U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
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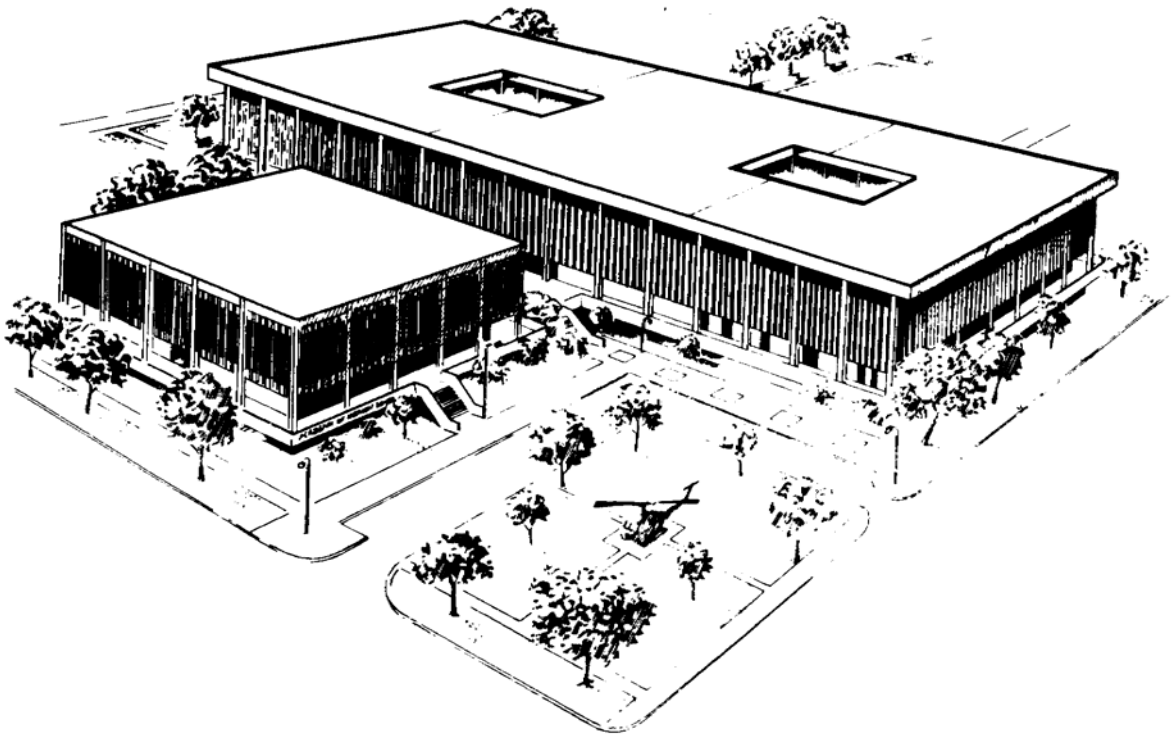

ARTHROPOD IDENTIFICATION AND SURVEYS

SUBCOURSE MD0170 EDITION 100

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

ADMINISTRATION

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CLARIFICATION OF TRAINING LITERATURE TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

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SUBCOURSE MED170

ARTHROPOD IDENTIFICATION AND SURVEYS

INTRODUCTION

Each year, advances in modern technology and research reduce the incidence of disease in humans. Disease is still a problem, however, in many areas of the world, principally in underdeveloped countries. Arthropods play an active role in this problem as they are the primary vectors of disease. In many cases, the success of disease eradication depends upon a knowledge of the arthropod vector. It is imperative, then, that those individuals dealing with arthropod-borne diseases be able to identify medically important arthropods.

Neither survey, collection, nor control programs can possibly be effective unless an individual knows what to look for and where to find it. The preventive medicine specialist, therefore, must be familiar with the bionomics (biology, behavior, and ecology) of a wide range of arthropod pests. A knowledge of the habits and habitats of medically important arthropods is a necessary basis for further entomological work. The objective of this subcourse is to provide the foundation required to develop field competence in medical entomology. Use of this information properly wiII assure success in survey, collection, and control of medically important arthropods.

Subcourse Components:

The subcourse instructional material consist of the following:

Lesson I. Arthropod Biology and Life Cycles.

Lesson 2. Arthropod Identification.

Lesson 3. Arthropod Surveys.

Lesson 4. Arthropod Preservation, Mounting, and Shipping.

Appendix A. Introduction to Mosquito Identification.

Appendix B. Supplies used in Arthropod Surveys.

Credit Awarded:

Upon successful completion of this subcourse, you wiII be awarded 12 credit hours.

Study Suggestions:

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas. Upon successful completion of the examination for this subcourse, you will be awarded 14 credit hours.

You can enroll by going to the web site **http://atrrs.army.mil** and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: **http://www.usapa.army.mil/pdffiles/p350-59.pdf.**

LESSON ASSIGNMENT

LESSON 1	Arthropod Biology and Life Cycles.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-16.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

1-1. Identify the major medical importance of arthropod.

1-2. Match the class, order, tribe, or family of an arthropod or group of arthropods to its common name.

1-3. Identify the type of metamorphosis an arthropod undergoes to include the stages in the proper order, and the habitat of each stage.

1-4. Identify the general characteristics of each stage of a type of metamorphosis.

1-5. Select biological factors characteristic of medically important arthropods to include habits, habitats, food, and reproductive, characteristics.

1-6. Select the arthropod associated with a stated habitat.

1-7. Define transovarian transmission.

SUGGESTIONS

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

Compare illustrations with arthropods collected during field survey.

LESSON 1

ARTHROPOD BIOLOGY AND LIFE CYCLES

Section I. INTRODUCTION

1-1. GENERAL

a. Ask the average person what an arthropod is and he probably will not be able to tell you. Then ask the same person what an insect is, and he 'will probably name such animals as flies, bees, spiders, chiggers, ticks, mosquitoes, centipedes, scorpions, etc. He will probably be astounded when you tell him that all of the animals that he has named are not insects but that all are arthropods.

b. War, floods, fire, and famine have all taken their toll on mankind, but the greatest decimator of all has been disease. Of these diseases, the worst have been arthropod-borne diseases. Everybody has heard of the infamous plague or "black death" that swept Europe in the 14th century. Millions died. In fact, one fourth of the population of Europe perished. That form of plague was arthropod-borne (transmitted by the rat flea). Nonetheless, horrible as it was, the "black death" was not the most severe arthropod-borne disease. Malaria, which is transmitted by the Anopheles mosquito, has killed more people throughout the world than any other communicable disease.

c. Some arthropod-borne diseases that have affected US soldiers are: yellow fever, African trypanosomiasis, viral encephalitides, malaria, typhus, Rocky Mountain spotted fever, and viral hemorrhagic fever. Because of our military commitment to 'other nations, US soldiers are often rushed to other parts of the globe and quickly exposed to disease-carrying arthropods. These diseases are usually endemic; that is, they exist at a low level among the local populace at all times. Because local personnel have been exposed to these diseases all of their lives, they have built up a natural tolerance or immunity to these diseases. The American soldier, lacking an immunity, can quickly become a victim of an arthropod-borne disease.

d. It must be emphasized, however, that the vast majority of arthropods are not enemies of humans. Some arthropods, such as the honeybee, are essential to our existence, as efficient pollinators of fruit trees, clover, vegetable crops, and other useful plants. Insect products such as silk, honey, beeswax, and lac (the basic material for shellac) are products we use. Many insect species are essential to human welfare because of their part in combating other species that are harmful, thus maintaining a biological balance in nature. Some serve as predators, feeding upon harmful four insects and plants and keeping them under control. Others are parasites of harmful pests and are used in various biological control situations.

1-2. PHYLUM ARTHROPODA

All forms of living matter belong to either the plant or animal kingdom. The kingdoms are divided into phyla. The phylum Arthropoda is part of the animal kingdom and is characterized by those animals, which have an external skeleton (exoskeleton) and jointed appendages. This group includes the following classes:
;

a. **Class Insecta.**

(1) This class contains the true insects and is the largest and most medically important class of arthropods. Some medically important insects include mosquitoes, fleas, flies, and lice. An adult insect can be distinguished from other arthropods since it has three distinct body regions--the head, the thorax, and the abdomen (see figure 1-1). The head has one pair of antennae and usually one pair of compound eyes; the thorax has three pairs of legs and up to two pairs of wings. Many insects have only one pair of wings; others have none. The abdomen contains most of the internal organs of the insect.

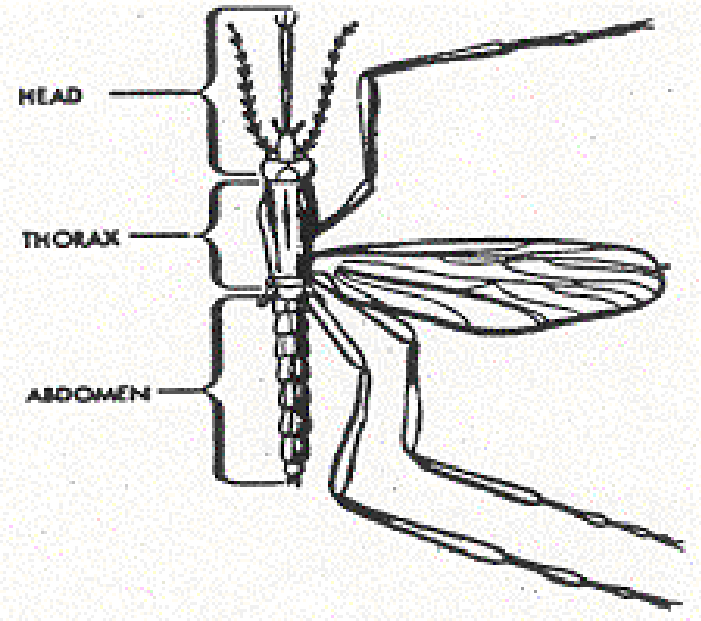

Figure 1-1. Three distinct body regions of an insect.

(2) Growth of arthropods involves shedding the cuticle, a process called molting. In insects, the number of molts varies usually from 4 to 8. Most insects stop molting once they become adults. Usually insects change at least somewhat in form during development, a process called metamorphosis. There are two basic types of metamorphosis. Gradual metamorphosis (see figure 1-11) involves some change in form and the young, called nymphs, which are similar in habits and form to the adults except for size and lack of sexual maturity. Insect examples include grasshoppers and cockroaches. Complete metamorphosis (see figure 1-7) is characterized by a more-or-

less worm-like larva (the young, feeding stages); an intermediate nonfeeding, transformation stage called the pupa; and finally, an adult that generally differs markedly from the larva in form as well as habits. Insect examples include butterflies, flies, and beetles.

b. **Class Arachnida**. This includes among others, the ticks, mites, scorpions, and spiders. The spiders and scorpions, have two distinct body regions: the cephalothorax and the abdomen (see figure 1-2). The mites and ticks have only one major body region (see figure 1-3). The adults have four pairs of legs, but no wings or antennae. Ticks and mites are the most medically important members of this class since some transmit many diseases.

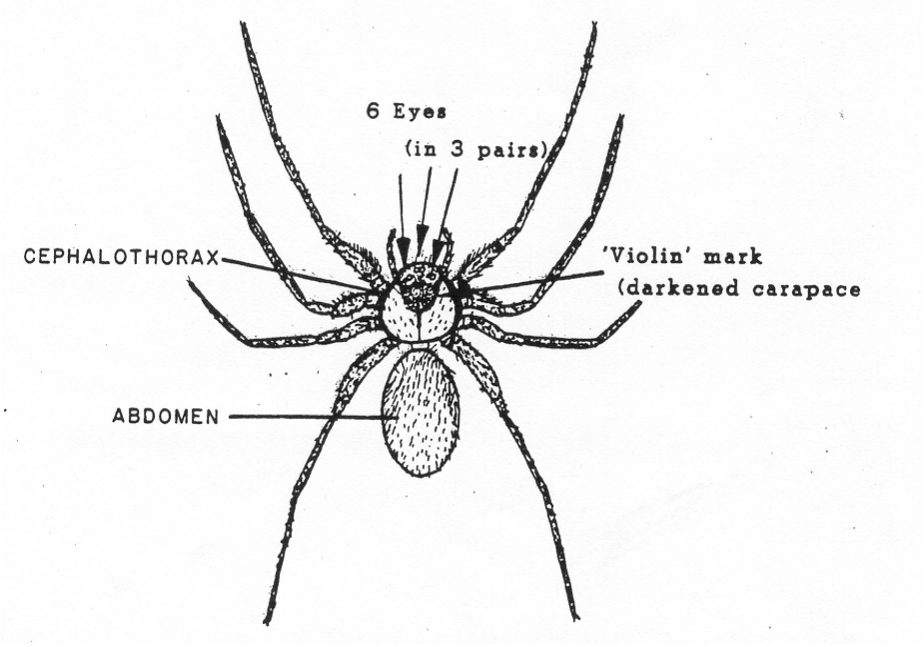

Figure 1-2. Brown recluse spider, example of an arachnid with two body regions.

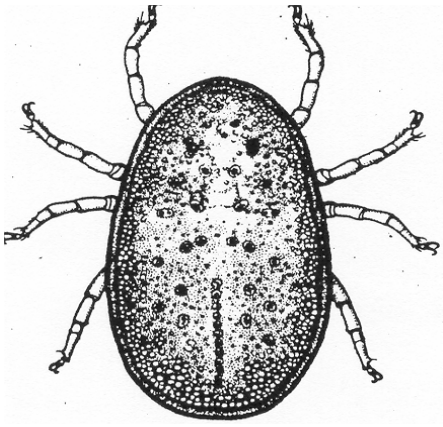

Figure 1-3. Soft tick, example of an arachnid with one body region.

c. **Class Chilopoda**. The class Chilopoda consists of the centipedes. The centipede has a distinct head and a flattened, worm-like, segmented body with one pair of legs on each segment (see figure 1-4). Some centipedes are up to 10 inches long and can inflict painful bites.

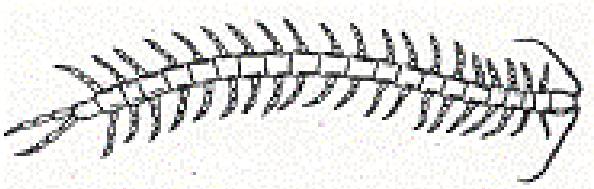

Figure 1-4. Centipede, class Chilopoda. (**Note**: One pair of legs per body segment.)

d. **Class Diplopoda**. The class Diplopoda consists of the millipedes, which are worm-like arthropods with many legs; hence, the name "thousand legger." The head is distinct and the remaining segments form a continuous trunk or body. Each of the body segments bears two pairs of legs, except the first three segments that have one pair each (see figure 1-5). Millipedes have repugnatorial glands, which open through pores along each side of the body. The secretions from these pores are offensive and repel other insects. They can also cause skin irritation to humans.

Figure 1-5. Millipede, class Diplopoda. (Note: Two pairs of legs per body segment except for first 3 segments.)

e. **Class Crustacea**. The class Crustacea is comprised of crabs, lobsters, shrimp, sow bugs, barnacles, and water fleas. A member of this class has two pairs of antennae and five or more pairs of legs (see figure 1-6). The anterior body region, as with some arachnids, is the cephalothorax.

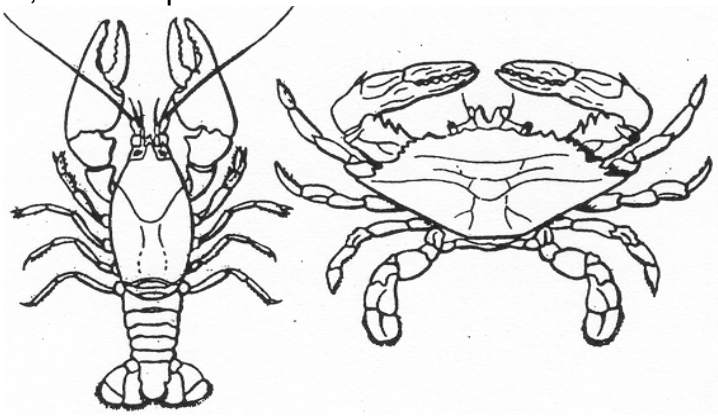

Figure 1-6. Lobster and crab, examples of class Crustacea.

1-3. SUBCLASSIFICATION OF THE CLASSES

Each class of arthropods is further divided into orders, families, and genera; and each genus is divided into the various species. The species division, particularly, is usually a true biological grouping in that members have common characteristics and can successfully mate only with members of their own species. For example, the classification of the mosquito that transmits yellow fever (Aedes aegypti) is:

a. Phylum--Arthropoda.

b. Class--Insecta.

c. Order--Diptera.

d. Family--Culicidae.

e. Genus--Aedes.

f. Species-aegypti.

NOTE: When writing scientific names, the first letter of the (generic) name is always capitalized and the species name is not capitalized; both are underlined. The complete scientific name includes the name or initials of the person who gave that particular species its name (Anopheles Walkeri Theobald, for example, was described and named by Theobald). When referring to more than one species within the same genus, the abbreviation spp. (species plural) is used. An example would be Culex spp. The complete specific name of the yellow fever mosquito is Aedes aegypti (L) that was named by Linnaeus.

1-4. HOW ARTHROPODS AFFECT HUMAN HEALTH

Aside from transmitting some of the deadliest diseases known, arthropods affect humans in other ways.

a. **Entomophobia**. Entomophobia is defined as an intense fear of insects and other arthropods. Although most persons find the presence of arthropods unpleasant, there are some people who actually lose control of their emotional state of well being and cannot function at the sight of or contact with certain types of arthropods. While fear may go away after the person learns more about arthropods, psychologically based entomophobia may not be easily cured and could intensify with increased knowledge of the habits and habitats of arthropods.

b. **Injury**. Arthropods can inflict painful injury to humans through their bites. They can cause injury to the sense organs such as the eye, the ear, and the nose.

c. **Envenomization**. In recent years, more people have died from the bite or sting of arthropods than from snakebites. Arthropods listed as responsible have been wasps, bees, ants, caterpillars, spiders, scorpions, and centipedes. The great majority of deaths have been from wasp and bee stings inflicted on persons who have become sensitized to these particular venoms.

d. **Dermatitis**. Dermatitis is a skin irritation that may be caused by ticks, mites, fleas, bedbugs, and other arthropods. This is usually a local reaction to the presence of the arthropod, its venom, or secretions. A serious problem that can develop is that of secondary infection commonly caused by scratching the part of the body bitten or invaded by the arthropod. Chigger mites are an example of an arthropod that can cause dermatitis.

e. **Myiasis**. Myiasis is a condition caused by the invasion of tissues by fly larvae. An example is the blowfly that lays its eggs in open sores or wounds. In a few hours or days, depending on temperature or other factors, the eggs hatch and the larvae invade the tissues of the wound. If the condition goes unnoticed or untreated in either humans or other animals, it can result in the loss of an limb or even death.

f. **Allergy**. Allergy may be defined as a hypersensitive reaction to arthropod secretions, excretions, or body parts. It may occur in workers involved in separating light trap catches (see para 3-3e) or anybody working with pulverized insect parts and scales of butterflies or moths. Allergic reactions may be manifested in various forms; hives: asthma, hay fever, urticaria, eczema, and so forth. Certain individuals are more susceptible than others are to these reactions; several factors such as heredity, predisposition, and previous exposure also may affect the degree of sensitivity.

Section II. CLASS INSECTA

1-5. MOSQUITOES

a. Mosquitoes belong to the family Culicidae of the order Diptera and constitute the single most important insect group from the standpoint of both disease transmission and annoyance. They are distributed throughout the world. Where water is found, mosquitoes are usually also found. There are over 3,000 described species with a great variety of habits. Knowledge of mosquito identification and biology is essential for efficient control.

b. Mosquitoes will breed in virtually any collection of water that has been standing for longer than 5 to 7 days. Those breeding in and around human dwelling places are called domestic mosquitoes. Different kinds of mosquitoes vary in their choice of breeding places. Some like sunlit places, whereas others prefer the shade. Some prefer fresh water to stagnant water; others prefer the brackish water of salt marshes. Common breeding sites are ponds, pools, slow-moving streams, swamps and bogs, salt marshes, ditches, tree holes, rock holes, and manufactured water containers.

c. Mosquitoes have complete metamorphosis, with four distinct, stages in their life cycle: egg, larva, pupa, and adult (see figure 1-7).

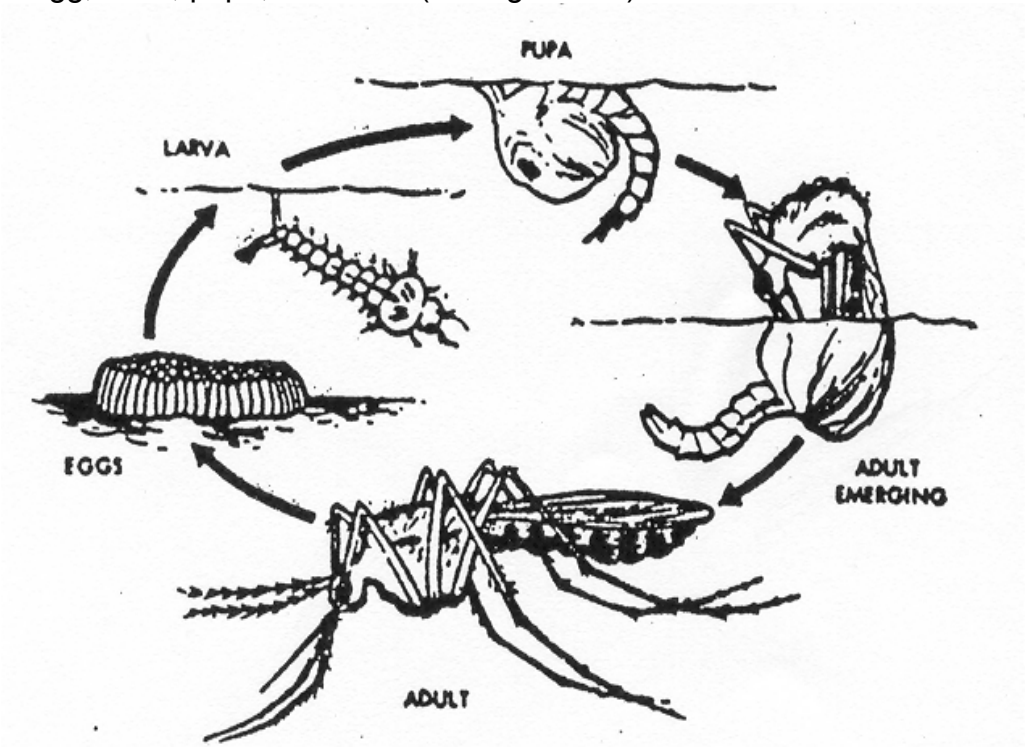

Figure 1-7. Life cycle of the mosquito.

d. An adult female may lay several eggs to hundreds of eggs on water or in low places where water collects. The eggs of Anopheles and Culex are laid on the water, while those of Aedes are laid on damp or loose soil that is likely to be flooded later. Aedes eggs are laid singly, as are Anopheles. The eggs of some Anopheles have floats to keep them on top of the water; while Culex eggs are laid in rafts (see figure 1-8).

