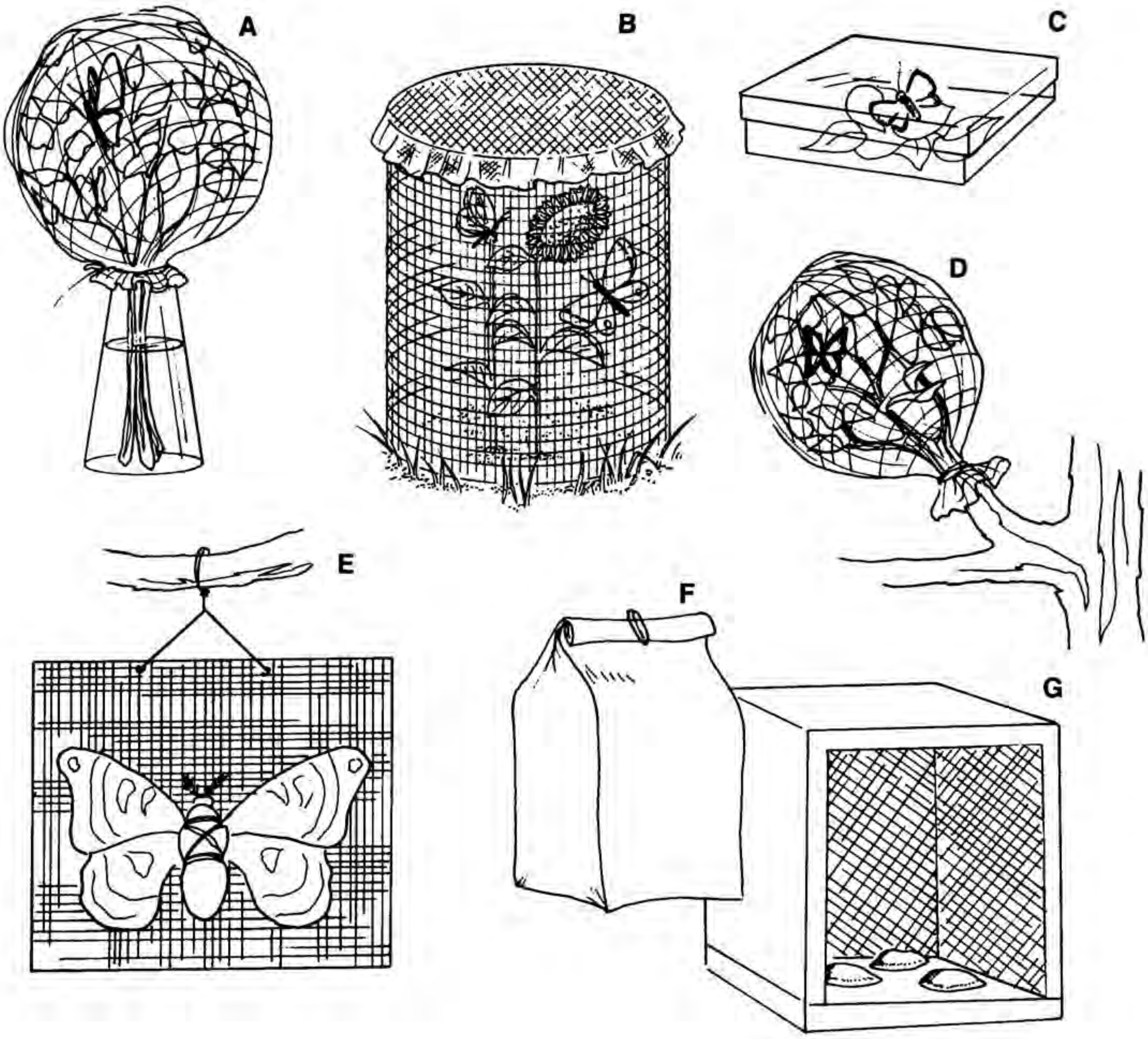

Figure 6. Techniques for rearing Lepidoptera: a) bouquet of foilage set in a bottle of water and covered with nylon netting, b) screen cage with plant growing inside, c) plastic box with leaves, d) nylon sack tied over a plant branch, e) female moth tied to a screen to attract males, f) paper sack for use as an egg laying chamber, g) emergence cage.

you can breed your own butterflies or moths. Several techniques for rearing butterflies and moths are illustrated in fig. 6.

