FLUKER'S®

FLUKER'S CRICKET BIOLOGY GUIDE

INTRODUCTION:

The House Cricket, *Acheta domesticus,* originated in Southeast Asia. Over thousands of years, the cricket spread slowly into India, where it still thrives in cultivated fields and jungles. The House Cricket was accidentally introduced to Northern Europe, but was never able to survive because of the harsh winters. In England it was able to survive the winters only by seeking refuge in trash piles and in homes, hence the name House Cricket. It is the "cricket of the hearth," whose friendly chirping was described by Charles Dickens. Introduced to America as an insect that could be easily reared for fish bait, it quickly became a commercial success. Though millions of House Crickets are released into the environment every year, the species has never become endemic (native) to the United States. The reason is simple. The House Cricket occupies the same environmental niche as the native Black Field Cricket (*Gryllus pennsylvanicus*), and the larger, more robust Black Field Cricket out-competes the House Cricket for resources and generally makes a quick meal of the House Cricket when they come in contact.

Fluker Farms, Inc has developed the largest, healthiest and most hearty House Crickets available. Through careful control of the diet and sanitary rearing conditions, a clean healthy product has been achieved. Cricket genes from several locations throughout the country were incorporated into a special strain, called the "American mix", which has been selectively bred for size and durability for over 60 generations. This is why Fluker's crickets have less mortality upon delivery and survive longer after they arrive.

A MESSAGE FOR STUDENTS:

We believe you will find this guide interesting, and we hope you will enjoy observing the behavior, biology and life cycle of the House Cricket. The House Cricket is a typical representative of the kind of insect with a simple life cycle. What makes this particular kit interesting is that everything is thoroughly explained in understandable terms, and all the procedures described actually work. If you follow the directions, over the next several weeks, you will be able to observe male chirping, courtship, sperm transfer, egg laying, hatching, growth and larval development. Finally, crickets are ideal specimens from which one can easily and inexpensively learn the basic anatomy of an insect with direct development (gradual metamorphosis).

HOW TO GET STARTED:

First make sure you have all the parts (see Section 1). Then proceed in sequence through the remaining 7 Sections of this Instruction Booklet. Section 8 provides you information about ordering replacement parts. Additional copies of the Instruction Booklet (Copyrighted) can be ordered.

1. SUGGESTED ITEM'S LIST:

One 13 inch long, 8 inch deep, and 10 inch high clear plastic terrarium with vented lid

One watering dish and one feeding dish consisting of 2 plastic cups

Two egg-laying dishes (3.5 inch diameter, 2 inches deep) with snap on lids

One container of Fluker's Cricket Feed and one container of Fluker's Cricket Quencher

One Disk of egg-laying medium

One square of sand paper to roughen up the sides of the drinking and egg- laying dishes

One Fluker Labs Thermometer

One cardboard container with 30-40 Fluker Crickets.

2. SETTING UP THE TERRARIUM AND ESTABLISHING REARING CONDITIONS:

A. Open package, lie out all parts, and make sure nothing is missing. (See List above).

B. The plastic cage should be empty and NOTHING should be added to make a floor. No sand, no dirt, no wood chips! Any kind of substrate makes cleaning difficult, introduces humidity problems and can obscure the observation of the crickets.

C. The watering Dish: The sides of the watering dish must be sanded so small crickets can climb in and out. After sanding thoroughly, fill the cup with cricket quencher.

D. The feeding Dish: The sides of the feeding dish should also be sanded so small crickets can climb in and out. Crickets tend to kick the food about, and the feeding dish helps reduce the mess.

E. The egg-laying dish: Be sure the sides of the dish are sanded so the crickets can climb in and out.

F. Adding the crickets: Open the top of the container and dump the crickets into one corner. Place the empty container and packing material in the terrarium.

***** Note *****

G. All dishes must be thoroughly sanded inside and out.

3. ESTABLISHING PROPER REARING CONDITIONS:

A. *Temperature* is the most critical environmental factor. The ideal temperature for all activities of the cricket is 82 - 86°F. At room temperatures (from 72 - 76°F), all events in the life cycle take a little longer, but for the most part they will mate, reproduce, and lay eggs. A lamp with a 60-watt bulb held close to the cage would generally provide enough heat to reach 84°F, but be careful not to let the bulb contact the plastic terrarium wall, as it will melt a hole. A better source of evenly distributed heat is a Fluker Labs Under Tank Heater. In any case, it is wise to check the temperature with a thermometer, because crickets will begin to die in a terrarium with a temperature over 96°F.