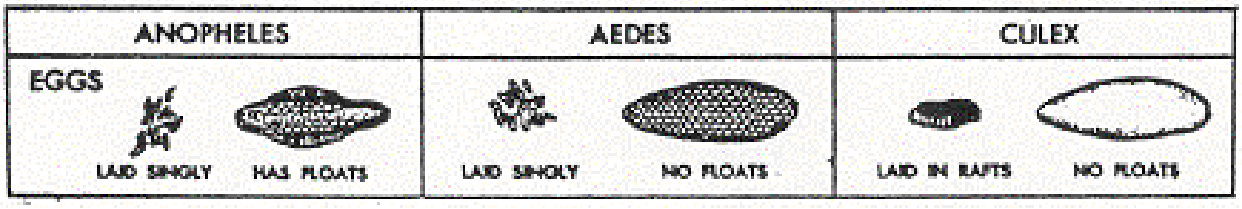

Figure 1-8. Examples of how mosquito eggs are laid.

e. The eggs incubate for several days and then hatch into larvae or "wrigglers." The time required for an egg to hatch varies within each genus of mosquitoes.

f. The larva molt (shed the skin and grow) four times, the last molting resulting in the pupa. The total larval period usually takes about seven days, depending upon temperature and species of mosquito. The pupa, or "tumbler," is remarkably active.

They react to slight disturbances of the water by tumbling to deeper water and, after a few moments, rising to the surface with little or no effort.

g. When the adult is ready to emerge from the pupa, the skin of the pupa splits along the upper surface and the adult pulls itself up and out of the floating skin on which it then rests until ready to fly. Both the male and female adult mosquitoes can feed on flower and plant juices, but the females of most species suck blood and attack humans and other animals. The adult mosquitoes exhibit a great variety of habits and capabilities with respect to flight range, biting preferences, disease transmission, and abundance.

h. Three common genera of mosquitoes that transmit disease are Anopheles, Aedes, and Culex, each of which consists of many species.

(1) The Anopheles will breed in almost any type of water, but prefer vegetated, permanent pools. The larvae lie parallel to the surface of the water, while the adults rest and feed with the body at an angle of 45° to the surface on which they are resting (see figure 1-9). Anopheles mosquitoes bite primarily during the period from dusk to dawn. They may bite during the daylight hours in an area that is heavily shaded or in a room that is dark. About 80 of the 350 species of Anopheles mosquitoes transmit malaria. A very common mosquito in the southern part of the US is Anopheles quadr imaculatus that was a very important malaria vector in the US before the 1940's. Although this species is still present in the US, it is only a potential vector because the human reservoirs no longer occur in this country.

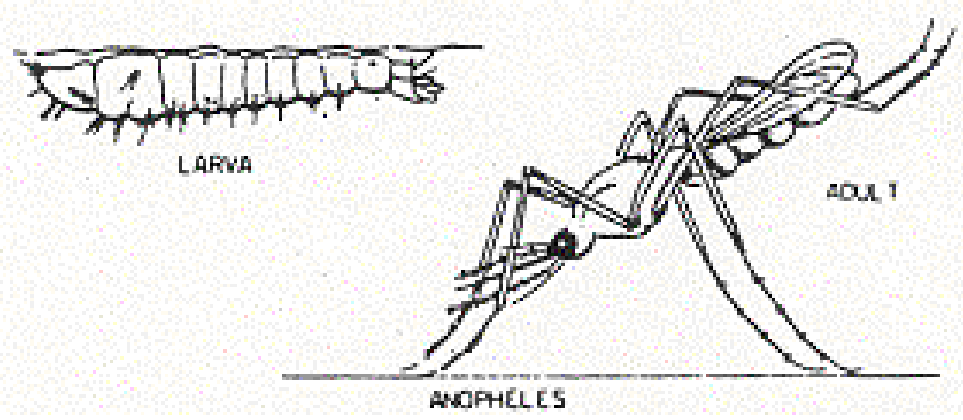

Figure 1-9. Typical resting positions of Anopheles mosquitoes in their larval and adult stages.

(2) Aedes mosquitoes are one of the most important vectors of disease; based on the variety of diseases they can transmit. They breed in temporary water that may be fresh, stagnant, or brackish. Aedes aegvpti, the yellow fever mosquito, larvae can be commonly found in discarded tires, tin cans, flower vases, and other artificial containers. The larvae are equipped with an air tube or siphon, and when they are

breathing, hang at a 45°angle below the surface of the water. The adult mosquitoes rest and feed with their bodies parallel to the surface (see figure 1-10). Some species such as Aedes aegypti bite during daylight hours and rarely come to light traps. Others bite any time of day or night, depending on the species.

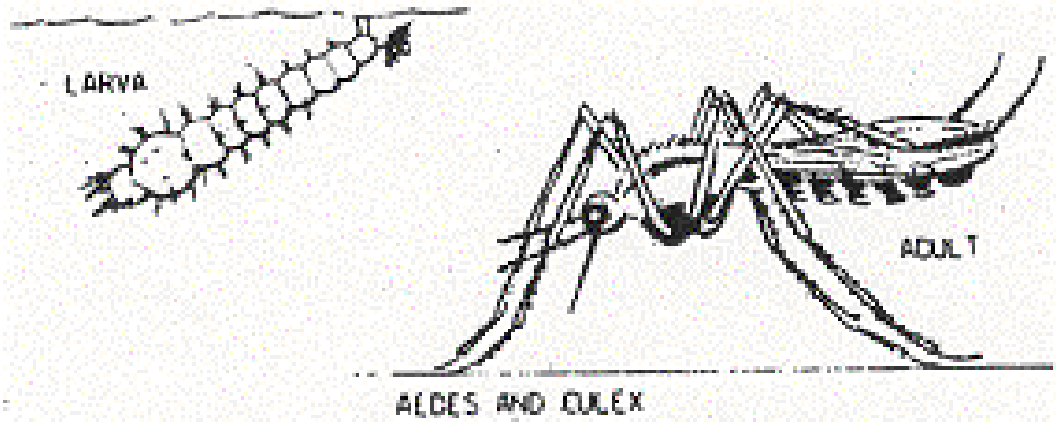

Figure 1-10. Typical resting positions of the Aedes and Culex mosquitoes in their larval and adult stages.

(3) Culex mosquitoes breed in fresh or stagnant water around buildings as well as in swamps, ditches, street gutters, cesspools, and almost 4 any other place that holds water. The larvae hang at a 45° angle in the water; and the adults rest and feed parallel to the surface, like the Aedes (see figure 1-10). Culex mosquitoes, depending upon the species, may bite at any time of the day or night.

1-6. LICE

Lice are in the order Anoplura. The most important member of this group is the human body louse, which many people feel has had a more profound effect on our history than any other insect. Lice thrive during hard times, when sanitary conditions are poorest, and human populations are homeless and dislocated. For this reason these insects have always been associated with wars. Entire wars have been lost because of casualties due to louse-borne epidemic typhus. Three species of lice are of medical importance to humans: the body louse, the head louse, and the crab louse. The body louse and head louse have overlapping structural characteristics that make them difficult to identify. However, they can be distinguished based on their habits and where you find them. The scientific names of these two species have a third name, the subspecies, because of their extremely close relationship. All lice have gradual metamorphosis. Developmental stages include the egg, three nymphal stages, and the adult (see figure 1-11).

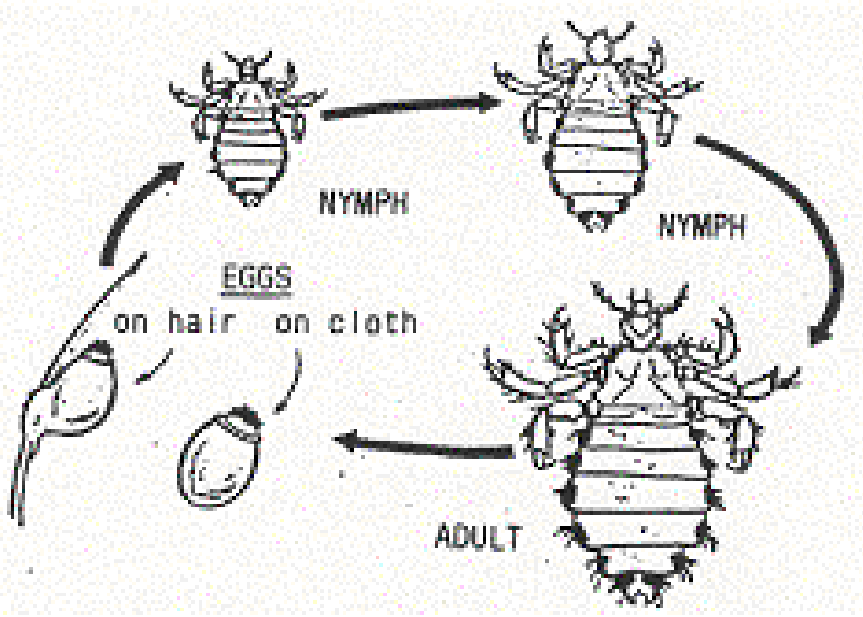

Figure 1-11. Life cycle of the louse.

a. **The Body Louse, Pediculus humanus humanus.** The body louse (see figure 1-12) is the common clothing louse and is the vector of epidemic louse-borne typhus, as well as epidemic relapsing fever. In World War I, soldiers referred to the body louse as a "cootie" or "grayback." Body lice are most common where the clothes are in close contact with the body. Eggs are laid in the seams of clothing where it comes in close contact with the body, for example, underwear, the crotch of the trousers, the waistline, etc. Depending on where the eggs are laid, incubation of eggs requires 5 to 10 or more days. After hatching, the young lice start to suck blood at once; throughout their development, they feed frequently, particularly at times when the host is quiet. The total development time averages about 3 weeks, from egg to adult. At maturity, the female begins to lay from four to as many as 10 eggs per day. She can live from 20 to 30 days, and can lay up to 300 eggs in her lifetime. Body lice thrive best in areas of the world where heavy to moderately heavy clothing is worn. Of the three species of human lice, body lice survive the longest away from the host (up to 10 days), and are the most active. They are well known to leave a feverish host or one that has grown cold in death. It is easy to see why they are a problem in times of war.

b. **The Head Louse, Pediculus humanus capitis.** This species is generally restricted to the head, where it commonly concentrates around the ears and at the base of the hair line near the neck. The head louse is similar in appearance to body louse (see figure 1-12), but is smaller. It is apparently of no importance in the spread of disease. In severe infestations, the hair may become matted with eggs and exudates from the pustules that originate from the louse bite. The female cements her eggs to the base of the hair, near the scalp. The cement is very persistent, and cannot be dissolved without harming the hair or the scalp. The empty eggshell thus remains in the hair long after the young louse has emerged, and does indicate an active infestation. Eggs have an incubation period of about 8 to 9 days, for a total development period of

approximately 16 to 18 days. Mature females normally live for 3 to 4 weeks, laying approximately four eggs per day. Crowded conditions, close contact, or sharing hats, combs, and so forth, can aid in the development of infestations.

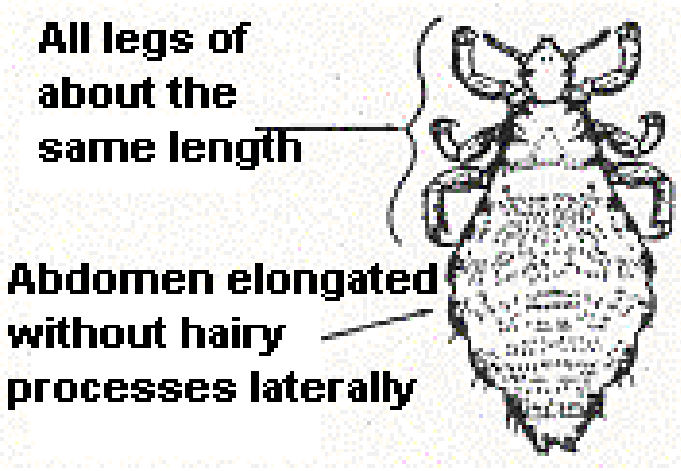

Figure 1-12. Body louse and head louse

c. **The Crab Louse, <u>Pthirus pubis</u>.** The crab louse (see figure 1-13), also called the pubic louse, is recognized by its crablike appearance. Mainly, it infests the pubic (groin) region. It also infests the armpits and, more rarely, the parts of the body such as the eyebrows and moustache. The crab louse is not known to transmit disease but can have a serious affect on morale. The female louse deposits her eggs on the coarser hair of the body where the lice occur. The number of eggs per female is usually quite small, usually not more than thirty. The incubation period is from 7 to 10 days and it takes about 15 days for the nymph to reach the adult stage. The total life cycle requires about 30 days.

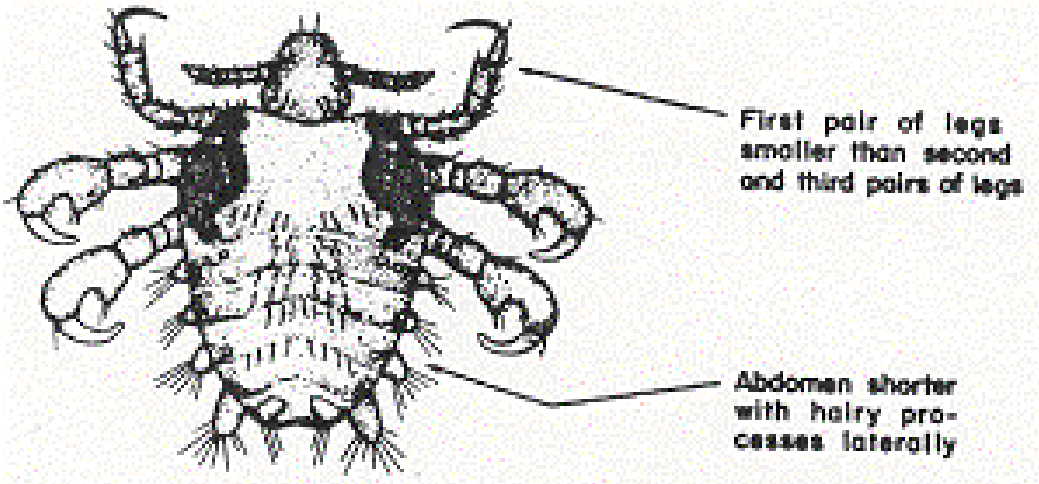

Figure 1-13. Crab louse.

1-7. FLEAS

a. Fleas (order Siphonaptera) are small insects flattened from side to side, usually dark in color, generally possessing many stiff bristles (see figure 1-14). Their legs are well developed and the hind legs are especially strong. Fleas are excellent jumpers and some species are able to jump 50 times their length. Flea eggs drop off the host and fall amongst debris on the ground. The active, immature stage is a maggot like, legless larvae (see figure 1-15). The larvae do not live on the animal but in the nest of the host in the yard or wherever the host is found. In buildings with pets, flea larvae thrive particularly well in carpets where they feed on organic debris such as dried blood, cast skins, or excreta. Larvae undergo three molts during development, and the entire larval period is frequently as short as 2 to 3 weeks. The larva spin silken cocoons just prior to pupation and camouflages them with bits of debris. Here the pupae develop into adults during a resting period that varies in length from a few days to a year or more. Adults are normally long lived and feed on a wide variety of animals including humans.

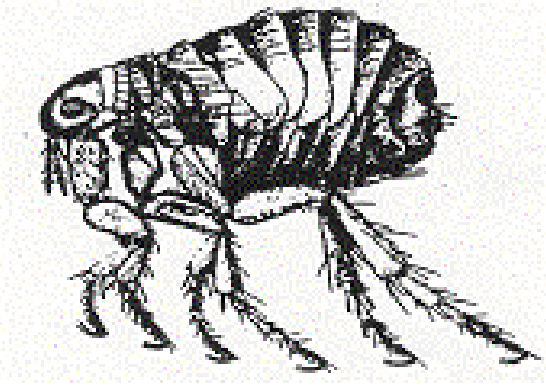

Figure 1-14. Adult Flea

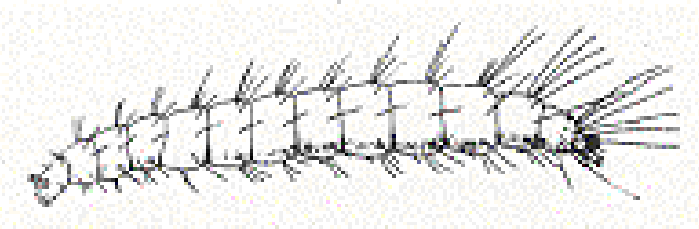

Figure 1-15. Flea larva.

b. Fleas are active biters and proven vectors of human disease. The oriental rat flea, Xenopsylla cheopis, is the most important vector of bubonic plague and murine typhus. Other species of fleas associated with rodent hosts may also be vectors of plague in human, but are not considered as important as Xenopsylla cheopis. There are approximately 1,500 species of fleas. Besides being vectors of disease, fleas can be very annoying and their bite may produce extreme itching and dermatitis in sensitive individuals.

1-8. FLIES

Flies (order Diptera) are found allover the world, but they are most abundant in warm, humid climates. Houseflies, which comprise the majority of all flies, found in homes and food service facilities are the most important of the nonbiting species in the transmission of diseases. These and other filth flies spread disease "mechanically;" that is; they land on a contaminated site (that is, pathogen-containing feces), get pathogens stuck to various body parts, and then contaminate our food when they land on it to feed. The medical history of past wars indicates that the health of troops has been seriously affected by flies. They carry the organisms that cause dysentery and may carry those which cause cholera, typhoid, and other diseases. In the tropics, various skin and eye diseases may be spread by flies. These include such serious diseases as yaws and trachoma. All flies have complete metamorphosis with four distinct stages in their life cycle: eggs, larvae, pupae, and adults (see figure 1-16).

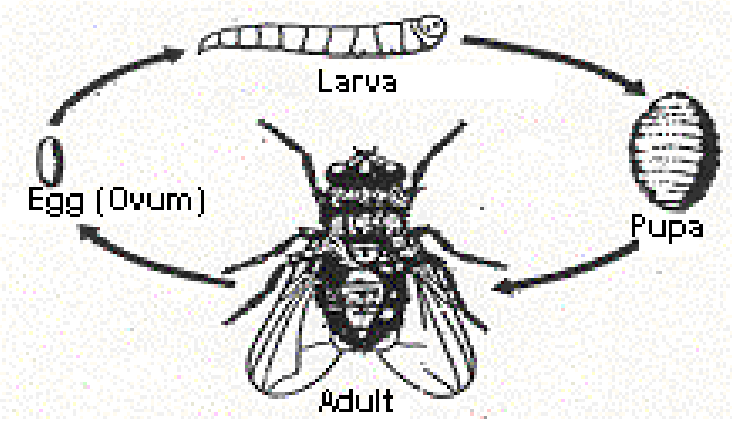

Figure 1-16. Life cycle of the common housefly.

a. **The Housefly, <u>Musca domestica</u>**. The housefly is known in all areas of the world and is the most widely distributed insect of importance to humans. In general, the housefly is gray in color and the thorax has four broad, dark stripes running longitudinally (see figure 1-17). The mouthparts are the sponging type and are adapted for taking up liquefied food (see figure 1-18). The adult female lays her eggs in garbage, pit latrines, animal manure, spilled animal feed, and soil contaminated with organic matter. Houseflies are very prolific; the female lays several masses of eggs. The eggs hatch in less than 24 hours under ideal environmental conditions. The maggots are white and about one-half inch long when mature. This is the larval stage, which lasts from 3 to 24 days depending on temperature. In warm weather, this stage develops rapidly in 3 to 7 days. When the full-grown larvae are ready to pupate, they move out of the breeding site into dry soil. The pupal stage lasts from 3 to 5 days, depending upon the temperature. When the pupal stage is completed, the adult emerges from the pupal case, works its way to the surface of the ground, and after its exoskeleton dries and hardens, flies away to feed. Mating may take place a day or two following emergence from the pupal case.

Figure 17. Adult housefly.