Life cycle. After the males and females have mated, place the females (distinguished by their larger body size and narrower antennae) in paper bags for oviposition. Some species will glue their eggs to the inside of the sack, and others will drop them to the sack's bottom (they may look like a sprinkling of sugar in the sack). After the eggs are laid, remove them from the sack and place groups of 20 eggs into separate hatching containers. If the eggs are glued to the sack, cut the sack around them and place the paper discs in the hatching containers. Any half-gallon or larger container will do.

When the eggs hatch, place several leaves of the appropriate food plant into the container (table 1 or 2, pages 17 and 18). Make sure the leaves you use haven't been treated with pesticide! Your container should have a screen or cheesecloth cover that prevents escape but provides adequate ventilation. If you use an airtight cover, moisture will build up and the leaves and larvae may mold. After the larvae start feeding, keep them supplied with plenty of fresh leaves. Remove any uneaten and dried leaves frequently.

If the larvae get large, or if you have many larvae, it may be necessary to transfer them to a larger container or to cages. Food plants may be placed in bottles of water to keep them fresh longer. Provide fresh food, keep the container clean and uncrowded, and provide plenty of ventilation if you want your rearing efforts to succeed.

Do not disturb the larvae once they have begun to spin cocoons or form chrysalises. You may need to supply them with sticks or other objects for chrysalis or cocoon attachment. At this point it is necessary to determine whether the species you are rearing overwinters (hibernates) in the pupal stage. This will determine whether the adults will emerge in a week or two, or whether the pupae (cocoons) must be exposed to cold temperatures before the adults emerge. Life cycle information for many common species of butterflies and moths is contained in tables 1 and 2 (pages 17 and 18). For species not listed in either table, refer to one of the books listed under "References" on page 35.

Pupae (cocoons) can be stored in any protected place that is exposed to cold temperatures, such as a breezeway, garage, porch or outdoor rearing cage. Many species will respond to a short "artificial" winter. Place the cocoons and a single green leaf (to maintain proper moisture) into a container and put the container in the refrigerator for 8 to 12 weeks. Remove the cocoons from the refrigerator and let them warm up gradually if you can. Then place them in a rearing cage lined with cheesecloth or screening (to provide footholds for adults to hang from while their wings expand). Do not disturb the emerging adults until the wings appear to be fully expanded and hardened; this usually takes 24 to 48 hours.

Some moths, such as sphinx moths, pupate in the ground. After the last molt, the larvae should be transferred to a container that has several inches of peat moss in the bottom. The mature larvae will crawl into the moss and can be left there until they emerge on their own.

Table 1. Quick Helps for Butterfly Rearing.

Butterfly Species	Larval Food Plants	Egg Color	Days to Maturity Egg	Larva	Adult Activity
Eastern black swallowtail	carrots, parsley, parsnip, celery, Queen Anne's lace	yellow white	5-7	24	May to Sept.; 2-3 broods
Spicebush swallowtail	spicebush, sweet bay, sassafras, prickly ash	yellow white	5-7	21	May to Sept.; 2-3 broods
Tiger swallowtail	cherry, ash, birch, lilac, aspen, willow, hornbeam	yellow white	5-7	22	April to Oct.; 2-3 broods
Common sulphur	clover, vetch, trefoil, alfalfa	white	5-6	21	April to Oct.; 3-4 broods
Cabbage	cabbage, collards, broccoli, winter cress, nasturtium	yellow white	5-6	14	May to Sept.; unavailable
Monarch	milkweed, dogbane	yellow white	7	10	June to Sept.; 2-4 broods
Great spangled fritillary	violets	yellow white	3-4	14	May to Sept.; 1-2 broods
Baltimore	turtlehead	yellow orange	21	hibernate	June to July; 1 brood
Questionmark and Comma	elm, nettles, hops	green	5-7	21	June to Aug.; 2 broods
Buckeye	plantain, Gerardia	green	5	14	April to Sept.; 2-4 broods
American painted lady	everlasting	green	3-5	21	May to Sept.; 2 broods
Painted lady	thistles, nettles	green	4-5	21	May to Sept.; 2-3 broods
Red admiral	nettles	green	4-5	21	May to Sept.; 2-3 broods
Milbert's tortoiseshell	nettles	green	4-5	14	May to Sept.; 3+ broods
Mourning cloak	willow, poplar, elm, hackberry	yellow brown	14	21	June to Sept.; 2-3 broods
Viceroy	willow, poplar, birch, cherry	brown	4-5	18	June to Sept.; 2 broods
Hackberry	hackberry	green	4	30	June to Sept.; 2 broods
American copper	sorrel	green	4	14	May to Oct.; 4-5 broods