DO NOT SET THE TERRARIUM IN A WINDOW, because the sun will cause overheating and death.

B. *Relative humidity* is the second most critical environmental factor. Eggs should beincubated at near 100% humidity. After the females have laid eggs over a period of several days in the egg-laying dish (incubator), the lid with the small holes should be firmly snapped in place. These small holes provide a near 100% humidity, which is required for the incubation of the eggs. Hatchlings prefer a high (80-90%) humidity for the first week of their life, which can be provided by leaving the incubator dish in the terrarium with the snap top lid open just a crack. After a week, remove and clean the incubator dish and reuse. The older larvae and adults prefer a dryer humidity (less than 50%), which is the usual humidity in the terrarium. Excessive humidity in the terrarium caused by overcrowding or spilling water will kill the crickets (they turn black and die). Keep the terrarium clean and dry!

C. *Light intensity and the light cycles* are not critical. Crickets in nature experience a day-night cycle, but continuous light (to maintain the desired temperature) has no adverse effect on their behavior or biology.

4. GROWTH AND DEVELOPMENT OF THE HOUSE CRICKET:

Crickets have direct development (gradual metamorphosis) in which the larvae (immature insects) resemble the adult (mature insect) except for smaller size and lack of wings. There are three stages of development in the life cycle of the House Cricket: egg, larva, and adult. Only the adults have wings and can reproduce. The body temperature of crickets matches that of its immediate environment, and they generally seek out areas with a temperature of about 82-86°F. At room temperature the life cycle is somewhat slower, but nevertheless will continue to completion. At temperatures below room temperature, they stop chirping and reproducing. Do not let the temperature rise above 96°F, because this is generally fatal.

A. Egg incubation time: The time for the eggs to hatch at 86°F is about 13 days and about 26 days at room temperature (74°F).

B. Molting and growth: There are 8 larval instars (stages) at 86°F and up to 10 instars at room temperature. At the end of each larval instar there is a molt to the next larval instar in which old cuticle (skin) is cast off in one piece. The next instar has a new and larger cuticle into which it can grow. Larvae roughly double their size in each molt. Short wing pads and a stubby ovipositor can be seen on the last two larval instars (stages) of the females. Notice that newly molted insects are soft and milky white in color. They require several hours for the new cuticle to harden and assume the normal gray-brown color.

C. Larval development: The time from growth and development of the larvae to adult emergence from the last larval instar takes about 6 weeks at 82 - 86°F.

D. Adult development: The day the last larval instar molts to the adult (the process is called emergence), the newly emerged cricket is designated as a “Day-1 Adult”. The adult males and females become sexually mature and capable of mating at 3-4 days old. An adult insect never molts again. The female will not lay eggs unless mated. She begins laying eggs (ovipositing) at 8-10 days old, and will lay batches of 50-100 eggs every 2-3 days over a period of two months. The female must re-mate every 2-3 weeks, because her supply of stored sperm runs out after 2-3 weeks. Oviposition and male mating activities begin to slow down after a month at 86°F and by two months most adults are dead.

5. COURTING, MATING AND EGG-LAYING BEHAVIOR:

Only male crickets chirp (sing), and they are capable of singing several different songs. Different chirp patterns (songs) are used by males to establish a pecking order amongst themselves, to attract females, and to induce the attracted female to mate with him. The tone or pitch (how low or high) of the chirping remains constant, but the number of chirps per minute (frequency) increases with increasing temperature. If accurately measured, the chirping frequency can be used to estimate the temperature.

A. Chirping: The males produce their songs by raising their first pair of wings at anangle of about 20-degrees to the body and then rapidly scraping one wing over the other. The action is similar to a frantic violin player. As shown in the drawing (figure 6), the under side of each forewing has a file, and a set of ridges on the top surface. The resonating area of the wing is set into vibration (causing a chirp) when the file of one wing is drawn over the ridges of the other wing. The raised wings and their rubbing action can be easily seen in your terrarium. There are right and left handed chirpers.