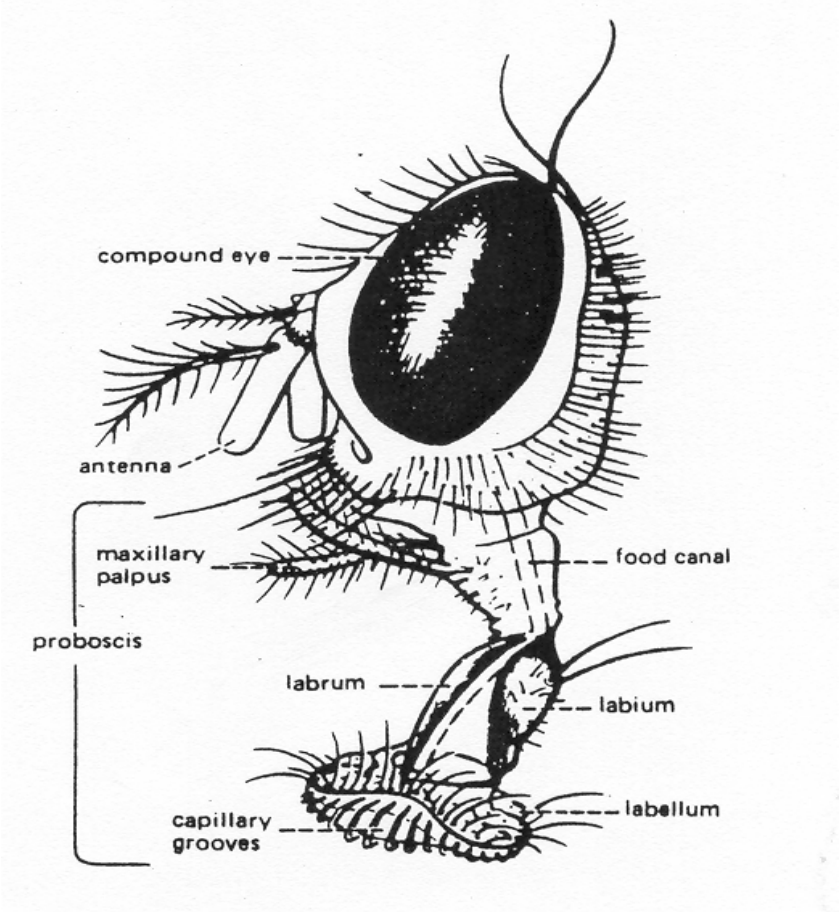

Figure 1-18. Housefly mouthparts.

b. **Blowflies (Family Calliphoridae)**. These flies are related to the housefly and have essentially the same potential for mechanically transmitting disease, as do houseflies. The life cycle is similar to that of the housefly. Blowflies may be identified by their large size and shiny blue, green, or black abdomen. Shiny, green flies in this family are about housefly-size. Various species of these files breed in animal

carcasses, meat scraps, and decaying vegetable matter. Adults are strong fliers and are attracted to ovipositor (egg laying) sites from long distances.'

c. **Sand Flies (Phlebotomines)**. Sand flies are small (about 1/3 the size of mosquitoes), flies that move in short, hopping flights unlike those of mosquitoes or other f lies. The bloodsucking sand flies are uncommon in northern areas, but are common in many subtropical and tropical areas throughout the world. They transmit several diseases including leishmaniasis (South America, Northern Africa, Southern Asia), sand fly fever (Mediterranean region and Southern Asia), and Oroya fever (South America). Sand flies are small-bodied flies, seldom larger than five millimeters (rrm) in length. The wings and body are densely covered with hair (see figure 1-19). The antennae are long and slender, consisting of 12 to 16 segments. The mouthparts of female phlebotomines (that is, Lutzomvia spp.) are long and are formed for bloodsucking. The female lays her eggs in caves, crevices, dry tree holes, stone embankments, crumbling ruins, earth fissures, and stony rubble. She may lay several batches, but requires a blood meal before each ovipositor. When the eggs hatch, four larval stages follow then pupation and adult emergence. The life cycle is completed in 1 to 4 months.

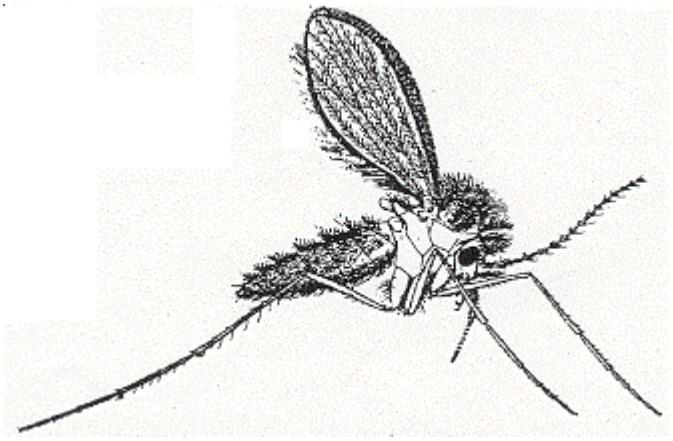

Figure 1-19. Adult sand fly.

d. **Blackflies (Family Simuliidae)**. Blackflies, or buffalo gnats, as they are sometimes called, are found throughout the temperate and tropical regions of the world. Blackflies transmit a chronic, nonfatal disease called onchocerciasis. They are also important as biting pests. Blackflies are small, black or gray flies 1 to 6 mm in length, with broad wings. The thorax has a characteristic "humped" appearance (see figure 1-20). The wings are relatively short, broad, and clear with only the anterior veins well developed. The antennae are short with beaded segments. The mouthparts are formed for bloodsucking. The female lays her eggs on plants or stones in fast moving streams. She may lay as many as 500 eggs at one ovipositor. These hatch in 4 to 12 days. The larvae attach themselves to stones or plants in the stream; pupation occurs after six molts and adults emerge from the pupal cases within 1 week.

Figure 1-20. Adult black fly.

e. **Punkies, Culicoides**. These flies are sometimes referred to as "no-see-ums" because of their small size. They are 1 to 4 mm long and occur in the tropics as well as in temperate zones. They are vicious biters. They mercilessly and persistently attack in large numbers. Sensitized persons have severe reactions and often must be hospitalized for treatment. These extremely small flies can pass through standard window screens and mosquito netting. The wings often have patterns of dark and light areas, which give the fly a speckled appearance. The first two veins are very heavy, while the others are somewhat indistinct. The mouthparts of female punkies are formed for piercing and sucking. The female lays as many as 100 eggs on damp sand or soil. These hatch in several days, and larval development takes place in water, wet marshy soil, decaying vegetation, or animal feces. The pupa, from which the adult emerges in several days, is formed following the fourth larval molt. The life cycle is illustrated in figure 1-21.

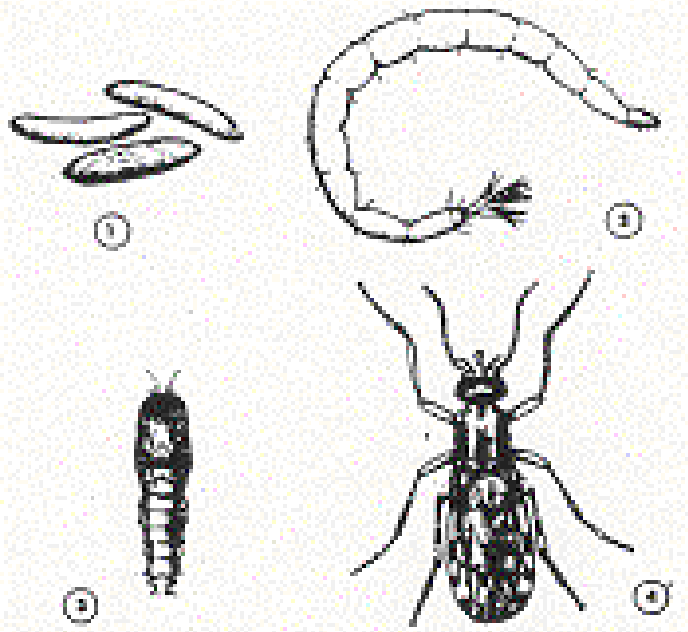

Figure 1-21. Life stages of Culicoides. (One, egg; two, larva; three, pupa; four, adult).

Section III. CLASS ARACHNIDA

1-9. TICKS

Ticks are found throughout the world, in tropic and temperate zones. They are divided into two groups: the soft ticks of the family Argasidae (100 species) and the hard ticks of the family Ixodiae (700 species). Hard ticks are capable of transmitting such diseases as tularemia, Rocky Mountain spotted fever, Lyme disease, Q fever, and tick-borne encephalitis. They can cause a direct injury resulting in a condition known as tick paralysis. The soft tick may transmit spirochetes that cause tick-borne relapsing fever. The tick gets spirochetes when ingesting the blood of an infected animal. The spirochetes then multiply within the body of the tick, invading the tissues and the body cavity of the tick. Spirochetes are transmitted to the tick's eggs by transovarian transmission, even to the third generation.

a. **Hard Ticks (Family Ixodidae)**. The mouthparts can be seen from above; therefore the hard tick has a shield on the back and (see figure 1-22). The life cycle of the hard-tick is a type of gradual metamorphosis, consisting of four stages: egg, larva (not worm-like), nymph, and adult (see figure 1-23). The completion of this life cycle may take from 6 weeks to 2 years. All stages past the egg feed on the blood of vertebrates, mostly mammals. The female becomes greatly distended while feeding, a period of usually 5 to 10 days. Copulation takes place on the host while the female is feeding. After copulation, the female takes more blood, drops to the ground, finds a sheltered place, and in a few days deposits a gelatinous mass of eggs that may number into the thousands. This oviposition may take several days, after which the female dies. Under favorable conditions, the eggs hatch in about a month; but during cold weather, they may not hatch for several months. Some days after hatching, the six-legged larvae (also called "seed ticks") climb weeds, stems, or twigs or walk over the ground to find a suitable host such as a small mammal. They engorge on the blood of the host, drop to the ground, and molt into the nymphal stage. The nymph then awaits an animal, feeds, drops to the ground, and molts into the adult which then repeats the cycle.

Figure 1-22. Adult hard tick.

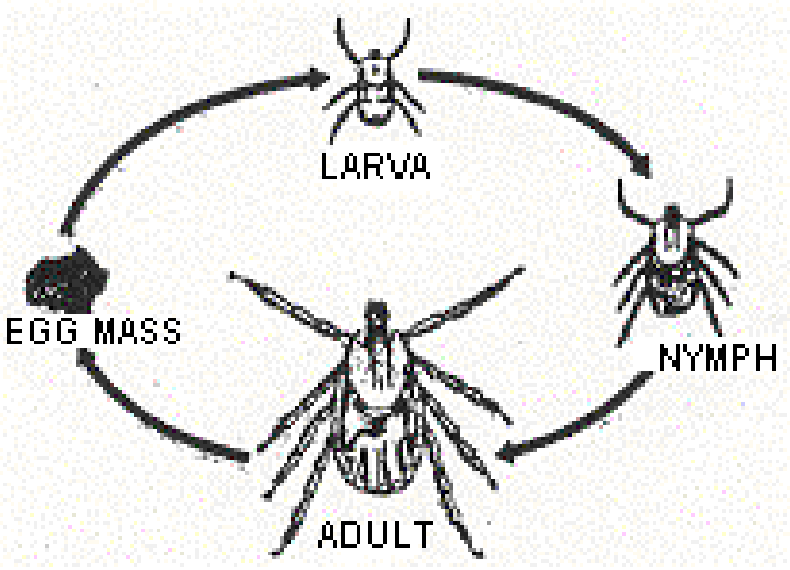

Figure 1-23. Life cycle of the tick.
(NOTE: The larval stage has six legs.)

b. **Soft Ticks (Family Argasidae)**. The soft ticks are round or oval and lack a shield on the back; their skin is leathery, wrinkled, and tough. In adults, the mouthparts are not visible from above (see figure 1-24). Their development is similar to hard ticks but they may have two to several larval and nymphal stages. Soft ticks are secretive in their habits, feeding at night and concealing themselves during the day in crevices or cracks near the nest or roost of the host. The female feeds and lays eggs alternately over a relatively long period. Thus, a single soft tick may feed, on several different hosts during one lifetime, which sharply increases its disease-carrying potential. Many soft ticks feed on birds and reptiles, although others prefer mammals as a host.

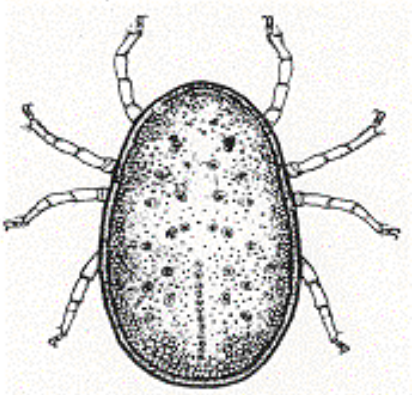

Figure 1-24. Soft tick.

1-10. MITES

Mites are minute animals. Most species are barely visible to the naked eye. They are found virtually worldwide. There are over 29,000 species of mites, but only a few of them attack humans. They are medically important because certain species transmit scrub typhus (southwest Pacific and the Orient). In attacking a person, various species of mites cause conditions ranging from mi Id irritation to severe forms of dermatitis.

a. **The Human Itch Mite, Sarcoptes scabiei**. This mite (see figure 1-25) causes a disease of the skin known as scabies or the "seven year itch." The life-cycle consists of egg, larva, nymph, and adult, with the female undergoing two nymphal stages. The mature female burrows into a person's skin, particularly at the hands and wrists, and other areas of the body where the skin creases or folds. As she burrows, she deposits eggs at a rate of about two per day. Egg laying continues for about 4 to 5 weeks, and a single female lays an average of 40 to 50 eggs. Eggs generally hatch in 3 to 4 days, and the larvae migrate from the maternal burrow to form new burrows nearby. After about 3 days, larvae molt in the burrows to become nymphs. Total development time for females averages 14 to 17 days. After reaching maturity, mating occurs either in the burrows of virgin females or on the surface of the skin after which the fertilized female repeats the process of burrowing and egg laying.

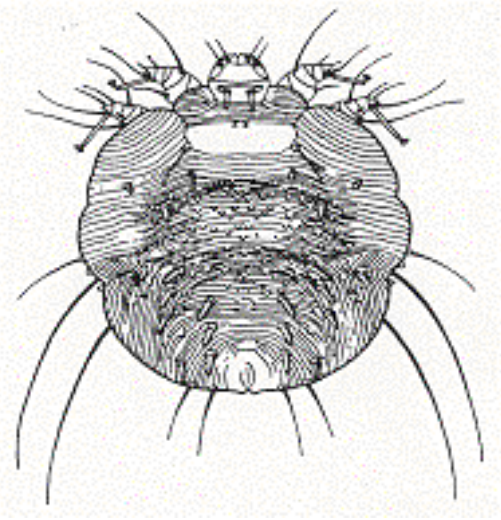

Figure 1-25. Adult human itch mite.

b. **Chiggers (Trombiculid Mites)**. This is the common chigger or "red bug." Its bite causes an intense itching and infection can result from scratching the bites. In the Asiatic-Pacific area, certain species of this mite are vectors of scrub typhus. The life cycle of the trombiculid mite is very complex. Females lay eggs singly in the soil. In about 2 weeks, the six-legged larva hatches and crawls into nearby vegetation or along the ground in search of a host. Many species feed on a wide variety of vertebrate hosts including reptiles, rodents, large mammals, and humans. The larva feeds at the surface of the host skin, usually requiring 1 to 3 or more days for engorgement. Then the fully

fed larva drops off the host, burrows into soil, and molts to an eight-legged nymph. The nymph and later the adult feed on immature stages of other arthropods, frequently the eggs of grasshoppers. Chigger larvae, the only medically important stage, do not disperse far from the point they hatched in their search for a host. Thus, they tend to be much clumped in distribution, forming what are referred to as "chigger islands," in areas of tall grass, weeds, and brushy vegetation.

1-11. SCORPIONS

Scorpions are most commonly found in warm climates. They prefer damp locations and are particularly active at night. Although all the scorpions found in the United States are capable of inflicting painful stings, the stings are seldom fatal. However, in the Middle East, South America, Mexico and some parts of North Africa, the stings of certain species can be fatal. Scorpions are recognizable by their crablike foreparts and their long, fleshy, six-segmented tail that ends in a sharp spine or stinger (see figure 1-26). Their diet consists of insects, spiders, millipedes, and other small animals. They seize their prey with their pincers and mouthparts and strike with the stinger, which is thrust forward, in a characteristic fashion, over the scorpion's head. Scorpions have four pairs of legs and one pair of large claws or pedipalps. The body has two divisions: the anterior, unsegmented cephalothorax; and the posterior, segmented abdomen. The last six abdominal segments form the "tail." The last segment is modified to form a hooked stinger. Adult scorpions vary in length from less than an inch to almost 8 inches. Colors vary from nearly black to straw-color and some are striped. Most scorpions have smooth bodies, though some are hairy. Scorpions bear their young alive. When the young are born, they attach themselves to their mother's body, and they are carried around for some time.

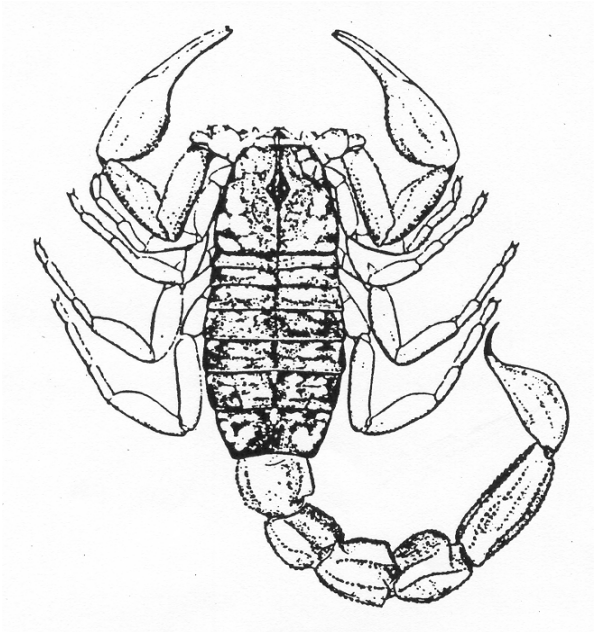

Figure 1-26. Scorpion.'

1-12. SPIDERS

Spiders are cosmopolitan in distribution, but the majority is found in the temperate and tropical zones. Many spiders use their venom to paralyze their prey. Although their venom is sufficient for this purpose, humans are not affected seriously by most spiders. Very few spiders have mouthparts that can penetrate the skin of a person; most of those that do have venom that can produce only local symptoms or an occasional allergic reaction. Spiders have eight legs, no wings, and no antennae. They have an unsegmented abdomen attached to the cephalothorax by a short pedicel or stalk. The eyes are simple, vary in number, and are grouped together or separated across the head. After hatching from eggs, immature spiderlings pass through several molts before reaching sexual maturity. The life span of individual spiders varies with such factors as food supply, natural enemies, temperature, and humidity. Two common poisonous spiders of North America are the black widow and the brown recluse.

a. **Black Widow Spider, <u>Lactrodectus</u> <u>mactans</u>**. The black widow spider is known to occur in virtually every state in the US, with the exception of Alaska.

(1) The adult female is glossy black to dark brown. In the US, it is usually completely black dorsally, although an irregular red (rarely white) stripe or pattern is sometimes present. The characteristic crimson hourglass marking on the underside of the abdomen (rarely, altogether absent) varies among individual spiders from the distinct hourglass marking (see figure 1-27) to a design comprising two or more distinct triangles or blotches, or sometimes only an irregular longitudinal area. The abdomen is globe-shaped. The average width of the abdomen is 6 mm, and the overall length of the female spider is about 40 mm. The abdomen of the gravid female often measures 9 to 13 mm.

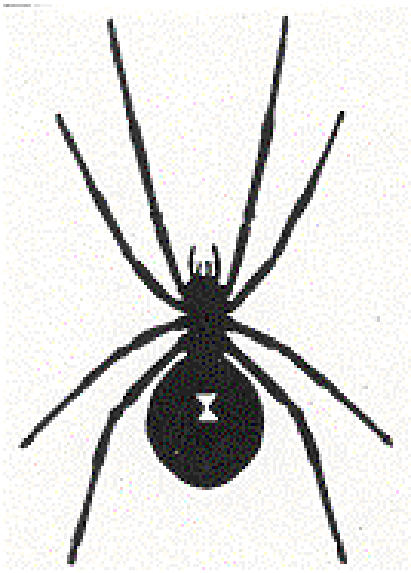

Figure 1-27. Black widow spider showing hourglass marking on center of the abdomen.

(2) During her lifetime, the female black widow produces several round, cream-white egg sacs with an average of some 200 eggs within each. These sacs are attached to the spider's web. The eggs hatch In 2 to 4 weeks into tiny, active, young spiders. The eggs are usually laid during the summer and the young reach maturity the following spring. These spiders are found on the undersides of outhouse seats, in piles of lumber and trash, and in empty cans and buckets. They are frequently found beneath houses and in storerooms and garages. The web is recognized as it is usually extremely irregular, very loosely woven, and has a ragged appearance. In addition, the tube into which the female retires is not in plain view. Black widows live in dark areas and generally avoid light. Their normal food is insects and they are usually not aggressive, unless they are agitated or hungry. When guarding her egg sac, the female is particularly prone to bite.

(3) The bite of the female black widow spider is not always felt, and often there is little visual evidence except for slight swelling and two tiny red spots at the bite site. Clinical cases are characterized by severe muscular pain, a rigid abdomen, tightness in the chest, and difficulty in breathing that may (in 6 to 6 percent of untreated cases) result in death. Although very young children or the very aged are the most susceptible to black widow spider venom, they are rarely bitten. Bites in the genital area and buttocks have commonly occurred while using outhouses. The majority of deaths have occurred among migrant workers in the California vegetable fields. The male black widow spider has very little venom and the mouthparts are not sufficiently strong to penetrate the skin of people.

b. **Brown Recluse Spider, <u>Loxosceles reclusa</u>**. See figure 1-2. The brown recluse spider is found in South, Central, and North America.

(1) This spider is of medium size, with body measuring about 7 to 10 mm long and about 3 to 6 mm across. The body color varies from light fawn to dark brown. The most distinguishing characteristics are the dark fiddle-shaped mark on the anterior portion of the cephalothorax and six eyes in three pairs. The young resemble the adults. There are eight molts in the development to the adult stage; sometimes this development takes as long as 200 days. Indoors, these spiders are commonly found in houses and associated buildings, boiler houses, schools, churches, libraries, stores, and other such buildings. In outdoor locations, it has been found beneath flat rocks, under loose bark, in crevices of old decaying logs, and in trash piles.