Table 2. Quick Helps for Moth Rearing.

Moth Species	Larval Food Plants	Egg Color	Days to Maturity Egg	Days to Maturity Larva	Adult Activity
Cecropia	apple, willow, maple, box elder, cherry, lilac	ivory	10	60	May to June
Io	willow, cherry, oak, hickory, plum, ash, poplar, linden, elm	white and yellow	10+	40	June to Aug.
Promethea	cherry, sassafras, willow, poplar, ash, apple, pear, lilac, plum	pinkish	11	42	May to June
Polyphemus	elm, maple, cherry, oak, linden, apple, box elder, hickory, birch	white	7	48	May to June
Cynthia	ailanthus, cherry, willow, ash	white	7	42	July
Luna	walnut, birch, oak, hickory, butternut, beech, willow	white and gray	15	48+	May to June
Imperial	spruce, pine, cherry, birch, alder, elm, maple, hickory	yellow	13	42	July
Tomato hornworm	tomato, potato	pale green	7	40+	July
Bumblebee	vibernum, snowberry, hawthorn	green	7	35-42	June to July
White-lined sphinx	grape, apple, dock, chickweed, purslane, weeping willow	yellow green	6	30	July
Twin-spotted sphinx	apple, elm, ash, willow, birch	greenish	6	30	June to July
Underwings (Catocala)	plum, apple, cherry, willow	various	(overwinters)		July to Sept.
Virgo tiger	dandelion, plantain	white	*	49	July to Aug.
Garden tiger	dandelion, plantain, dock	white	*	56	imported
Four-horned sphinx	elm	green	*	35	July
Laurel sphinx	privet	green	*	35	July
Pen mark sphinx	ash, cherry	green	*	40	July
Oak silk	oak, crab apple, hawthorn	brown	7	28+	imported

*Information is unavailable.

ANTS

Ant "farming" has been a fascinating hobby for many generations of nature enthusiasts. Ants are especially interesting because of their social habits. Ants live in colonies where there is a division of labor. The tasks necessary to maintain the colony are divided among three groups or castes of ants.

The workers are responsible for building, maintaining and defending the nest. They also gather food and care for the immatures (larvae and pupae). A single queen lays most of the eggs but she may be assisted by supplemental (auxiliary) reproductive females. At certain times males are also present in the colonies. Because of their complex social system, ants are highly successful insects that inhabit virtually every environment.

Obtaining the insects. As with many other insects mentioned in this manual, you can either buy your ants or collect your own. Ants can be obtained just about any time of the year, but late July through early September is the best time because you are most likely to find winged, mature ants in or near the nests. All you need to collect ants is a shovel, trowel, kitchen strainer and large (at least gallon-sized) pail or other container with a lid.

Find an ant hill, preferably a small one in loose, sandy soil. If there is a large mound, remove it with the shovel. Dig into the heart of the nest. Use the trowel and strainer to collect ants and place the ant/soil mixture in your container. Fifty workers should be enough to stock the average artificial ant nest (12 inches by 12 inches). Find and capture the queen if you can; she'll be bigger than the other ants in the nest. Also collect samples of any other life stages you see, such as larvae, pupae ("ant eggs" to the nonentomologist) and winged reproductives.