B. Courting behavior: Males produce long interval chirping as a general courting song to attract females from a distance. Females are more attracted to males with a stronger and more aggressive chirp. If he does manage to attract the interest of a female, she will gradually approach. He becomes very excited as she approaches and his chirping becomes stronger and the intervals between chirps shorter. With practice you will hear the difference.

C. Male hierarchy (pecking order): Males will try to establish dominance over other males, based on their strength and the confidence of their chirping (song). He will sometimes try to defend a corner or crevice (his turf) from other males. A dominant male can scare off a subdominant with his confident song alone.

Sometimes male dominance can only be settled by wrestling matches (Photos 2, 4), in which the cricket thrown on his back (Photo 6) loses confidence and becomes a subdominant male. Thereafter he sings a less confident courting song.

D. Mating behavior: As the female gets closer to the male, he starts to stroke her with his antennae and his chirping song changes, becoming even more intense, which excites her and scares off all but the most confident rivals. The combination of his intense chirping and his antennal stroking induces her to climb onto his back (mount) so that her ventral surface lies against his dorsal surface and her head is directly over his. If the female does not respond and mount, the male gets impatient and starts to butt the female with his head. In fact, a male can be annoying to the point that he will sometimes keep her from eating or ovipositing. He is especially confident when he has attracted a female and will aggressively drive off all other approaching males. The mating behavior is not difficult to observe, but it occurs more often at temperatures near 86°F than at room temperature. The best way to observe mating is to isolate several males and several virgin females (newly emerged) for several days, then bring them together in a separate small clear plastic container. With patience, mating can also be seen in the crowded terrarium, however other crickets often interrupt the act.

E. Sperm transfer: There is no true copulation in crickets; instead the male packages his semen (containing the spermatozoa) into a sack-like structure called a spermatophore. The spermatophore is a small, milky sack with a long thread-like tube attached. This spermatophore transfer is easy to observe after the female mounts the male. The spermatophore emerges from the genital opening at the posterior end of the male. It is manipulated by the paired cerci on the last body segment, and it is passed directly dorsally to the female genital opening where the long tube is inserted into her reproductive tract. She quickly dismounts after the spermatophore is transferred and moves away. The sack-like spermatophore contracts and forces the semen via the long tube into her seminal receptacle (an internal sack to store the sperm). The male then stands guard over the female and tries to prevent her or other males from removing and consuming his spermatophore.

F. Fertilization and oviposition: The female can store the sperm in her seminal receptacle for about two weeks, which means that females need to be remated about every two weeks in order to continue laying fertile eggs. The female grows and retains hundreds of mature eggs in her body, but will only lay the eggs (oviposit) after she has filled her seminal receptacle with sperm from a spermatophore. Once she has sperm in her seminal receptacle, she will fertilize each egg one at a time as the mature egg passes from her oviduct into the egg-laying tube (ovipositor). The long, thin ovipositor of the adult female is inserted into the moist peat moss and eggs are laid in small clusters of 10-20 eggs each.

Observe how she withdraws the ovipositor after one cluster is oviposited, and how she reinserts it in another area slightly away from the previous site. You may be able to see the sliding of the four shafts of the ovipositor that work the egg down the length of the ovipositor. It is important that the peat moss not be too wet or too dry (see setup).

G. Preparing egg-laying medium: Place disk of egg-laying medium in a small bowl. Add 6 oz of water and let soak for 12-18 hours. STIR occasionally. After medium is soaked and mixed, add to egg-laying cup. Fill to within 1/8" from the top. Unused medium should be stored in a sealed container until needed.

H. Incubation of the eggs: Allow the females to have access to a properly prepared egg-laying dish for a period of 3-6 days (see under Set Up). After 3-6 days of egg-laying activity, cover the dish with the lid provided. This creates an incubator. The holes in the lid are of the correct size to keep in moisture and retard drying out, yet permit oxygen to reach the eggs. It is often convenient to leave the covered egg container in the terrarium. The eggs are transparent and you can remove some at intervals to observe the development of the cricket embryo (becomes darker). An ordinary magnifying glass helps to follow embryonic development. Just before hatching, the head and eyes of the cricket are clearly visible. After 13 days at 86°F, the eggs hatch and the hatchlings squeeze out of the holes in the lid. Open the lid a crack and leave the dish in the terrarium for several days to allow all eggs to hatch.