(2) Experiments with the venom of the brown recluse spider have shown that both sexes are capable of inflicting poisonous bites to mammals. This is unlike the black widow in which only the female is dangerous to humans. The symptoms following a bite by the brown recluse are quite unlike the typical symptoms of the black widow bite. Following a bite by the brown recluse, the typical reaction in humans is necrosis (killed tissue) at the site of the bite. The victim may not be aware of being bitten for 2 or 3 hours, or a painful reaction may occur immediately. A stinging sensation is usually followed by intense pain. A small blister usually rises and a large area around the bite becomes inflamed and swollen. The patient may become restless, feverish, and have

difficulty in sleeping. The local pain is frequently quite intense and the area surrounding the bite remains scabbed and hard to the touch for some time. The tissue affected locally by the venom is killed and gradually sloughs away, exposing the underlying muscles. The edges of the wound thicken and are raised while the central area is filled by dense scar tissue. Healing takes place quite slowly and may take 6 to 8 weeks. The result is a sunken scar that has been described as resembling a hole punched or scooped from the body. Scars ranging from the size of a penny to half-dollar have been reported. The necrotic condition described above is typical of all bites of the brown recluse. However, in some cases a general systemic reaction has also occurred. In one case, the patient broke out with a rash resembling that of scarlet fever. In another case, the kidneys were apparently affected causing bloody urine to be passed. These systemic disturbances probably occur infrequently and are the result of a "full" bite (that is, the injection of a maximum amount of venom) or extreme sensitivity to the venom. This general reaction to the bite of the brown recluse is certainly a serious condition and hospitalization of the patient is usually required. Those in poor general physical condition, young children, and older people are more apt to be affected seriously by the bite of the brown recluse.

Section IV. CLASSES CHILOPODA AND DIPLOPODA

1-13. CENTIPEDES (CHILOPODA)

a. Centipedes are found mostly in the tropical, subtropical, and warm-temperate regions of the world. They are all-predaceous and possess well-developed poison glands for killing their prey. The venom of centipedes is considered to be weak, and is not fatal to humans. The poison glands are at the base of the first pair of legs, which arch forward to function with the mouth parts. These legs end in pointed claws, which have outlets for the poison glands. Most centipedes are harmless since only a small number have fangs large enough to penetrate human skin.

b. Centipedes are flattened dorso ventrally. The body is made up of a distinct head and 15 to 170 or segments that are more similar. Each segment has one pair of tracheal openings and one pair of legs with six or seven joints (see figure 1-4). The head has a pair of extremely long, many-jointed antennae and a pair of strong mandibles. Adults of several species have shining greenish or blackish bodies and orange or red legs and heads. Some are yellowish with dull red, longitudinal bands. The young resemble the adults, having approximately the same number of segments.

1-14. MILLIPEDES (DIPLOPODA)

a. Millipedes affect humans primarily because of their "stink" glands, which are present in the majority of the species. These glands secrete a liquid, which may produce a vesicular contact dermatitis in humans. During World War II, millipedes were a continuous source of annoyance during the invasion of some of the western Caroline

Islands; the troops, in crawling over the ground, came in contact with the glandular fluids of these pests. Certain species of millipedes squirt their irritating fluids a distance of several inches.

b. The members of this class are characterized by their long cylindrical bodies of many segments with two pairs of legs and two spiracles for each of the body segments (see figure 1-5). Some are brightly colored whereas others are black.

c. Millipedes prefer a dark, moist, terrestrial habitat such as is found under rotting logs, leaves, or beneath stones. On certain of the tropical Pacific Islands, millipedes have been observed crawling on low-lying bushes.

Section V. CLASS CRUSTACEA

1-15. GENERAL

Crustacea is a class containing a large number of species, most of which are marine. The oceans are teeming with these animals which are said to occur at all depths wherever animals live. Medical significance of the group is minor because relatively few species cause injury to humans; the few species that do affect people serve as intermediate hosts of human parasites. Humans become infected by drinking water that has not been properly treated and which contains parasitized crustaceans. Eating fresh-water crustaceans (crayfish and crabs, for example) that are raw or insufficiently cooked may also produce an infection in the consumer.

1-16. RECOGNITION, CHARACTERISTICS, AND BIOLOGY

Crustaceans have a compact, rigid anterior body region and usually have a visible segmented posterior region (see figure 1-6). Two pairs of antennae occur anteriorly and three pairs of segmented appendages comprise the mouthparts. All body segments may bear a pair of jointed appendages. Some species add segments as they grow, and they may have 70 or more pairs of legs. All have closed respiratory systems with gills. For examples of different kinds of crustaceans, see figure 1-6 and figure 2-2, A Standard Identification Key to Common Classes and Orders of Arthropods of Public Health Importance.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS. Answer the following exercises by marking the lettered response that best answers the question, by completing the incomplete statement, or by writing the answer in the space provided at the end of the question.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Ticks are medically important because they transmit:

   a. Scrub typhus.

   b. Rocky Mountain spotted fever.

.

   c. Yaws.

l

   d. Trachoma.

2. Which of the following transmit disease mechanically?

   a. Lice.

   b. Fleas.

   c. Ticks.

   d. Flies.

3. Mosquitoes have four distinct stages in their life cycle. In the order that they occur are:

   a. Egg, larva, pupa, and, adult.

   b. Egg, larva, nymph, and adult.

   c. Egg, pupa, larva, and adult.

   d. Egg, nymph, larva, and adult.

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'

4. Anopheles and Culex eggs are laid:

   a. On damp or loose soil.

   b. On debris on the ground.

   c. On the water.

   d. In garbage, pit latrines, and animal manure.

5. Match the following arthropods to their scientific names.

____Black widow spider	a. Aedes aegypti.
____Head louse	b. Pediculus humanus bumanus.
____Human itch mite	c. Xenopsylla cheopis.
____Brown recluse spider	d. Anopheles.
____Oriental rat flea	e. Musca domestica.
____Sand flies	f. Pediculus humanus capitis.
____Crab louse	g. Pthirus pubis.
____Housefly	h. Lutzomyia.spp.
____Mosquito transmitting malaria	i. Sarcoptes scabiei.
	j. Lactrodectus mactans.
____Mosquito transmitting yellow fever	k. Loxosceles reclusa.
____Body louse	

6. A type of dermatitis called scabies or the "seven year itch" is caused by the:

   a. Human itch bug.

   b. Itching tick.

   c. Human itch mite.

   d. Spelunking itch mite.

7. The primary vector of bubonic plague is:

   a. Aedes aegypti.

   b. Pediculus humanus Qumanus.

   c. Xenopsylla cheopis.

   d. Musca domestica.

8. In the event of an outbreak of epidemic louse-borne typhus, which louse would the environmental health technician look for and set about eliminating?

   a. Pediculus humanus capitis.

   b. Pediculus humanus humanus.

   c. Pthirus pubis.

9. During warm weather, the larval stage of the housefly develops in _____ days.

   a. 3-24.

   b. 3-14.

   c. 3-7.

   d. none of the above.

10. Both the male and the female mosquito suck blood and wiII attack humans and other animals.

    a. True.

    b. False.

11. After the tick has ingested the blood of an infected animal, spirochetes may be transmitted to the tick's eggs even to the third generation. This is known as:

    a. Transstadial transmission.

    b. Gonotropic association.

    c. Transovarian transmission.

    d. Congenital transmission.

12. Individuals who use outhouses should beware the most of:

    a. Black widow spiders.

    b. Mites.

    c. Ticks.

    d. Sand flies.

13. Which one of the following does not belong to the class Insecta?

    a. Spiders.

    b. Fleas.

    c. Mosquitoes.

    d. Lice.

14. _____ have "stink" glands that produce irritating fluids.

    a. Centipedes.

    b. Scorpions.

    c. Millipedes.

    d. None of the above.

15. Various species of these flies breed in animal carcasses, meat scraps, and decaying vegetable matter.

    a. Sand.

    b. Blow.

    c. House.

    d. Black.

16. The period of the day when Anopheles mosquitoes generally bite is:

    a. During daylight hours.

    b. Anytime during the day or night.

    c. From dusk to dawn.

17. The complete life cycle of the body louse averages about:

    a. Two weeks.

    b. Three weeks.

    c. Four weeks.

    d. Five weeks.

18. Body lice eggs are laid:

    a. At the base of hairs on the head.

    b. At the base of bodily hairs.

    c. In the seams of clothing.

    d. In masses in pockets of clothes.

19. Which of the following statements is true about the crab louse?

    a. It transmits louse-borne relapsing fever.

    b. It transmits louse-borne typhus fever.

    c. It transmits trench fever.

    d. It is not known to transmit any disease.

20. Only one feature is typical of all insects. Which one?

    a. Four pairs of legs.

    b. Wings.

    c. Three body regions.

    d. Cephalothorax.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. b (para 1-9).
2. d (para 1-8).
3. a (para 1-5c).
4. c (para 1-5d).
5. j (para 1-12a).
   f (para 1-6b).
   i (para 1-10a).
   k (para 1-12b).
   c (para 1-7b).
   h (para 1-8c).
   g (para 1-6c).
   e (para 1-8a).
   d (para 1-1b).
   a (para 1-5h(2)).
   b (para 1-6a).
6. c (para 1-10a).
7. c (para 1-7b).
8. b (para 1-6a).
9. c (para 1-8a).
10. b (para 1-59).
11. c (para 1-9).
12. a (para 1-12a(3).

13. a (para 1-2a and b).

14. c (para 1-2d).

15. b (para 1-8b).

16. c (para 1-5h(l)).

17. b (para 1-6a).

18. c (para 1-6a).

19. d (para 1-6c).

20. c (para 1-2a(1)).

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2	Arthropod Identification.
TEXT ASSIGNMENT	Paragraphs 2-1--2-3.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

2-1. Select the basic taxonomic structures used in the identification of medically important arthropods.

2-2. Properly identify arthropods using taxonomic keys.

2-3. Recognize the definition of taxonomy.

2-4. Recognize the appropriate taxonomic capability for a given preventive medicine situation.

SUGGESTIONS

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

Refer to illustrations and keys provided.

LESSON 2

ARTHROPOD IDENTIFICATION

2-1. GENERAL

a. As a preventive medicine specialist, you may someday be asked to recommend a method for controlling a certain type of arthropod. This request could come from a dining facility manager who has found “bugs” in his dining facility; or, it could come from a high level staff officer who is responsible for planning a field training exercise in an area that is known to abound with many different types of arthropods. There are many ways in which you may become involved with arthropods. The end result will usually be that of ‘recommending control measures for these arthropods or actually performing the control operation yourself.

b. Before any sound recommendations for control can be made, it is imperative that the arthropods involved be identified. The science of classification is known as taxonomy. The ultimate goal is to identify an arthropod specimen down to its genus and species. Trained specialists are able to identify to genus and species those arthropods that are important in transmitting disease. They do so by the same method that will be taught in this lesson. That method employs standard identification keys. These keys have been developed, after years of research and study, by entomologists to classify the arthropods into meaningful groups. One of your jobs as a preventive medicine specialist will be to use these keys to identify arthropod specimens.

2-2. USE OF CORRECT SCIENTIFIC TERMINOLOGY

a. It is important to use the scientific names of genus and species when referring to a particular arthropod. A species is a group of individuals that are all very similar in appearance and habits, and that naturally mate within their own kind but not with members of other species. The genus and species stays the same for a particular kind of insect regardless of where in the world it occurs or in which language it is written. However, common names often are different between countries and even in different parts of the same country. Ixodes dammini is the same species whether it is in the US or in Germany. This information could be important to a preventive medicine specialist whether serving overseas or in the US.

b. It is imperative that arthropods of medical importance be correctly identified before any control recommendations are made. In many situations without identification to the appropriate level, control action cannot be implemented. As an example, both Culex pipiens, which is the primary vector of St. Louis encephalitis, and Culex tarsalis, which is a primary vector of western equine encephalitis, occur in the central US. It is obvious that identification only to Culex is not sufficient information. If a preventive medicine specialist is doing a survey of mosquitoes in this area and identifies Culex pipiens as a species, which is increasing in abundance, then he knows under these circumstances that there is an increase in the risk of people being infected with

St. Louis encephalitis virus and control of Culex pipiens may be needed. Additionally, because habitat preferences can vary greatly even between species of the same genus, efficient control efforts must be based on proper pest identification. A preventive medicine specialist has to be able to use scientific names of medically important arthropods when reporting identifications.

c. Similarly, in writing a report the specialist should refer to the "proboscis" of the adult mosquito rather than to the common name "beak." In respect to usage of scientific terms for specific structural characteristics, accuracy and clarity are very important. Common terms such as head, thorax, and abdomen (the three major body segments of an insect) are acceptable; however, there are some characteristics for which there is a specific term. For example, only in arachnids are there found appendages called "pedipalps." This name implies the function of this appendage and there is no other suitable term to use.

d. As stated before, the ultimate goal is identification of an arthropod to genus and species. The genus is placed first and the species is second. The first letter of the genus is capitalized; the first letter of the species is not. Both words are underlined. Culex quinquefasciatus, for example, identifies one of the mosquitoes that is important in the transmission of a group of diseases known as arthropod-borne viral encephalitides.

2-3. STANDARD IDENTIFICATION KEYS

a. Standard identification keys are universally used to identify arthropods. These keys consist of a systematic arrangement of drawings and/or a brief description of specimens. Rather than having to look in a random fashion for a specimen resembling the one you are seeking to identify, you are able to make a series of choices that match with your specimen as you work through the key in an orderly manner until, by the process of elimination, you are able to establish the identity of your specimen.

b. Only by becoming familiar with a key can you learn to understand the way a key works. Figure 2-1 shows a pictorial key to classes and orders of adult arthropods of public health importance. Pictorial keys such as this, uses descriptive statements as captions to point out distinguishing characteristics in the pictures, but the pictures are the chief components that provide a means of quick identification. You work through a pictorial key by process of matching and eliminating. There may be one, two, three, or more figures in a set with which you can compare your specimen. When you reach the last figure in a hierarchical sequence, you look at the accompanying caption to identify your specimen. Assuming you have not made an error in matching, you will then have made a correct identification.

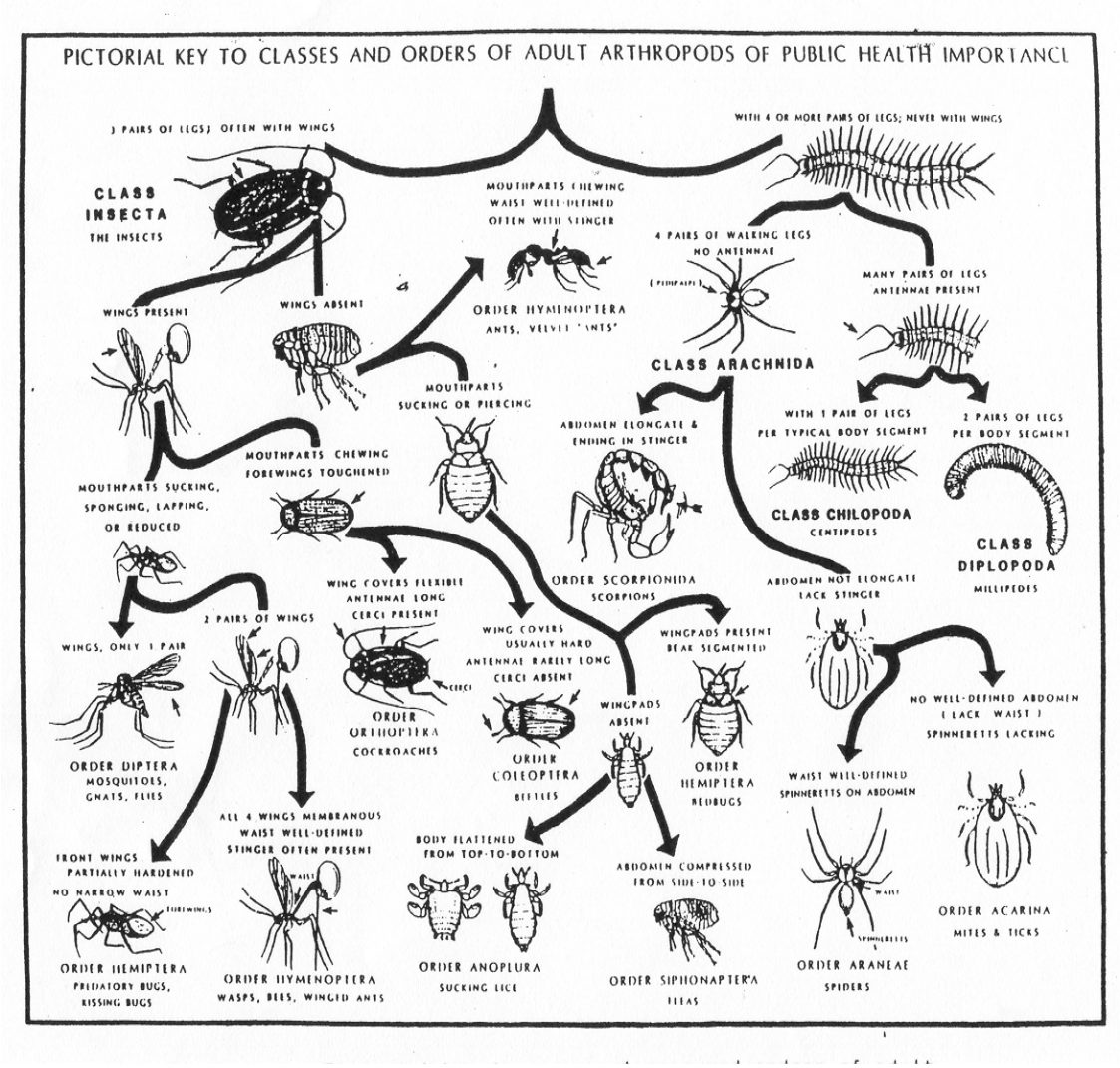


Figure 2-1. Pictorial key to common classes and orders of adult arthropods of public health importance.

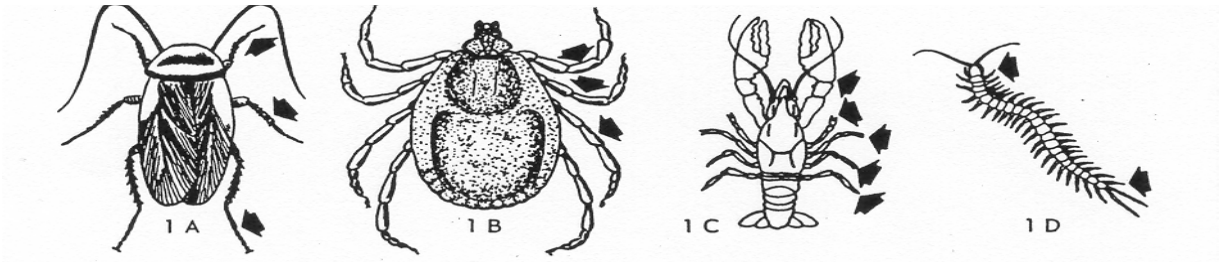
c. Another type of key is known as the couplet key, illustrated in figure 2-2, “Standard Identification Key to Common Classes and Orders of Arthropods of Public Health Importance.” It has pairs of descriptive statements against which you match the specimen you want to identify. In each pair, only one statement fits your specimen. You select the statement that describes your specimen and then look at the number in the right hand column. This number will direct you to the number of another pair of statements (not a page number) that may or may not be the next number in sequence. When you have developed enough information to permit identification, the statement will be followed by the name of the specimen. You have now determined what your specimen is. Remember that not all keys identify to genus or species levels. For example, the couplet key shown as figure 2-2 will identify class and order and sometimes familiar and common names for each. The couplet key is more likely to be used in basic reference works and in scientific papers. Its advantage lies in its relative completeness and its capacity for giving very detailed information in a systematic manner. For purposes of rapid identification in the field, the pictorial key is more useful

simply because there is less reading to do. There is more visual matching. The couplet key, on the other hand, provides descriptive statements that must be carefully read. Inexperienced personnel often find the pictorial key easier to work with, but both pictorial and couplet keys can be used alternately in the field, in the laboratory, or in the classroom.

d. The only way to become truly familiar and comfortable with standard identification keys is by using them. In this lesson, you have already seen examples of pictorial and couplet keys that will identify an unknown specimen to class and order. Additional pictorial keys are shown in Appendix A. Since much of the preventive medicine technician's work in entomology involves mosquitoes, these keys are limited to mosquito identification. The keys in Appendix A will enable the reader to identify larval or adult mosquitoes to genus level.