Place the ant/soil mixture in the artificial nest. Remove any large clumps of soil, rocks, vegetation and other debris. Cover the glass faces with cardboard and leave the nest undisturbed for several days. If you don't cover the glass with an opaque material, the ants are likely to construct their galleries in the center of the nest and you won't be able to see most of their activity. Once the colony is established, keep the glass covered when you aren't observing it, or cover the glass with red acetate to simulate darkness.

Habitat requirements. Ants are easily reared in just about any kind of container, but if you want to observe their activity you will need to use an artificial ant nest or ant farm. Ant farms are available from many biological supply companies and hobby shops, both assembled and as kits. The typical ant farm is nothing more than two panes of glass or plastic 1 to 3 inches apart and filled with sand or soil. You can easily construct your own ant nest by studying figure 7.

Most ants are omnivorous and will eat just about anything. You can feed them dabs of honey thinned with water, molasses (also thinned), fruit syrup, dead insects, or crumbs and food scraps from the dinner table. Periodically remove any unused food to prevent mold. Water your ants by placing two small pieces of wet sponge in the nest. Many nests are built with special holes in the lid so that you can feed and water the ants without opening the entire lid.

The long-term success of your ant farm will depend on whether your colony has an active queen or supplemental reproductives. If your

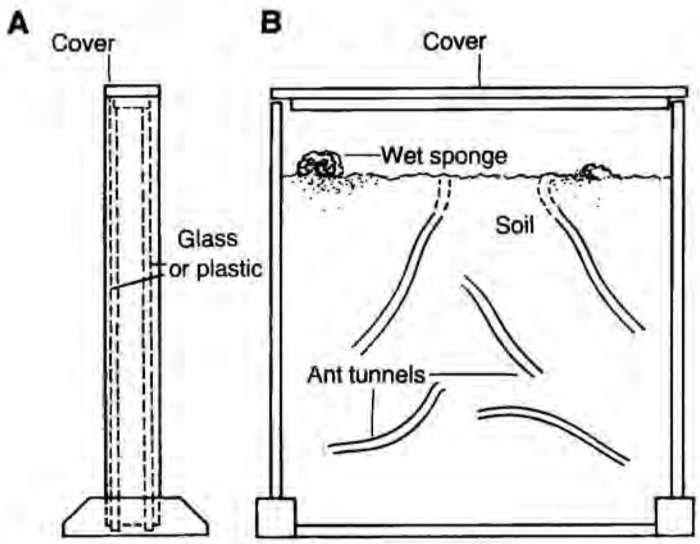

Figure 7. Typical artificial ant nest or "ant farm": a) end view, b) front view.

colony has no queen it may die out each year, but this is really no problem because you can replace the ants easily.

Once your ant nest is well-established, you may want to try some other interesting observations. You can connect your colony to a separate feeding chamber or to a captive colony of ant lions (a predator of ants) by attaching a length of ⅜-inch to ½-inch plastic or rubber tubing between them. Now you can observe ant foraging behavior or predator/prey interactions.

SPIDERS

Although spiders are not insects, they are often reared by 4-H'ers interested in entomology. Spiders are exciting to keep and observe, even temporarily. All spiders are predatory, and watching their diverse food gathering and feeding habits is very interesting. There are a few problems with keeping spiders alive. Since they are predatory you must have a supply of living insects to feed them (they will not accept dead insects). For this reason many people who rear spiders, especially tarantulas, also rear crickets, cockroaches or mealworms as food sources. Spiders are definitely inclined to eat each other; therefore, they must be well-fed or kept in separate containers.

Obtaining spiders. Like insects, spiders can either be purchased or collected in the wild. Many native Michigan spiders can be successfully collected and reared. Many people are interested in keeping tarantulas, which can be collected in the southwestern United States and Mexico. Most people buy theirs from a biological supply company or a pet shop, however.

Habitat requirements. The type and size of the container is relatively unimportant, as long as it is big enough to let the spider move around freely, and small enough to regulate the humidity if necessary. If your spider is one that normally builds a web to catch its prey, the container must be large enough to hold a web. A gallon jar with several twigs or branches inside to support the web will work well for web-building spiders.