6. EXPERIMENTS WITH LIVING CRICKETS:

Crickets are hardy insects and are not damaged by being picked up and handled. They do not bite and do not transmit any diseases.

A. Breathing rate and heartbeat: The breathing rate and the heartbeat (pulse) can only be
determined in a living cricket. The expansion and contraction of the abdomen is easily observed with the naked eye in crickets in the terrarium. This breathing movement is how the cricket moves air in and out through the small holes (spiracles) that you can see on the side of the abdomen (Figure 5). Insects do not breath through their mouth.

In order to observe the heartbeat you must first cut off the wings or use a large larva. First pin the living cricket to a dissection dish with one pin through the thorax near the head and another pin near the posterior end of the body. The thin tubular heart of the cricket is located just under the cuticle (skin) along the dorsal midline (Figure 4). It is very thin and runs from the tip of the abdomen into the thorax. You probably need a magnifying glass, and you may have to move the light to a good angle to see the pulsations of the long, thin, tubular heart. Becareful and don't confuse breathing with heartbeat!

(Note: If a dissection dish is unavailable, a sheet of cardboard can be substituted.)

B. Effects of temperature and activity: Determine the breathing rate and heartbeat rate of a cricket at rest. Compare the findings with a cricket at two different temperatures. Your body temperature is 98.6°F, the terrarium should be about 84-86°F, and the room temperature is about 72 °F. Simply hold a cricket in your hand for one minute and you have raised its body temperature; place it in a small jar outside the terrarium and you have lowered its body temperature. How much farther can a hand-warmed cricket jump than a cold cricket? You should be able to demonstrate an increase in breathing rate with higher temperatures.

C. Flight: House Crickets can fly during the first two days after the final molt into the adult stage, but then the wing muscles degenerate on days 3-5 to provide nourishment for the developing eggs. Thereafter flight is impossible. If you isolate an adult cricket that just molted (white color), you can observe flight if you gently cast them into the air during the next two days.

7. EXTERNAL PARTS (ANATOMY) OF THE HOUSE CRICKET:

All observations regarding cricket anatomy require that you drown the animal in water or kill it in 50% isopropyl alcohol (rubbing alcohol), because a living cricket squirms about too much to study the anatomy. First, determine if you have an adult (Figures 1-2) or a larva (Figures 3-4). In insects with gradual metamorphosis, such as the cricket, the larvae resemble the adults, but they are smaller and lack wings. The last two larval stages (called instars) however do have wing buds (Figure 4). Second, determine the sex (whether it is a male or female). The adult female has a long tubular ovipositor at the posterior end of the body (Figure 2 and 5), which is lacking in the male (Figure 1). The plates on the top of the body are called tergites and on the bottom are called sternites.

A. Head: Using Figure 5 as a guide, locate and identify the paired antennae and the compound eyes on the head. The antennae are used for touch and for smell. Turn the cricket onto its side and hold it in place by inserting a couple of pins through the body into the Styrofoam. Find the mouthparts located on the ventral side of head, and use a pencil tip to move them apart. Using the magnifying glass, identify the labrum (the single upper lip), the mandibles (paired jaws), the maxillae (paired food manipulators) and the labium (the single lower lip). The Single labrum and single labium act like your lips to keep the food in the mouth. The paired mandibles are like two molars and are used to grind up the food, except they move from side to side instead of up and down like yours. You can use your fingers to pull off the labium and a maxilla (Figure 7) and pin to the styrofoam for better observation.