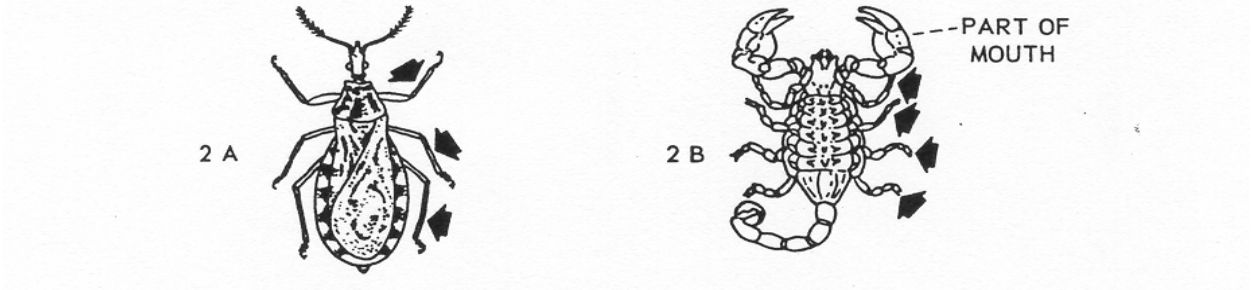
1. Three or 4 pairs of walking legs (1 A & B)……..2

   Five more pairs of walking legs (1 C & D)……33



2. Three pairs of legs walking (2 A)……..……..3

   Four pairs of walking legs (2 B)……25



3. Wings present, well developed (3 A)……4
   Wings absent or rudimentary (3 B & C)……13

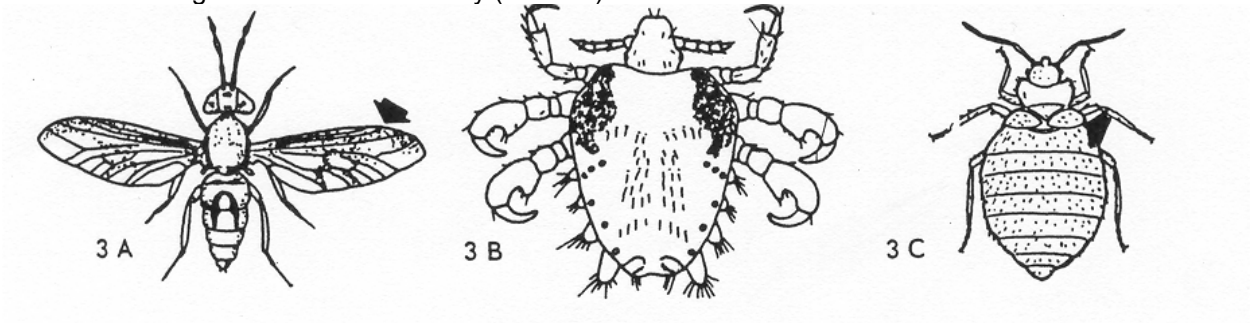
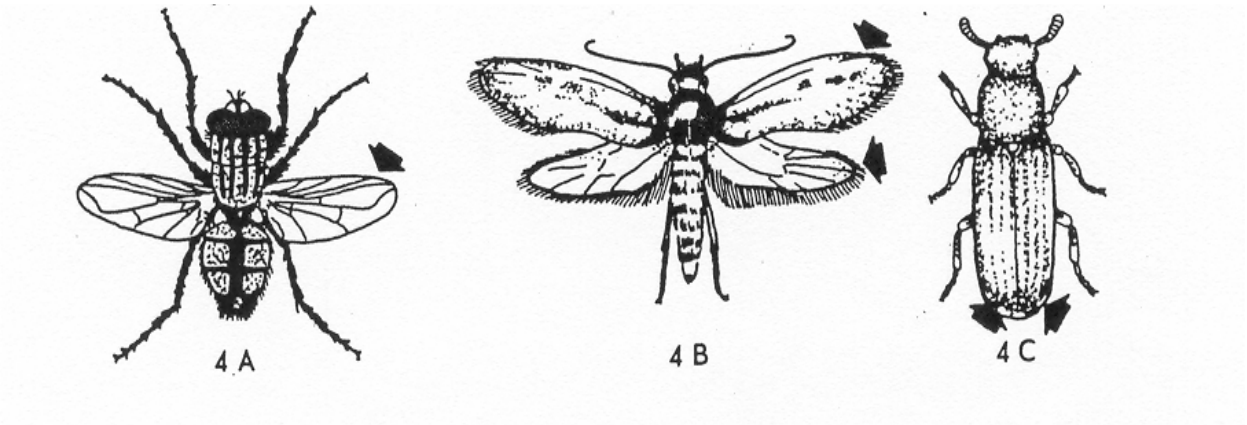


Figure 2-2. Standard identification key (continued)

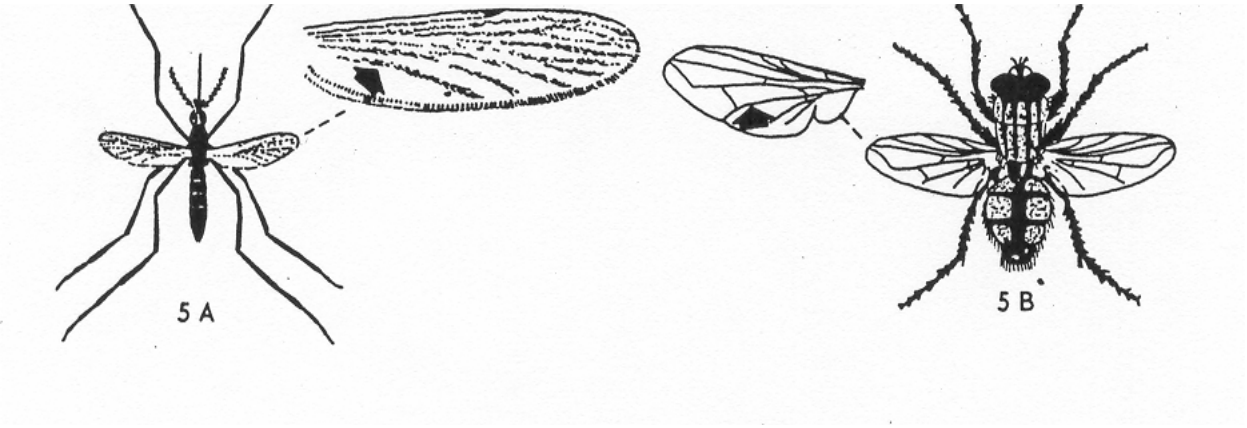
4. With one pair of membranous wings (4 A)……5

   With two pairs of wings (4 B & C)……6



5. Wings with scales (5 A). FAMILY CULICIDAE……..MOSQUITO

   Wings without scales (5 B). DIPTERA OTHER THAN MOSQUITOES……..FLY



6. Mouthparts adapted for sucking, with elongate proboscis (6 A)…….7

   Mouthparts adapted for chewing, without elongate proboscis (6 B)……..9

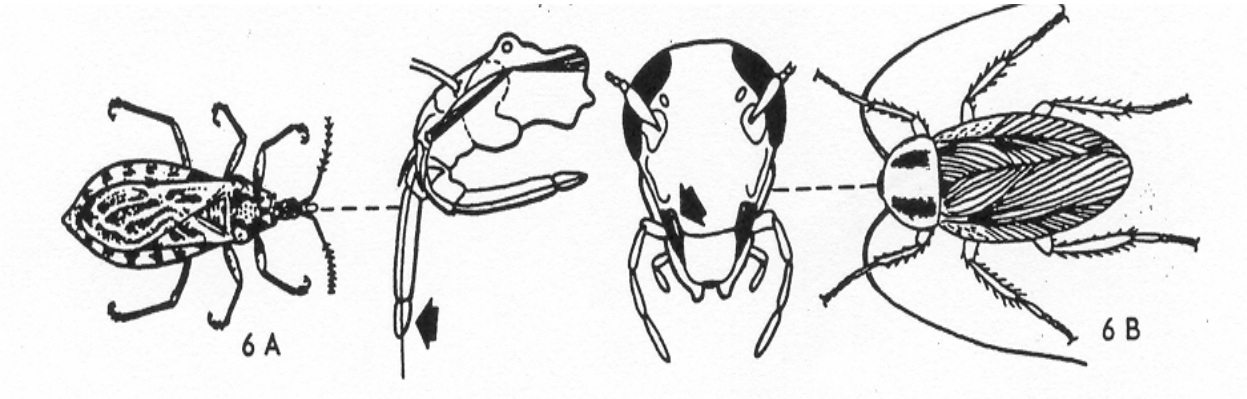
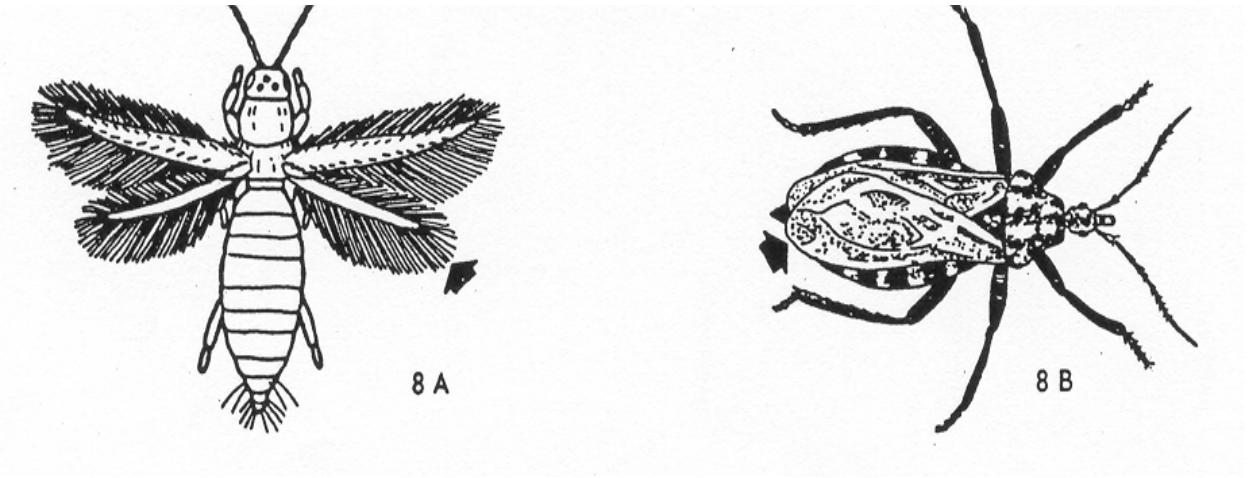


Figure 2-2. Standard identification key (continued)

7. Wings densely covered with scales; proboscis coiled (7 A). ORDER LEPIDOPTERA…..
……..…MOTH OR BUTTERFLY
Wings not covered with scales; proboscis not coiled (7 B)……..8

8. Wing with fringe of long hair (8 A). ORDER THYSANOPTERA……THRIPS

Wing without long hair (8 B). ORDER HEMIPTERA……...KISSING BUG



9. Both pair of wings membranous and similar in structure (9 a)……..10

Front pair of wings shell-like or leathery, serving as covers for the second pair (9 B)…..11

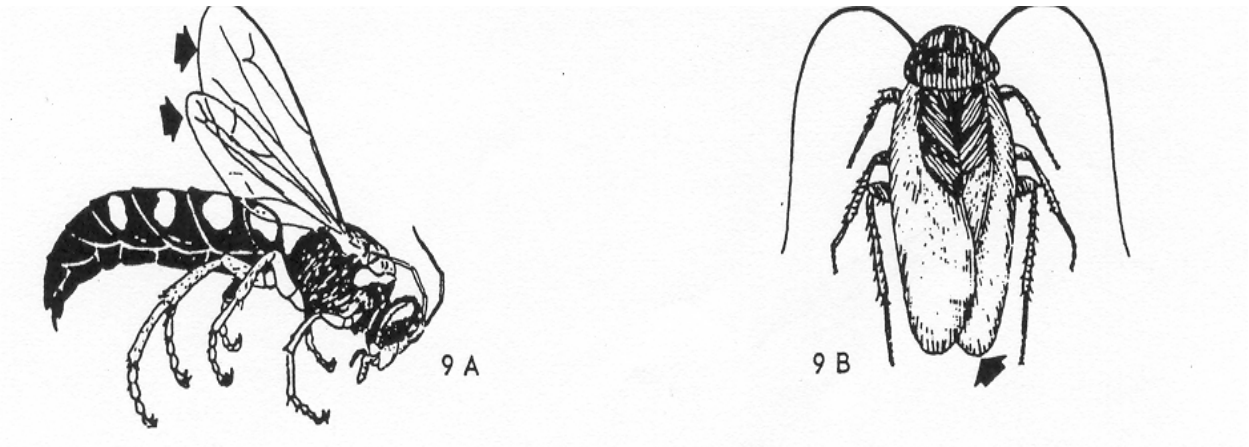
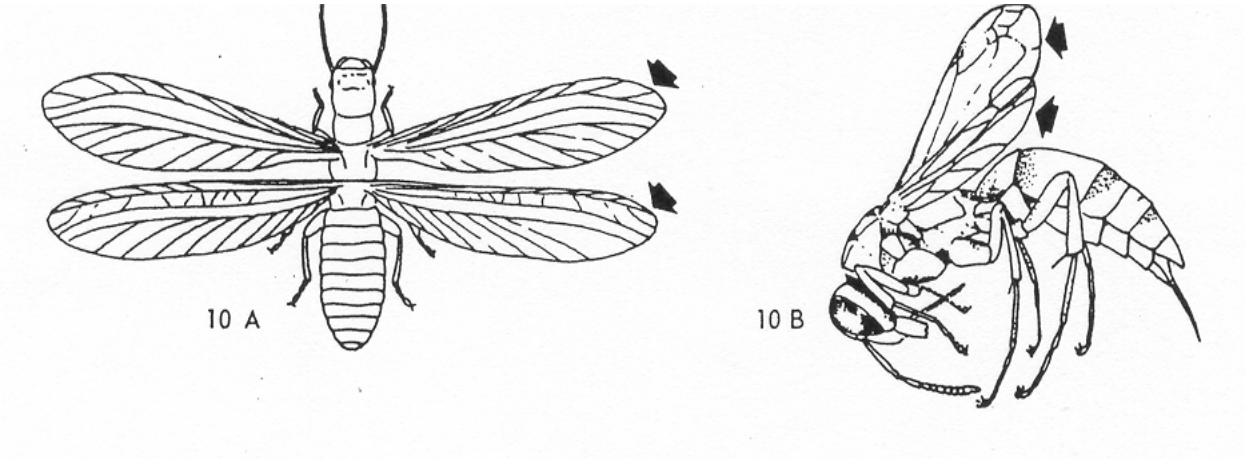


Figure 2-2. Standard identification key (continued).

10. Both pairs of wings similar in size (10 A). ORDER ISOPTERA……...TERMITE

    Hind wing much smaller than front wing (10 B). ORDER HYMENOPTERA……
    ……BEE, HORNET, WASP, YELLOW JACKET, OR ANT



11. Front wings horny or leathery, without distinct veins (11 A)……12

    Front wings leathery or paper-like, with distinct veins (11 B). ORDER ORTHOPTERA……
    ……COCKTROACH

12. Abdomen with prominent cerci; wings shorter than abdomen (12 A). ORDER DRMAPTERA
    ……..……EARWIG
    ……BEETLE

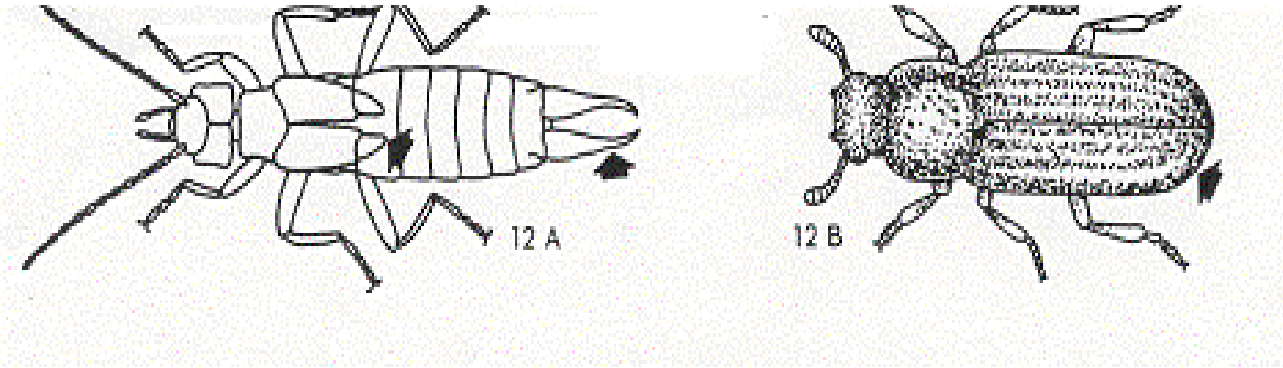
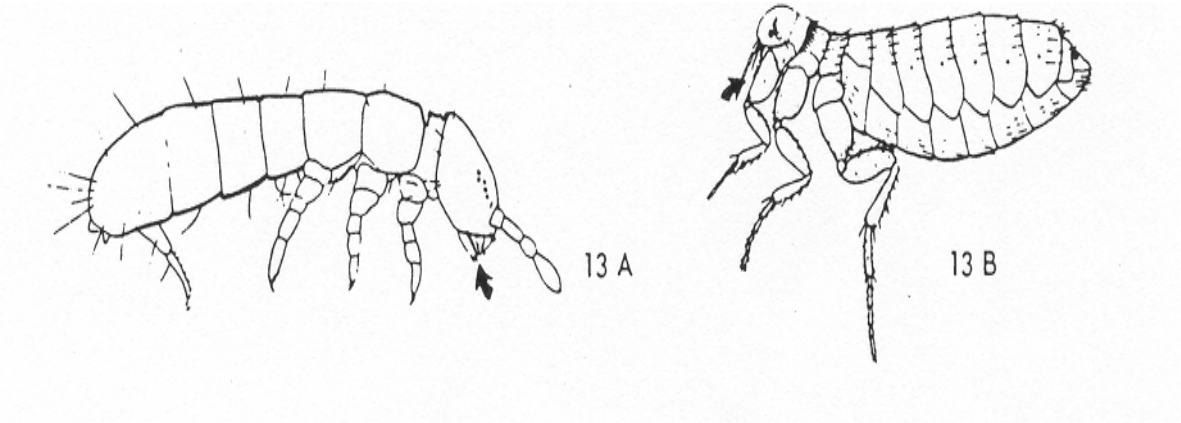


Figure 2-2. Standard identification key (continued).

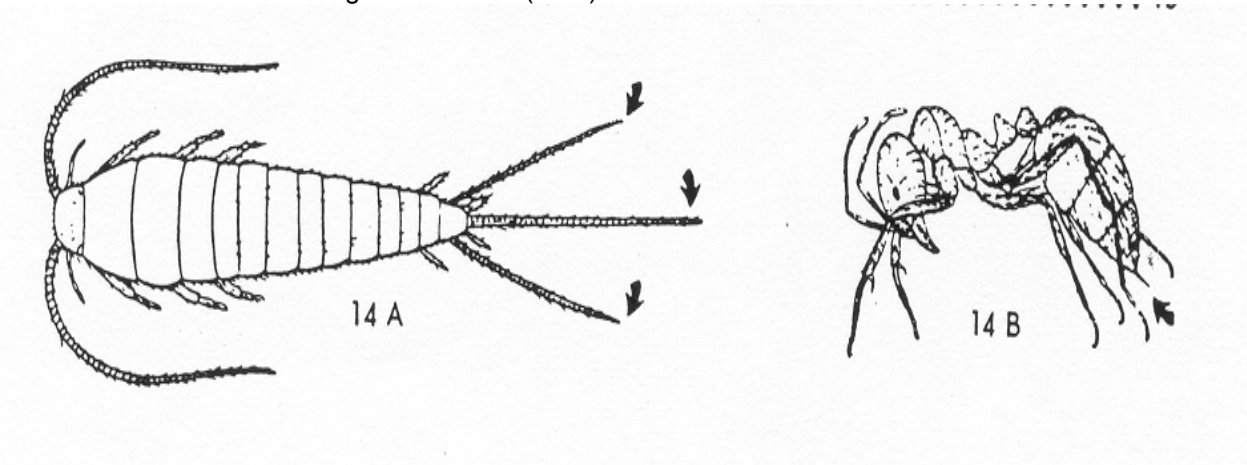
13. Mouthparts with jaws for chewing (13 A)……..14

    Mouthparts with a long beak or stylets for sucking up food (13 B)……21



14. With three long terminal tails (14 A). ORDER THYSANURA..SILVERRISH AND FIREBRAT

    Without three long terminal tails (14 B)……15



15. Abdomen with prominent pair of cerci (15 A). ORDER DERMAPTERA……..….EARWIG

    Abdomen without prominent pair of cerci (15 B)……16

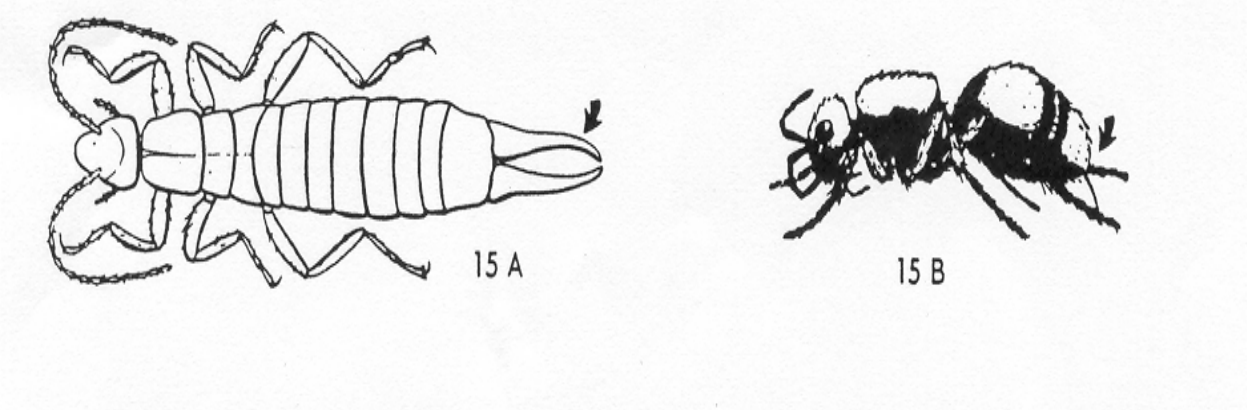
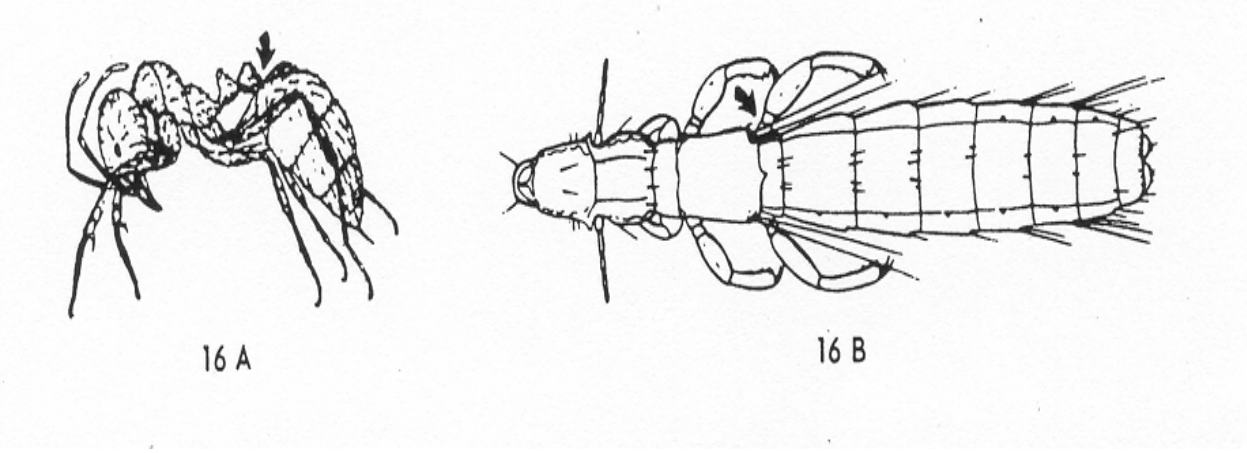


Figure 2-2. Standard identification key (continued).