An adequate supply of moisture, both in relative humidity and drinking water, is critical for most species of spiders. Placing a piece of wet absorbent cotton in a shallow dish allows spiders easy access to moisture without the risk of drowning. You can also use a cotton-stoppered, water-filled vial (fig. 4, page 7). Be sure to change the cotton every week. The relative humidity of the atmosphere in the container appears to be very important for many spider species. The natural habitat of your spider can serve as a clue to its humidity requirements. Those species which live near water or in the ground require higher relative humidities than do other species. Wet the soil in your container so that it remains slightly moist to the touch. Do not overmoisten it!

Spiders are predators, which means they require live prey. Lack of or improper food is usually the reason spider raising efforts fail. The feeding problem may be particularly acute with spiderlings (young spiders) that have just emerged from the egg sac. The young of most spider species need food immediately in order to prevent them from eating each other. It is often hard to find prey small enough for the young of some spider species. If you have many spiderlings in a single container you can solve this problem by allowing them to eat each other until some are big enough to accept larger insect food. Another solution is to rear a suitable small insect species, such as flour beetles. The larvae of flour beetles work quite well as spiderling food.

If you plan to rear spiders over the winter months, you have almost no choice but to start a culture of some insect species as a constant food supply. Wingless fruit flies, mealworms, crickets and lepidopterous larvae (caterpillars) all work well, especially for larger spiders.

Spiders, like insects, are subject to a variety of diseases. No matter how careful you are, you will still lose some spiders to bacteria and fungi. Healthy spiders have the best chance of avoiding disease, so be sure that your spiders are well-fed and well-watered. Rearing containers should be thoroughly washed and dried between uses. Change the cotton of your water fountain frequently, especially if it has been contaminated by the juices of insects the spider has killed. These juices form a very good medium for the growth of many fungi.

Tarantulas. Tarantulas require nearly the same conditions as other spiders. A terrarium with sand in the bottom makes an ideal container. Never place more than one tarantula in a terrarium, because they are strongly cannibalistic!

Most spiders only live for a year or so, but female tarantulas may survive for up to 20 years. When you buy a tarantula, try to get a female or an immature male, because mature males will only live for another year or so! Look at the "knee joint" of the first pair of legs. If the joint has a small pair of thumblike projections, then the spider is a mature male. Don't buy that one if you want a long-term pet.

Contrary to popular belief, tarantulas are not dangerous, although they will bite if handled roughly. The bites are painful (like a bee sting) but not fatal. Although tarantulas are easily handled, the risk of hurting the spider is great, and you should only handle your spider when absolutely necessary.

Tarantulas need both food and water. Hungry tarantulas will try to eat just about anything that moves and is smaller than they are (spiders, large insects, small snakes, lizards, toads and baby mice). They can also be tricked into eating canned dog food or ground beef. Do this by forming a small ball of meat around the end of a piece of thread and then jiggling it in front of the spider. When the spider grabs the bait, keep jiggling the string while you gently pull the string out of the meat. The spider will think the "prey" is struggling to get away and should then really hold on to it.

One large insect a week is enough for most tarantulas. During spring, summer and fall most tarantula species should be fed every 4 or 5 days. During the winter the spiders seldom eat, but it's a good idea to offer them food once every other week. It is impossible to overfeed tarantulas; they will only eat according to their needs. Water can be provided by placing moist cotton in a shallow dish and putting it in the spider's terrarium.

OTHER ARTHROPODS

If you can duplicate the natural conditions (food, water and environment) required for growth and survival, there are many other arthropod species you can rear. More information is contained in "References" (page 35). Some other arthropods you can rear are:

- Isopods (sowbugs, pillbugs, etc.)
- Millipedes
- Centipedes
- Scorpions
- Giant whipscorpions (vinegaroons)
- Dragonflies and damselflies
- Mole crickets
- Grasshoppers
- Walkingsticks
- Praying mantids
- Termites
- Earwigs
- Tent caterpillars
- Grain, meal and flour moths
- Ant lions
- Ladybird beetles
- Ground beetles
- Passalid beetles (bessbugs)
- Bean and pea weevils
- Wood-boring beetles
- Hide and carpet beetles
- Mosquitoes
- Fruit flies *(Drosophila)*
- House flies