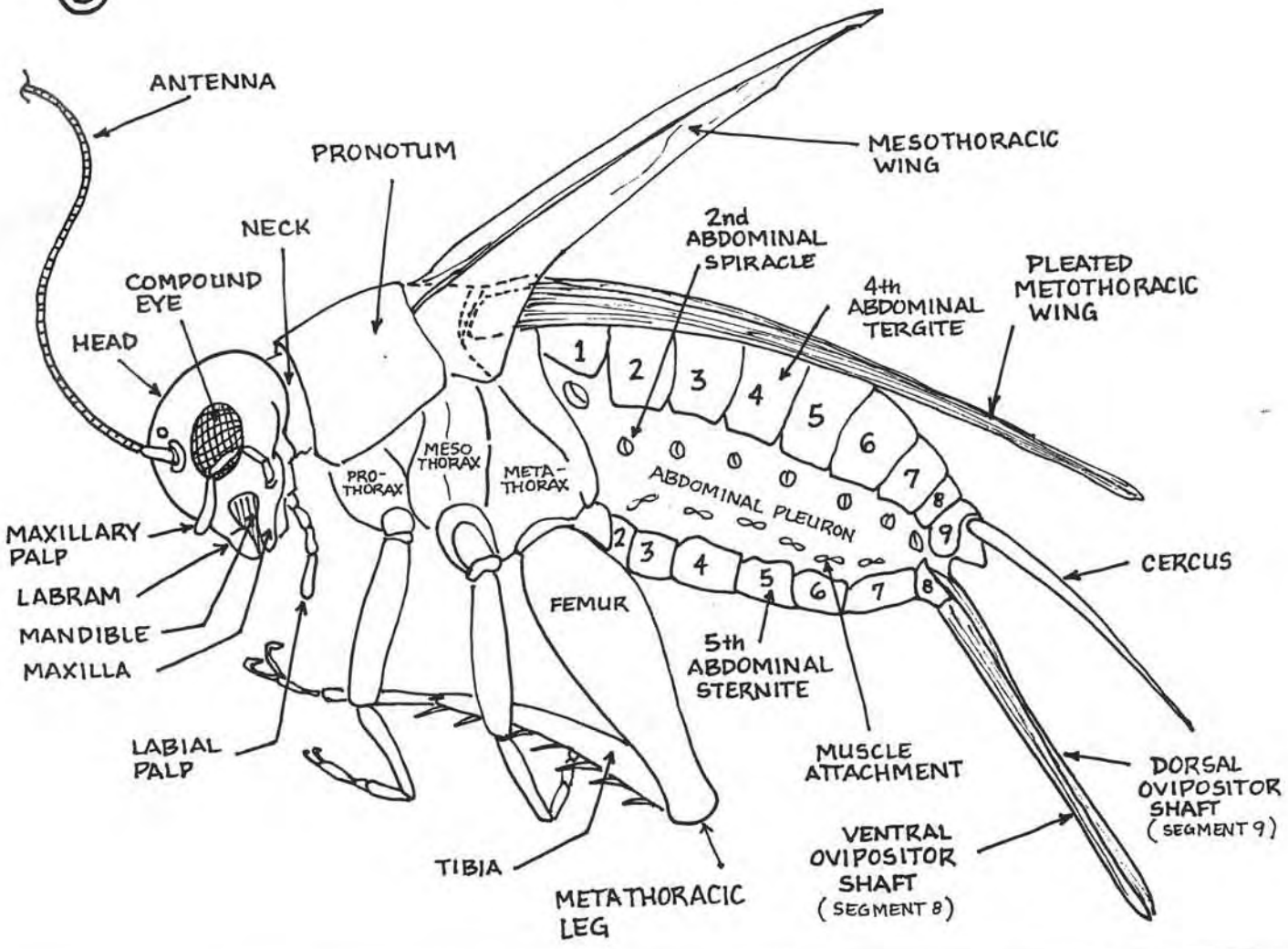
B. Thorax: Use at least three pins stuck through the body and into the dissection dish to hold the cricket in a position similar to that in Figure 5. The thorax is divided into three segments, the prothorax, the mesothorax and the metathorax. The top of the prothorax forms a prominent thick shield just behind the head called the pronotum The pronotum folds down over the sides of the prothorax. The first pair of wings arises from the dorsal surface of the mesothorax, and the second pair of wings arises from the metathorax.

Cut off the wings, and with a magnifying glass, examine the file and ridges on the first pair of wings of the male (Figure 6). Each thoracic segment bears a pair of legs. The large pair of legs on the metathorax is modified for hopping, which is an escape behavior for crickets. Try picking a cricket up off the floor, which is not easy, and you will see how effective this escape behavior is.