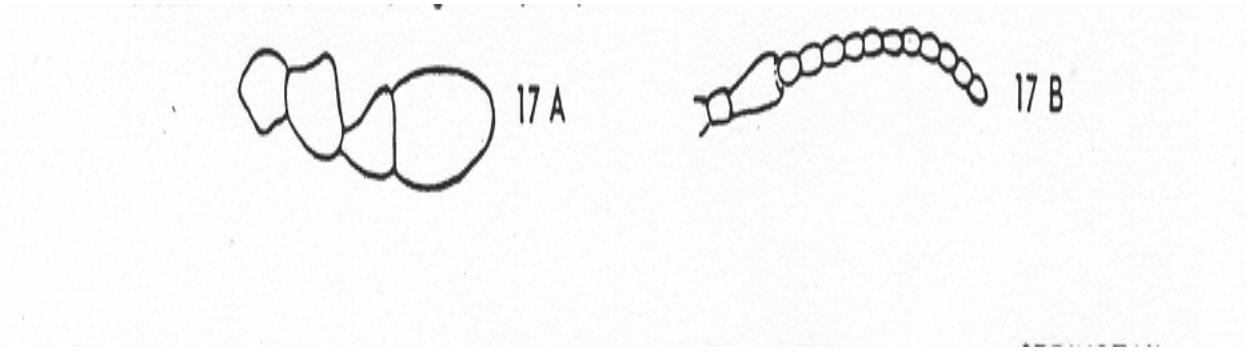
16. With narrow waist (16 A). ORDER HYMENOPTERA……ANT

    Without narrow waist (16 B)……17



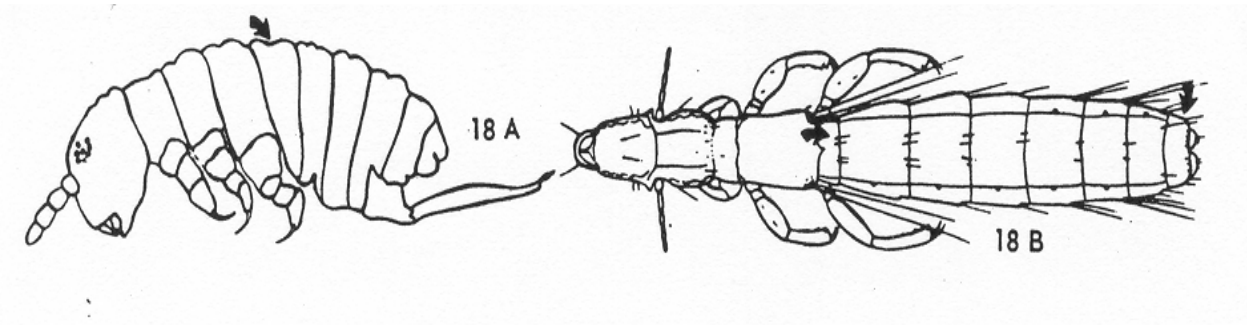
17. Antenna with fewer than 8 segments (17 A)……18

    Antenna with more than 8 segments (17 B)……19



18. Abdomen with 6 or fewer segments (18 A). ORDER COLLEMBOLA……SPRINTAIL

    Abdomen with more than 6 segments (18 B). ORDER MALLAPHAGA…CHEWING LOUSE



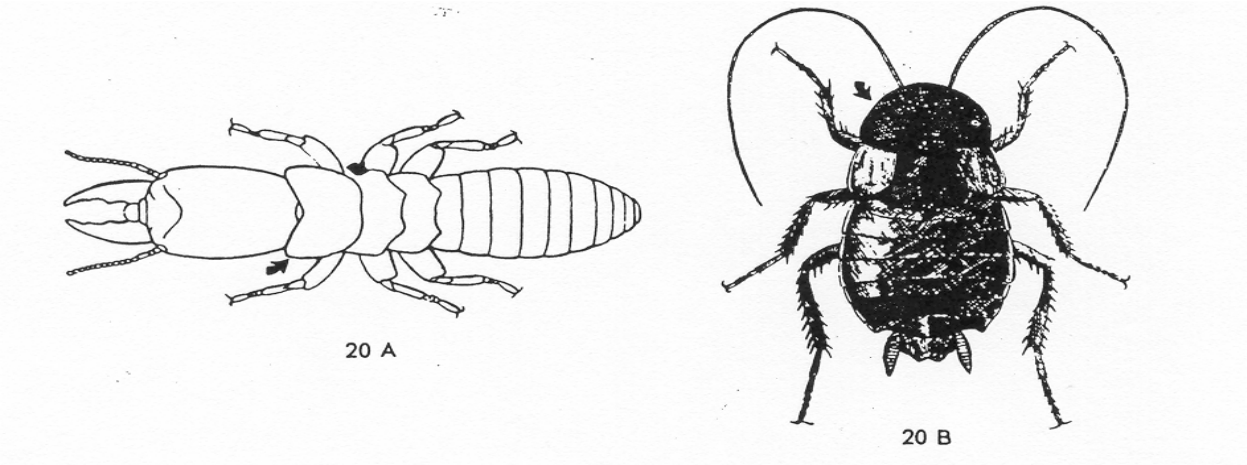
19. Tarsus with 4-5 segments (19 A)……..20

    Tarsus with 1-3 segments (19 B). ORDER PSOCOPTERA….BOOK LOUSE OR PSOCID

Figure 2-2. Standard identification key (continued).

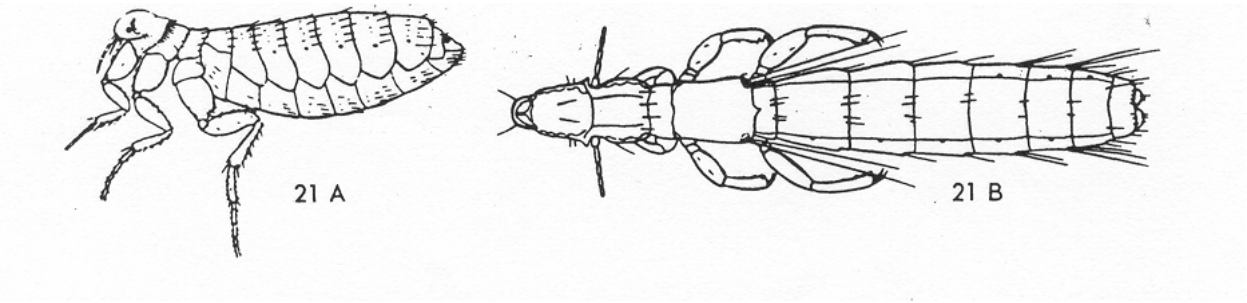
20. Pronotum narrower than head, never covering head (20 A). ORDERSOPTERA…TERMINTE

    Pronotum broader than head, often covering head (20 B). ORDER ORTHOPTERA……
    ……..COCKROACH



21. Flattened laterally (21 A). ORDER SIPHONATERA……..FLEA

    Flattened dorso-ventrally (21 B)……22



22. Foot terminating in protrusible bladder (22 A). ORDER THYSANOPTERA……..THRIPS

    Foot not terminating in protrusible bladder (22 B)……..23

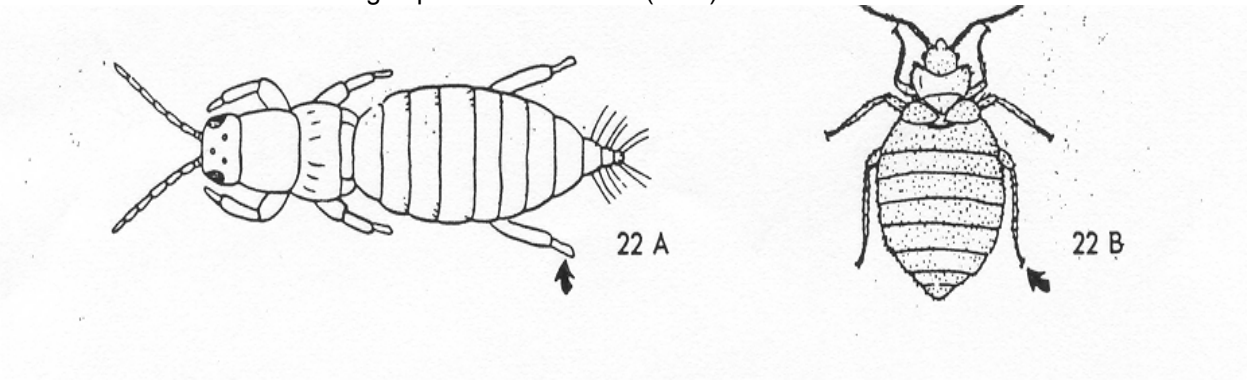
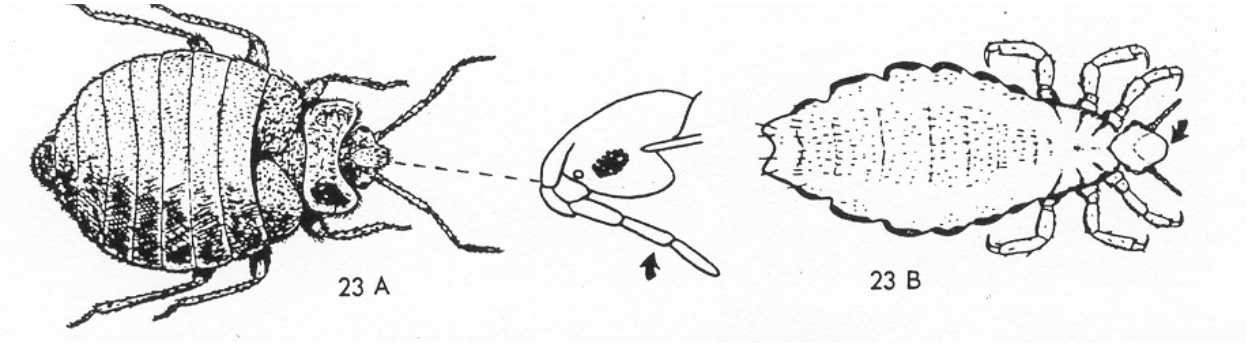


Figure 2-2. Standard identification key (continued)

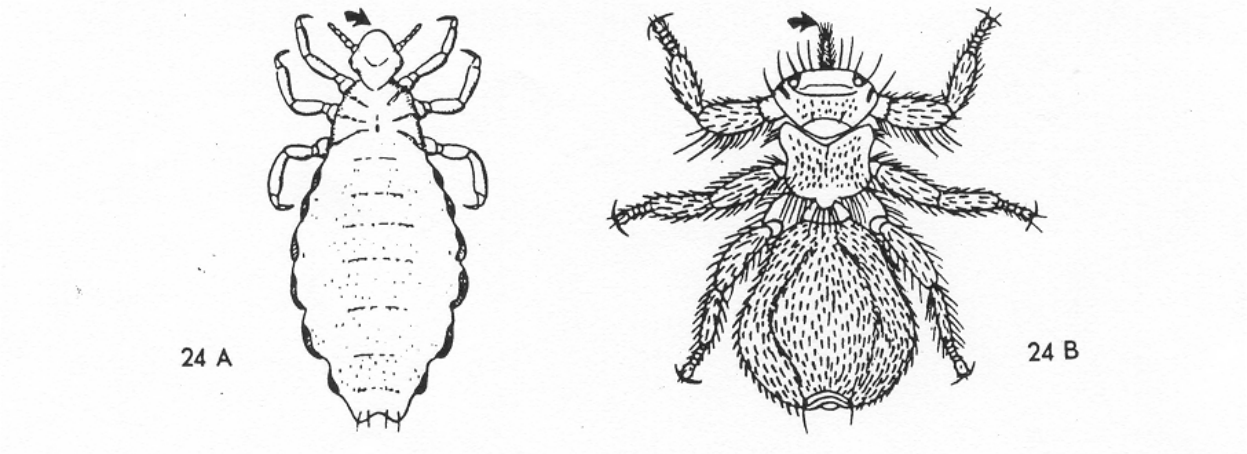
23. Beak jointed (23 A). ORDER HEMIPTERA…….DEBUG

Beak not jointed (23 B)……24



24. Mouthparts retracted into head (24 A). ORDER ANOPLURA……..SUCKING LOUSE

Mouthparts not retracted into head (24 B). ORDER DIPTERA…….KED OR LOUSE FLY



25. Abdomen well developed (25 A). CLASS ARACHNIDA……26

Abdomen peg-like (25 B). CLASS PYCNOGONIDA……..…SEA SPIDER

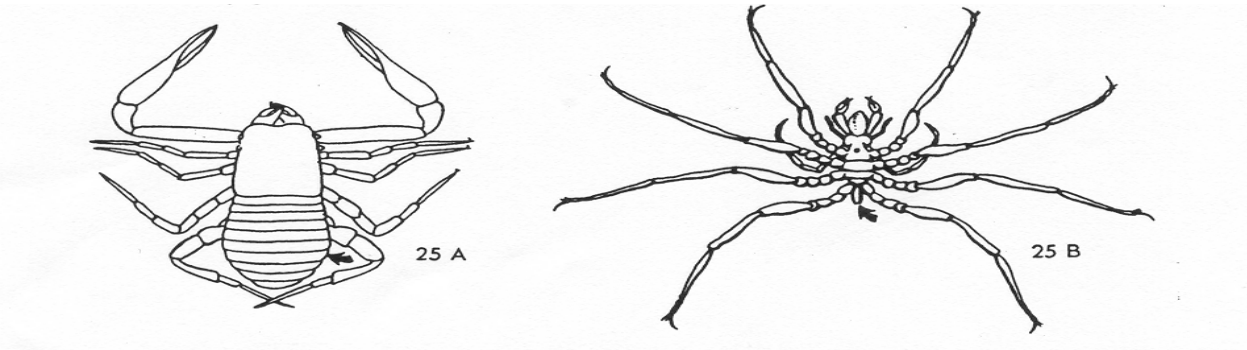
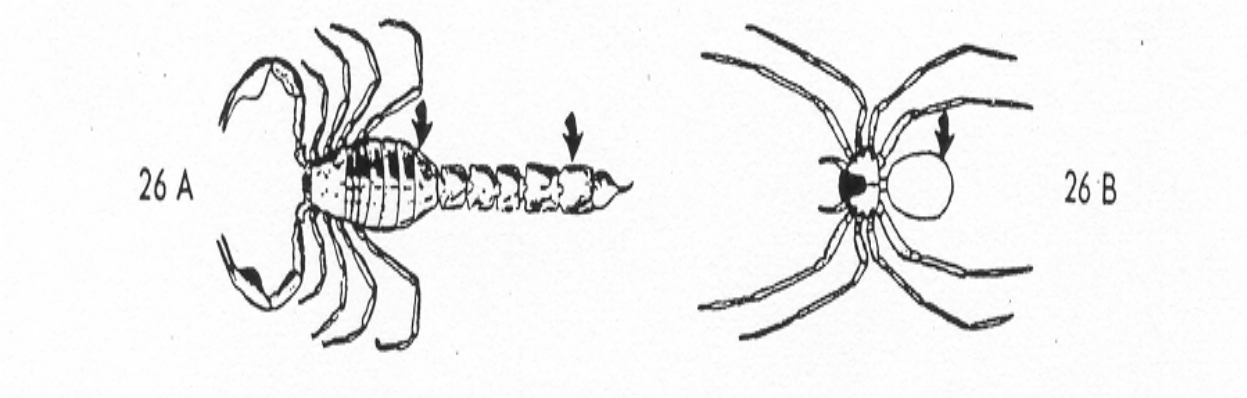


Figure 2-2. Standard identification key (continued).

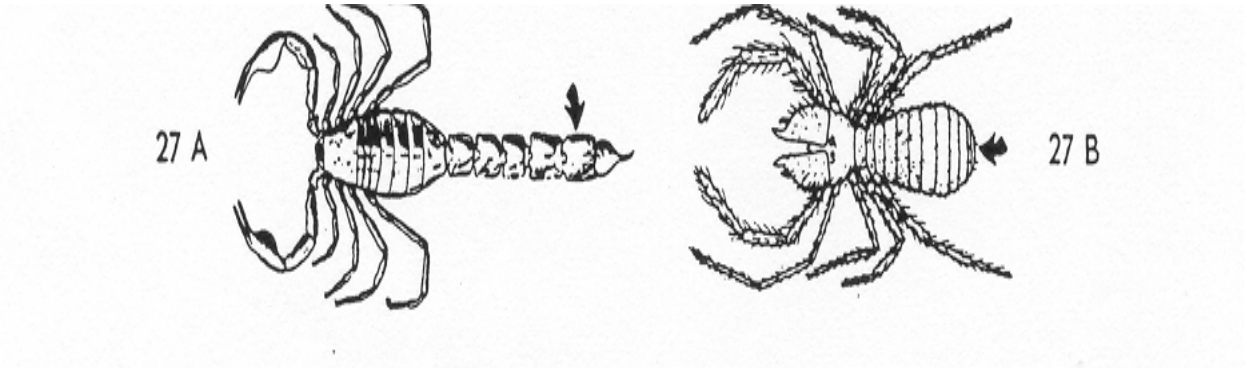
26. Abdomen distinctly segmented (26 A)……27

    Abdomen not distinctly segmented (26 B)……31



27. Abdomen lengthened to form a long tail (27 A)……28

    Abdomen not lengthened to form along tail (27 B)……29



28. Tail with stinger (28 A). ORDER SCORPIONIDA……SCORPION

    Tail without stinger (28 B). ORDER PEDIPALPIDA……..……WHIP SCORPION

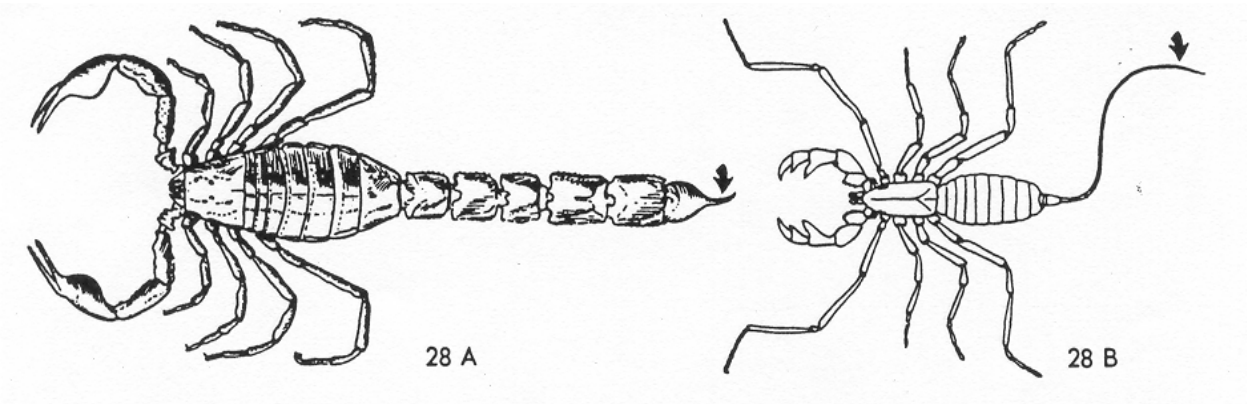


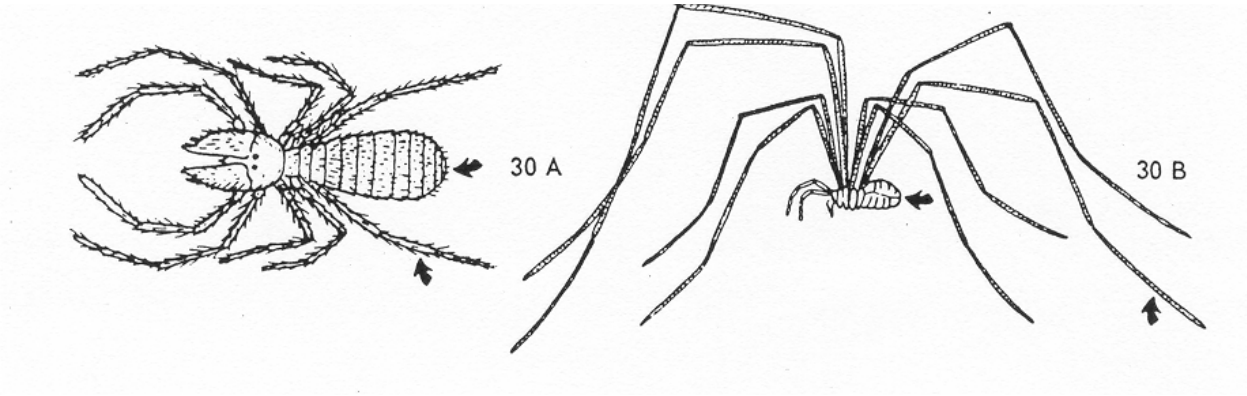
Figure 2-2. Standard identification key (continued).

29. With large pincer-like claws (29 A). ORDER PSEUDOSCORPIONIDA…PSEUDOCORPION

Without large pincer-like claws (29 B)…….. 30

29. Legs not longer than body (30 A). ORDER SOLPUGIDA……SUN SPIDER

Legs much longer than body (30 B). ORDER PHALANGIDA…DADDY LONG LEG SPIDER



30. Abdomen constricted to form a narrow waist (31 A). ORDER ARANEIDA……..SPIDER

Abdomen not constricted (31 B)……..32

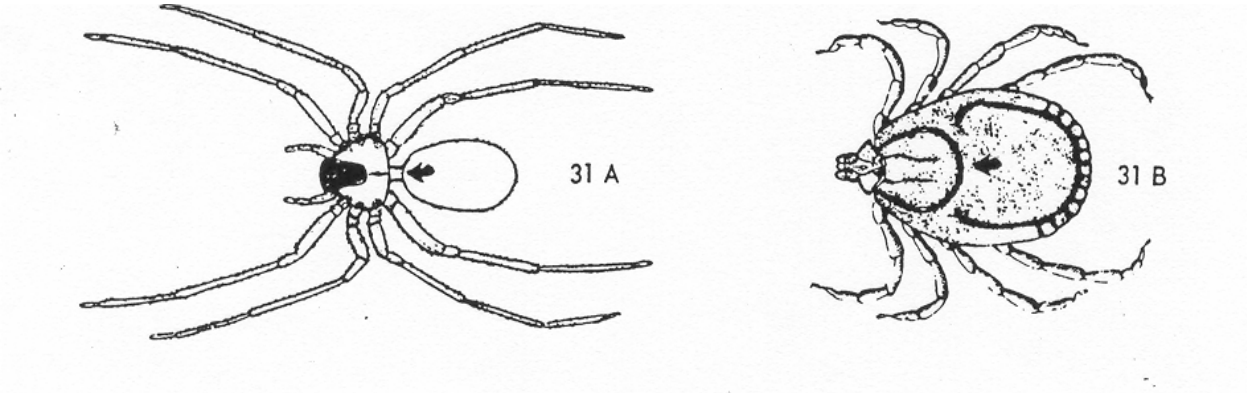
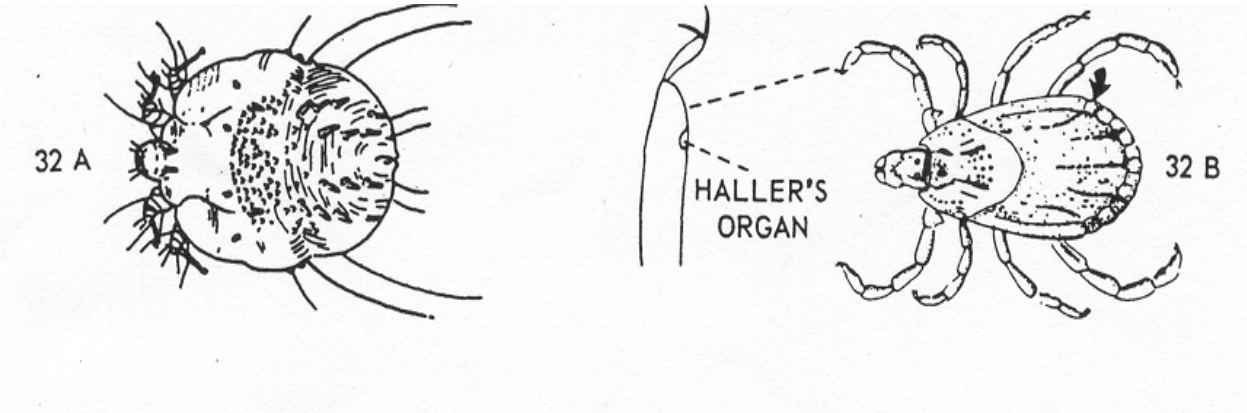


Figure 2-2. Standard identification key (continued).

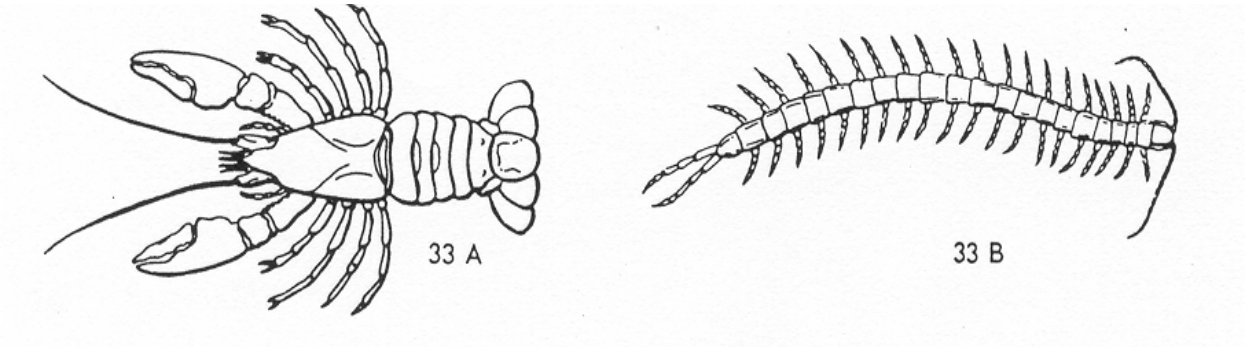
31. Body with long hair; Haller's organ absent (32 A). ORDER ACARINA…….MITE

Body without hair or short hair; Haller's organ present (32 B). ORDER ACARINA……..TICK



31. Five to 7 pairs of walking legs (33 A). CLASS CUSTACEA…….34

More than 14 pairs of walking legs (33 B)…….36



32. Abdomen without appendages (34 A). ORDER COPEPODA……..…….COPEPOD

Abdomen with appendages (34 B)……..35

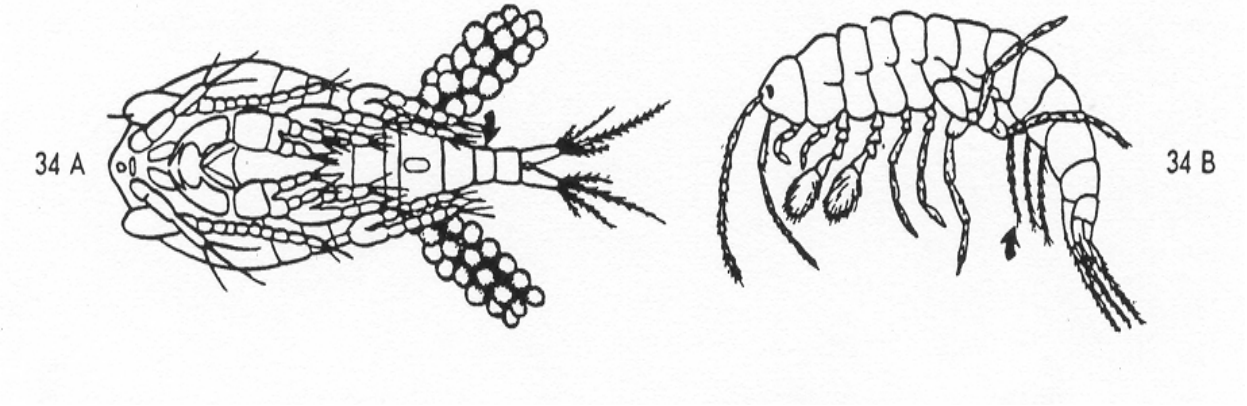
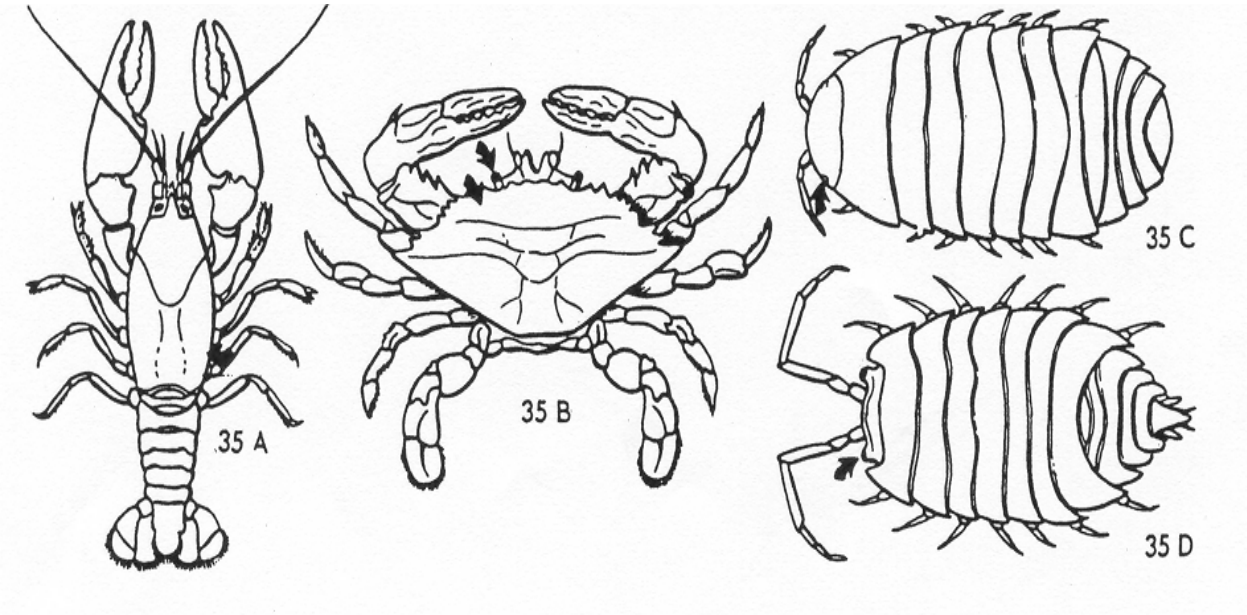


Figure 2-2. Standard identification key (continued).

33. Thorax covered with a fused plate; eyes, when present, on movable stalks (35 A & B)…….
ORDER DECAPODA……..LOBSTER, CRAB, CRAYFISH, SHRIMP, and so forth.

Thorax not covered with a fused plate; eyes, when present, not on movable stalks (35 C & D)
ORDER ISOPODA……SOWBUG, PILLBUG



33. One pair of legs per body segment (36 A). CLASS CHILOPODA……..……CENTIPEDE

Two pairs of legs per body segment (36 B). CLASS DIPLOPODA……..MILLIPEDE

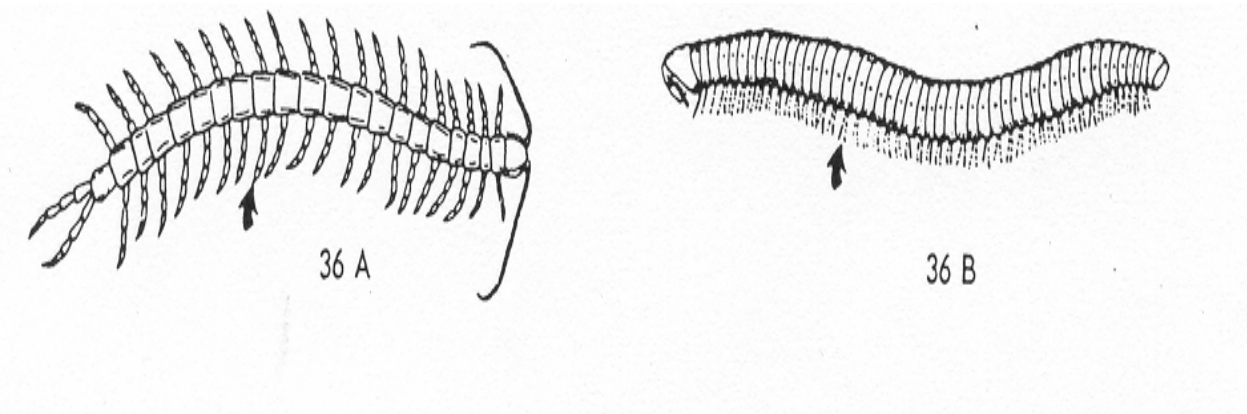


Figure 2-2. Standard identification key (concluded).

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the question, by completing the incomplete statement, or by writing the answer in the space provided at the end of the question.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Insects have:

   a. Two pairs of antennae.

   b. Three pairs of walking legs.

   c. Four pairs of walking legs.

   d. Many pairs of walking legs.

2. _____ are characteristic only to arachnids.

   a. Extremely short antennae.

   b. Compound eyes.

   c. Pedipalps.

3. The science of classification is called. _____

4. Below are three instances of a preventive medicine specialist at work. In which instance is he using his taxonomic capability?

   a. In the field, a specialist is transferring mosquito larvae into vials of alcohol.

   b. Having placed a tick specimen in the family Ixodidae, the specialist consults references to identify the species.

   c. The specialist undertakes emergency treatment for a soldier who has gone into anaphylactic shock from a bee sting.

5. Taxonomic capability is usually necessary for:

   a. Matching control measures with the proper arthropod.

   b. Giving emergency medical treatment.

   c. Collecting mosquito larvae.

6. Which of the following labels would be in the proper form for reporting the identification of specimens?

   a. Xenopsylla cheopis.

   b. Xenopsylla Cheopis.

   c. Xenopsylla cheopis.

   d. Xenopsylla Cheopis.

7. The scientific designation for the common housefly is Musca domestica. One part of the name refers to the genus of the fly; the other part refers to the species. Which is the genus ?

   a. Musca.

   b. Domestica.

8. The class Arachnida has:

   a. Two pairs of antennae.

   b. Three pairs of walking legs.

   c. Four pairs of walking legs.

   d. Many pairs of walking legs.

Use Figure 2-2 to locate the correct answer for exercises 9 through 14.

Match the statements concerning arthropods in Column A with the Illustrations in Column B.

COLUMN A

_____ 9. One pair of legs per body segment.

_____ 10. Tail with stinger.

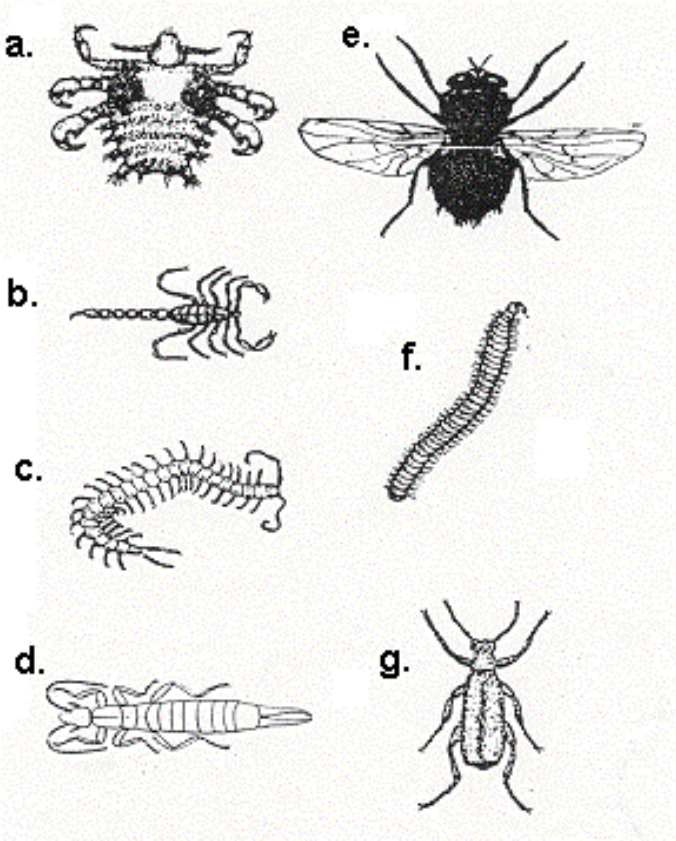
_____ 11. Member of order Diptera.

_____ 12. Two pairs of legs per body segment.

_____ 13. Wings absent or rudimentary.

_____ 14. Abdomen with prominent pair of cerci.

COLUMN B



Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. b (figure 2-1)
2. c (para 2-2c, fig. 2-1)
3. taxonomy (para 2-1b)
4. b (para 2-1b)
5. a (para 2-2b)
6. c (para 2-2d)
7. a (para 2-2d)
8. c (figure2-1)
9. c (figure 2-2, item 36)
10. b (figure 2-2, item 28)
11. e (figure 2-2, item 4)
12. f (figure 2-2, item 36)
13. a (figure 2-2, item 3)
14. d (figure 2-2, item 15)

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Arthropod Surveys.
TEXT ASSIGNMENT	Paragraphs 3-1 through 3-11.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

3-1. List the various types of arthropod surveys and include purposes of each.

3-2. From a list, choose the types of common sampling and collecting devices employed to survey for mosquitoes, filth flies, cockroaches, mites, ticks, and fleas.

3-3. Given a choice, select the correct procedures for recording data, labeling field notes, preparing data sheets, and entomological surveys.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

ARTHROPOD SURVEYS

Section I. INTRODUCTION

3-1. GENERAL

Arthropod surveys are necessary to detect actual or potential breeding populations of vectors and pests in order to make sound recommendations for their prevention or elimination. Such surveillance involves operating light traps, locating and mapping breeding sources, making landing and biting counts, taking population estimates, making sanitary inspections, and collecting specimens in their resting stations.

3-2. EQUIPMENT, TOOLS, AND SUPPLIES

Most of the equipment needed for an arthropod survey is standard US Army issue and is available through normal supply channels. A complete field entomological collecting kit (NSN 6545-00-982-4121) may be obtained through supply channels also. The following list is considered as a minimum for most arthropod surveys. In addition to the listed items, a number of survey devices can be improvised in the field. For example, resting boxes for adult mosquito surveillance can be improvised from just about any kind of large container, including a cardboard box.

a. Mosquito light trap.

Solid State Army.	(NSN 3740-01-106-0091)
Miniature New Jersey.	(NSN 3740-00-607-0337)
Collapsible unit.	(NSN 3740-01-317-4641)

b. Fly trap (see TM 5-632).

c. Animal cage trap (NSN 3740-00-472-2743).

d. Roach sticky trap (NSN 3740-01-096-1632).

e. Black plates (10"X10"), one dozen.

f. Cloth tick drag or clothing lint roller (adhesive).

g. White drop cloth or bed sheet.

h. Insect sweep net (NSN 6640-00-435-6100).

i. Entomological dipper (NSN 6640-00-149-1196).

j. Insect aspirator (battery operated) (NSN 3740-01-210-2368).

k. Shallow pan.

l. Flashlight with optional colored lenses (NSN 6230-00-264-8261).

m. Hard rubber comb.

n. Forceps.

o. Pocket knife.

p. Pipet medicine dropper.

q. Small artist's camel's hair brush.

r. Blood syringe or kitchen baster.

s. Laboratory dissecting needle.

t. Folding magnifier.

u. Hand held counter.

v. Chloroform killing tube.

w. Chloroform or Ethyl acetate, one pint.

x. Alcohol, 70 percent, one pint.

y. Assorted pillboxes.

z. Assorted vials.

aa. Urine specimen cups.

bb. Plastic storage bags.

cc. Notebook and pencil.

dd. Insect repellent

personal (NSN 6840-01-284-3982).
clothing (NSN 6840-01-278-1336).

ee. Aerosol pyrethrin insecticide.

ff. Protective examination gloves.

gg. Leather welder's gloves.

hh. Cotton.

ii. Facial tissues.

jj. Masking tape or adhesive tape.

kk. Twine.

ll. Rubber tubing, 3/8".

mm. Plastic turkey baster.

3-3. MOSQUITO SURVEYS

a. **General**. Mosquito surveys are essential to determine the species present, their abundance, their potential hazard in transmitting disease, and to collect information on which to base an efficient control program. Two types of mosquito surveys are widely used.

(1) The original basic survey determines the species, source, location, densities, and flight range of mosquitoes.