C. Abdomen: Make sure the wings have been cut off, so that you can clearly see the entire abdomen. You should be able to count 7-8 pairs of spiracles on the side of the abdomen. The spiracle is the opening to the respiratory system of insects, through which the insect breathes. In both sexes and in all stages, there arises a pair of feeler-like structures from the last abdominal segment (Figure 5 #9) called cerci (Figure 4). They are covered with long fine hairs, which are used to detect very faint movements of air. The ovipositor is as long as the abdomen and of course is only found on females. The ovipositor consists of 4 shafts that slide alternately (right, left, right, etc) in grooves, causing the eggs to be moved down to the end and out of the ovipositor.

ADULT ♂, ♀

⑤



MESOTHORACIC WING ♂

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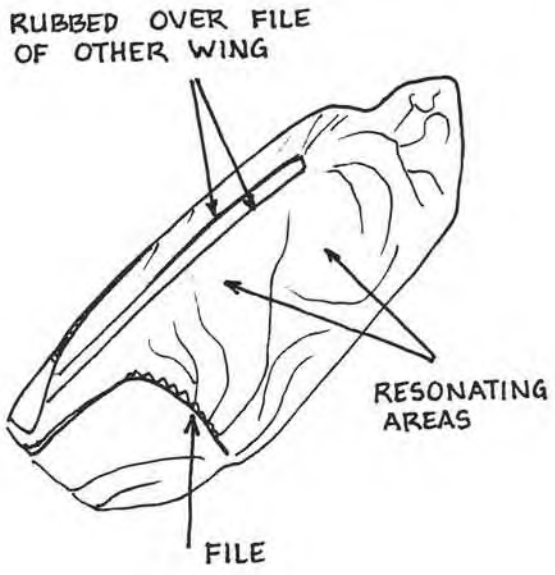

MOUTH PARTS ♂, ♀

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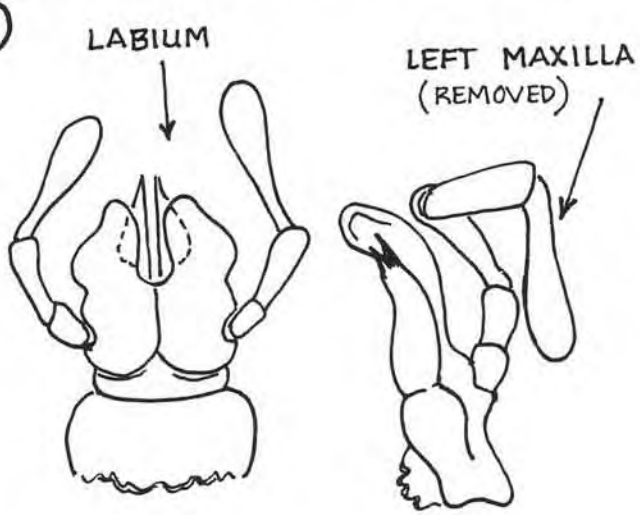
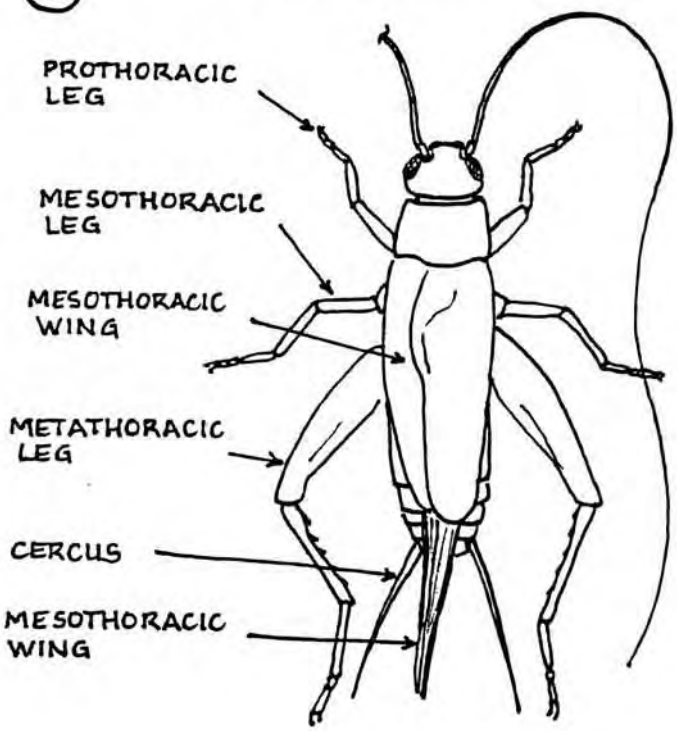
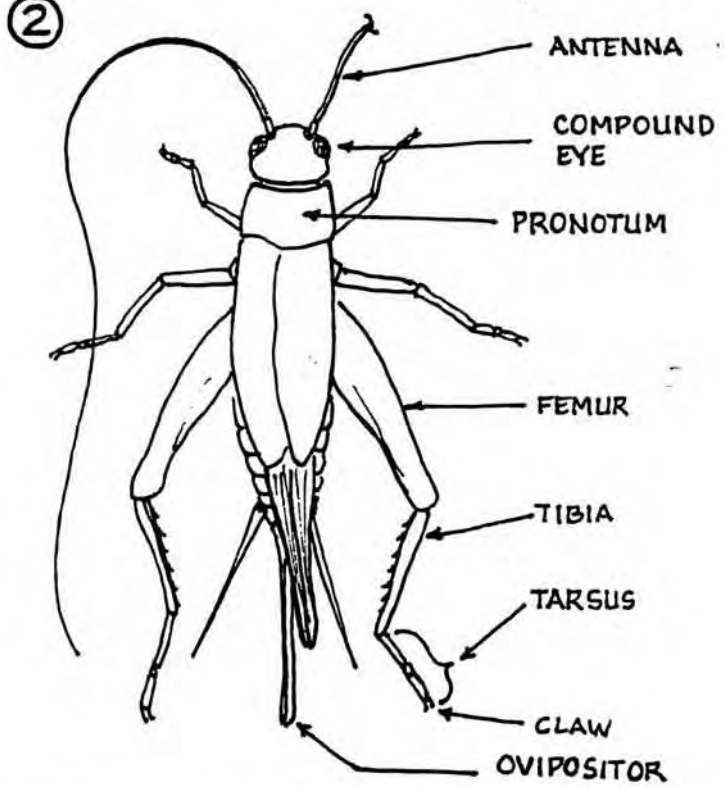


Acheta Domesticus

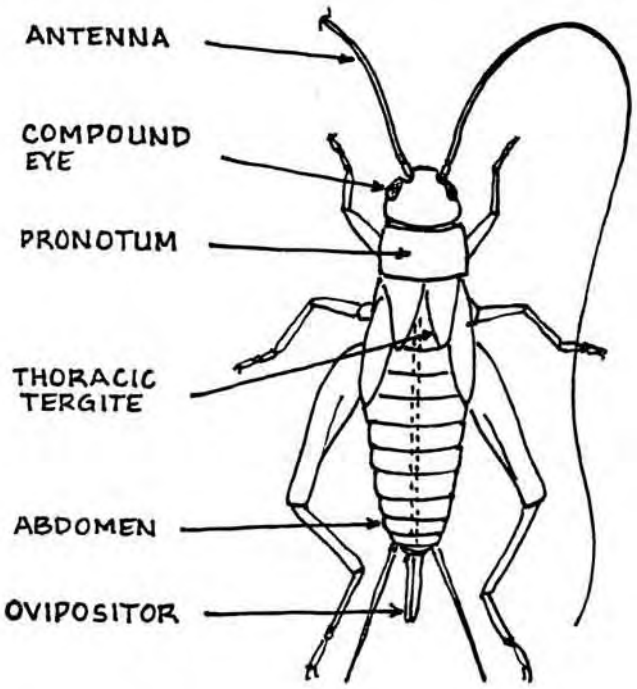
① ADULT MALE ♂



② ADULT FEMALE ♀



③ LAST LARVAL INSTAR ♀



④ LAST LARVAL INSTAR ♂