(2) The operational survey is a continuing evaluation which is extremely valuable in the daily operation of a mosquito control program, providing information on the effectiveness of control operations, and data for comparison throughout a season or from year to year. Equipment for mosquito surveys are shown in figure 3-1.

b. **Maps**. A good map of the area to be surveyed is the first requirement. A sample map is shown in figure 3-2. The map should show, as a minimum, the location of light traps, resting stations, biting stations, and larval breeding sites. A complete description of each of the above sites should be prepared separately from the map to include all pertinent information such as, "Biting Station Number 1 is located behind the gristmill at the crossroads of Smith Road and Foster Road." The importance of these maps cannot be overemphasized. They should be kept up to date at all times and reviewed on a continuing basis.

c. **Larval Surveys**. Mosquito larval dipping stations can be anywhere water stands. It can be anything from a lake to a tree hole. Common larval dipping stations are small pools in wooded areas, barrels and other containers, open ditches and drains, and even truck tire tracks on unpaved roads. Most larval collections are done with the white enamel dipper and the number of larvae taken at each station is recorded as

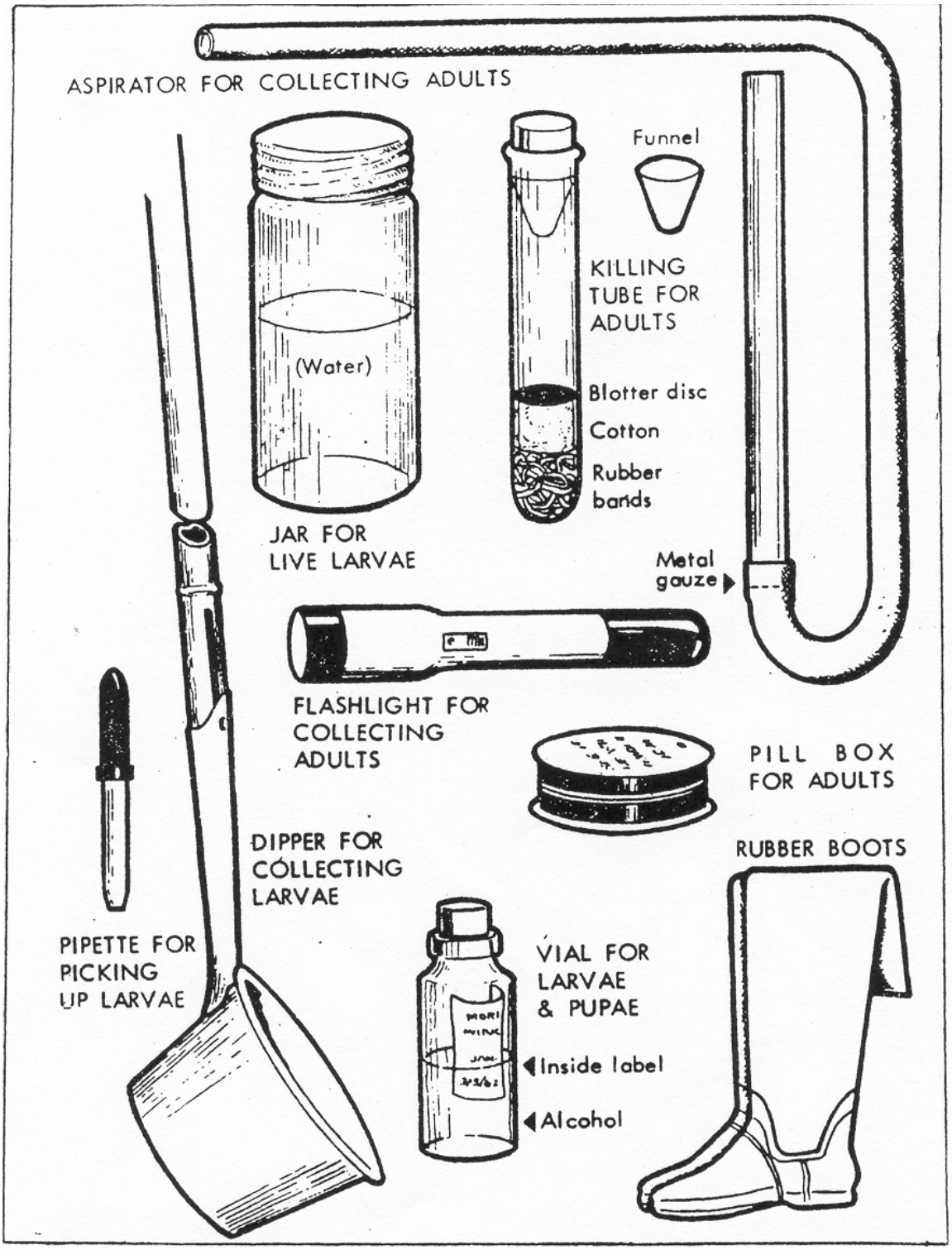


Figure 3-1. Equipment for mosquito surveys.

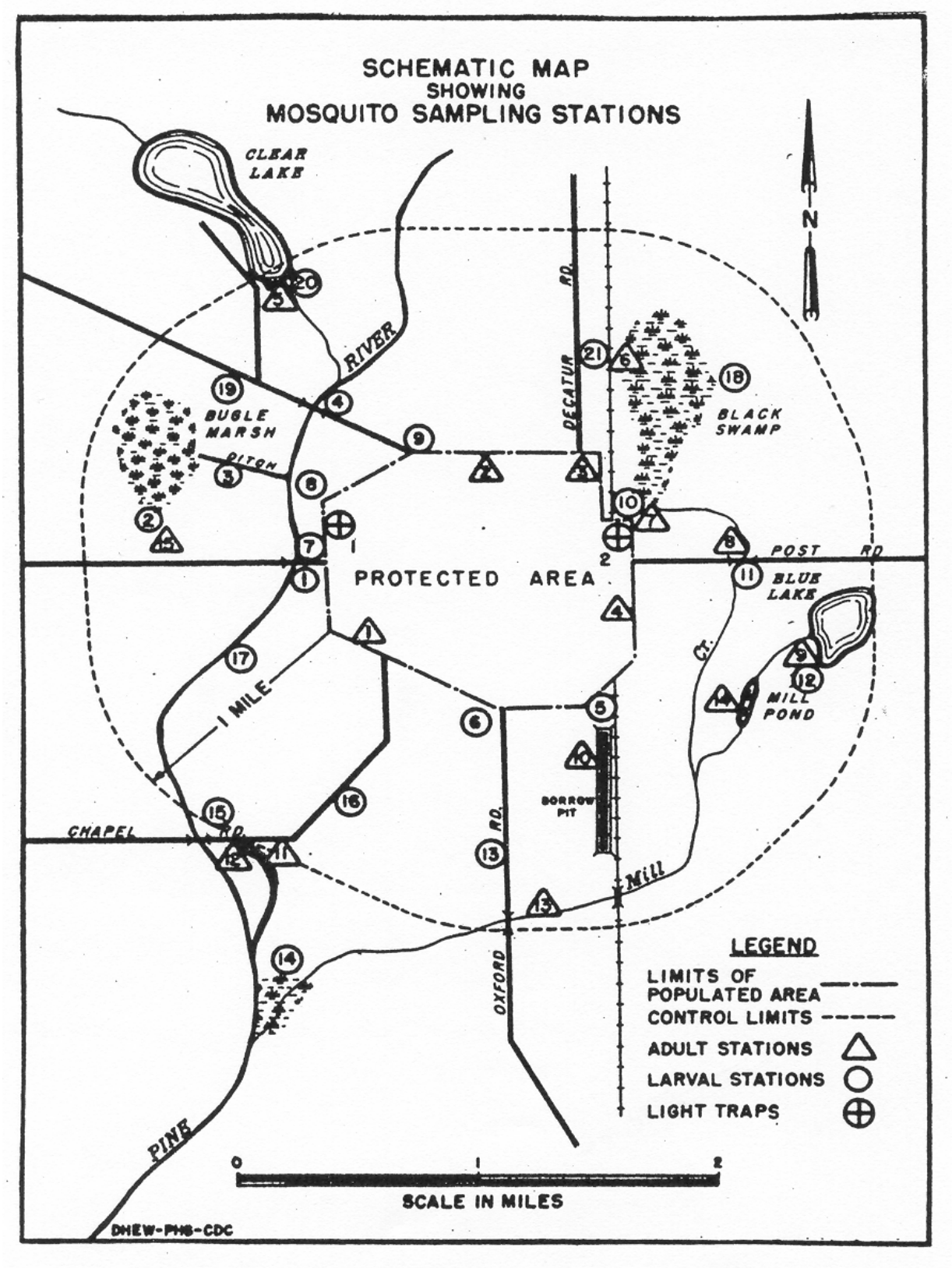
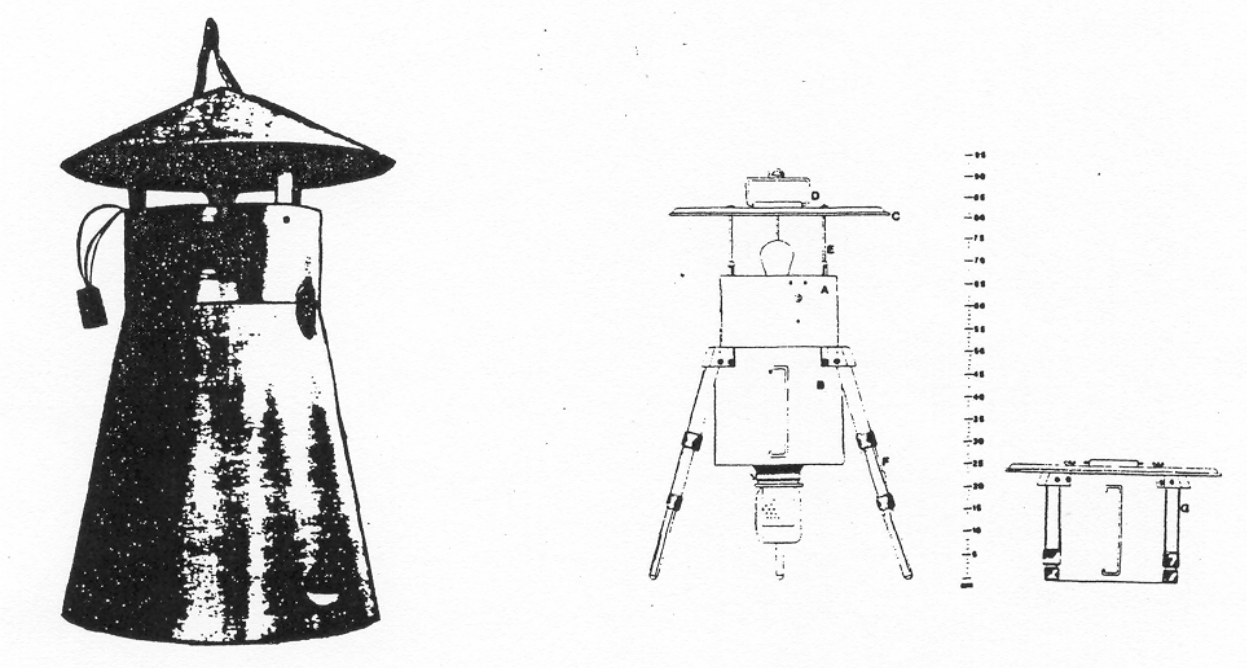


Figure 3-2. Schematic map showing mosquito sampling stations.

larvae per dip. Large-bulb pipettes (turkey basters) are used to remove water from small areas such as tree holes or leaf axils. Larval surveys show the exact areas in which mosquito breeding occurs and should be marked on the survey map. Larvae surveys are of special value of guidance of control operations.

d. **Adult Surveys**. The adult survey permits evaluation of the incidence of mosquitoes and shows the relative abundance of the various species at any time. Adult mosquito surveys are conducted by the use of traps, resting station collections, and biting or landing rates. In addition to these common survey methods, there are a number of special procedures used in research or disease survey programs. These are: traps baited with humans or animals, oviposition traps, carbon dioxide traps, and large nets of various designs and constructions.

e. **Light Traps**. Many mosquito species are attracted to light. Making it possible to utilize this response in sampling adult populations between dusk and dawn. Three widely used light traps are the New Jersey mosquito light trap (see figure 3-3) which was developed in the 1930's and has been used extensively In obtaining data on the intensity and specific composition of mosquito populations, the collapsible unit. and the battery-powered CDC type miniature light trap. Of these light traps, the CDC miniature light trap is the most versatile since it is more portable, light weight, and battery operated. Light trap data are reported as numbers of mosquitoes per trap per night, or simply as per trap night. The numbers per trap night are calculated by dividing the number of mosquitoes captured by the number of traps in use then dividing by the number of nights the traps were operated. Data from widely separated sites that consistently differ in the numbers of mosquitoes captured should not be combined.



NEW JERSEY STYLE UNIT COLLAPSIBLE UNIT

Figure 3-3. New Jersey type mosquito light trap.

(1) Killing jars. Light traps attract many species of mosquitoes when placed in remote areas away from other light sources. As the adult mosquitoes approach the light, they are blown downward into the killing jar or a mesh bag. The killing jar is made from a pint or quart jar. Cut a vapona strip in half lengthwise; then cut each half into quarters (wear a respirator, protective gloves, and use a utility knife to cut the strip). Wrap each piece of vapona in tissue paper (to prevent insects from sticking to the greasy surface) and place a chunk in each kill jar. The jars should be clearly labeled as to their contents, marked as poison, kept tightly sealed, and stored in a locked container when not in use. Vapona strips/chunks are poisons and should be handled with extreme care. Killing jars may also be made by saturating chunks of rubber bands in chloroform, placing them in the bottom of the jar, and covering them with a layer of cotton topped with perforated cardboard. This type of killing jar has to be recharged with chloroform quite often.

(2) Location. The light trap is mounted on a post or hung from a tree with the light about 6 feet above the ground. It should not be placed near other lights, in open areas subject to strong wind, or near any plant or factory giving off strong odors, smoke, or gas. Preferred locations are between the installation and the breeding area. Traps are operated for 3 to 4 nights a week, unless the primary purpose is to detect the presence of uncommon species in which case the traps should be operated every night for 7 days. They are turned on just before dark and turned off just after daylight. Electric (AC) traps can be controlled with an adjustable electric timer. The solid-state, Army miniature (SSAM) light trap's battery operated system is controlled with a photo sensitive circuit. The specimens should be removed each morning and placed in a properly labeled box until they can be sorted and identified. Special attention should be given to the killing jars. They should be fully charged at all times so as to make a quick kill as soon as the mosquitoes are blown- into the jar by the electric blower.

(3) Delivery of specimens. Specimens should be delivered to the laboratory as soon as possible so the mosquitoes may be separated from other arthropods. Mold will grow on trap collections that are left in sealed airtight containers. Alternatively, insects in samples left to dry before sorting are very often brittle, resulting in excessive damage to specimens. Samples are sorted by emptying the specimens onto a large sheet of white paper or into a large white enamel pan. A pair of fine pointed forceps is used to gently separate the mosquitoes from the other arthropods. After the adult mosquitoes are separated, they are packed for shipment as outlined in lesson 4 if they are to be shipped to another location for identification.

f. **Resting Station Collections**. Adult mosquitoes rest quietly in dark, cool, damp places when not seeking a blood meal. Collections made in houses, stables, sheds, culverts, outhouses, caves, hollow trees, and similar natural shelters will give a good indication of the species of mosquitoes present' in an area. With experience, one is able to evaluate the suitability of shelters by casual inspection. Dwellings, especially when unscreened, often prove to be satisfactory resting stations, being especially important when mosquito-borne diseases are being investigated.

(1) Artificial resting stations. Artificial resting stations may be utilized if suitable natural resting stations are not available in sufficient numbers to give a satisfactory evaluation of the mosquito population. It may be necessary to construct special shelters or to use boxes, barrels, kegs, etc., as artificial resting stations. Many different types of artificial shelters have been used. Simple artificial resting stations can be made from plywood cut into square pieces, 12 inches on each side. Assemble five such pieces of wood to form an open box and paint the box black outside with a red interior (mosquitoes see red as black) to make it easier to see mosquitoes resting in the boxes. Place the boxes with the opening on the side in the area to be sampled. Mosquitoes enter such shelters at dawn, probably in response to changes in light intensity and humidity, and ordinarily do not leave until dusk.

(2) Requirements. In order to collect mosquitoes at a resting station, a flashlight, a kill jar, an aspirator, and pillboxes are needed. The kill jar should be fully charged so the mosquitoes are killed instantly as they enter the jar.

(3) Frequency. One collection per week from each station is sufficient for a routine survey and control operation.

g. **Biting Collections**. The collection of mosquitoes as they bite is a very good method of collecting adult mosquitoes.

(1) Animals. The preferred method is to make the collection from a domestic animal right after sundown. The animal should be white or light colored so the mosquitoes can be seen easily. Equipment needed is a flashlight, an aspirator, a kill jar, and pillboxes.

(2) Human beings. Another way to collect mosquitoes as they bite is to use a human being. The subject should expose part of his body by rolling up his sleeve or trouser leg, or by removing his shirt and sitting quietly' for a period of 10 to 15 minutes. The mosquitoes are collected with an aspirator operated by the subject or a co-worker. Whether counts are made from humans or animals, remember that certain persons or animals are more attractive to mosquitoes than others. Therefore, the same person or animal should be used throughout a given survey. The collection should be made at regular intervals and at approximately the same time so that biting rates at different stations may be compared.

(3) Landing rates. With day biting species, the index may be based upon the number of mosquitoes landing on a person's clothing in a given time interval (landing rate) rather than those actually in biting position. This is more practical when populations of mosquitoes are very high and is useful for a rapid check of mosquito abundance before and after control work has been accomplished.

3-4. FLY SURVEYS

Fly surveys are made to determine what kinds of flies and how many flies are present in an area. By looking up the ecology of common species in reference literature, personnel determine what larval habitats should be located and eliminated. By comparison of successive surveys, control effectiveness is evaluated. Since it is not practical to determine the precise number of flies, surveys are designed to give an index of the population. The weekly index is the average number of flies observed from the total fly survey stations. For example, the fly counting stations are observed weekly at 10 or more locations where flies are prone to be present. The average number of flies observed per station in a given time is the index for that period or week. A bar graph can be prepared and maintained which indicates, at a glance, the status of the fly population as compared with previous surveys.

a. **Fly Trap Surveys**. Trap surveys have the advantages of securing a reasonable cross section of the population for careful identification, securing an approximate count of the relative number of the various species, and trapping flies alive for laboratory study. For qualitative surveys of the fly population, the fly trap is a useful tool. Traps vary in size, but the outlines of their construction are similar. See figure 3-4 for details on the construction of a typical fly trap. The operating principle of the trap is simple. Flies are attracted to the baited trap and fly upward toward the light. Once they pass through the small opening at the top of the cone and into the cage, they are not likely to escape. Since success of the fly trapping depends upon getting the flies to enter the trap, the kind of bait used is of prime importance. Since different kinds of flies have different preferences for food, it is important to use all-purpose bait that includes some fish or chicken parts along with some waste vegetable or fruit. The bait should be placed in containers about 2 inches in depth and slightly smaller in diameter than the cage cylinder. The trapped flies are killed by placing the trap in a tight container and exposing the flies to chloroform or carbon monoxide and dioxide, or by freezing. The collections are measured by volume, weight, or actual count.

b. **Fly Grills**. Fly grills (see figure 3-5) are widely used in modern evaluation of fly populations. They are faster than baited traps or fly cone surveys and give a highly valid picture of the fly situation. The fly grill depends upon the tendency of flies to rest on edges and so it presents many attractive resting sites. The grill is placed over natural attractants and the number of flies landing on the grill during a 30-second interval is tabulated. When the grill is put down, the flies are somewhat disturbed and fly upward a short distance. When all is quiet again, they come back down, landing on the grill instead of the attractant. The inspector then records the total number of flies resting on the grill. If fly counts are so high that total counts are impractical, the grill may be divided into halves, quarters, or sixths, with painted markings. At least one-sixth of the grill must be counted. A minimum of 10 counts is made in each block sampled, and the 5 highest counts are recorded.

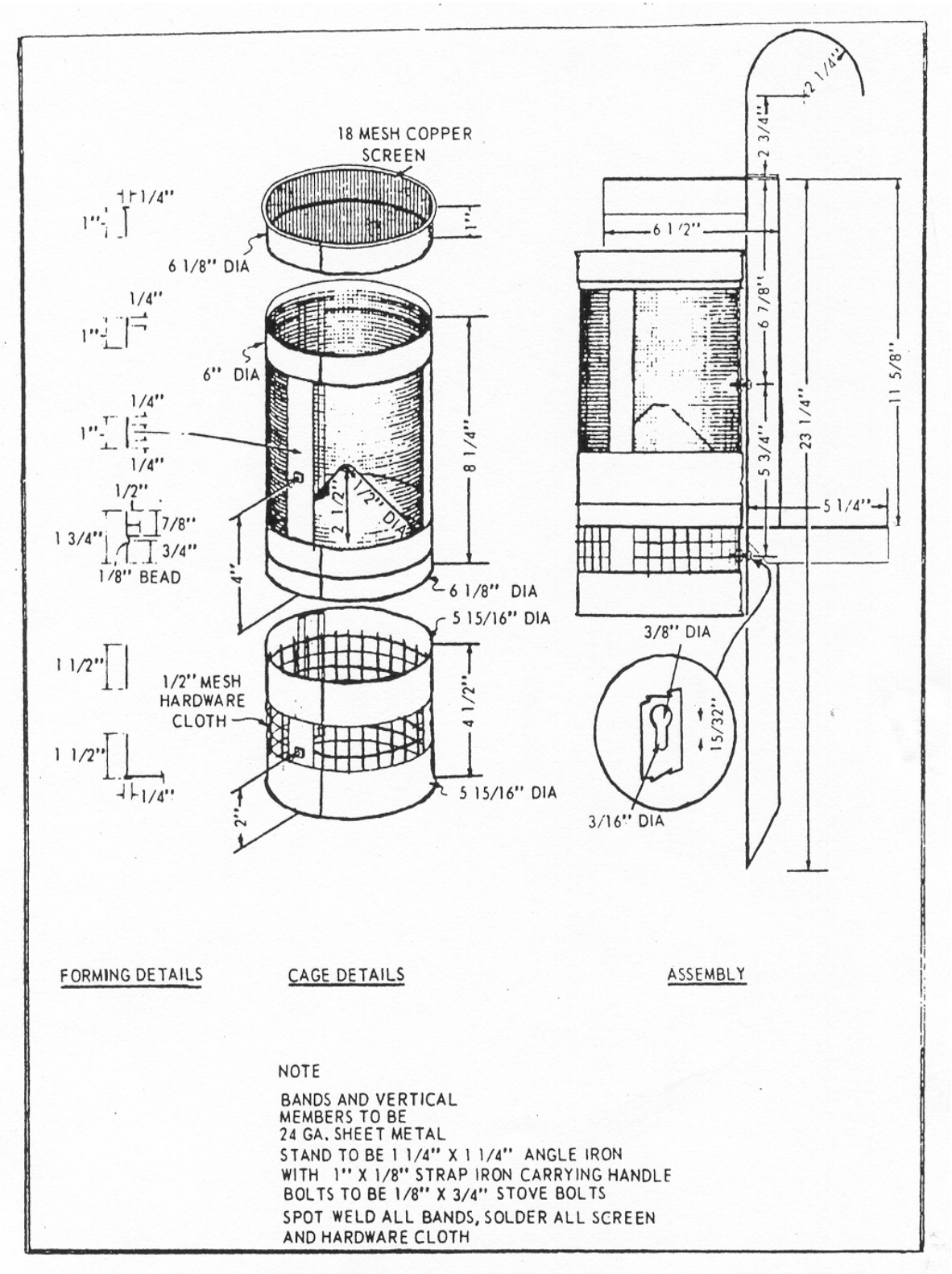


Figure 3-4. Fly trap---attached bait pan type.

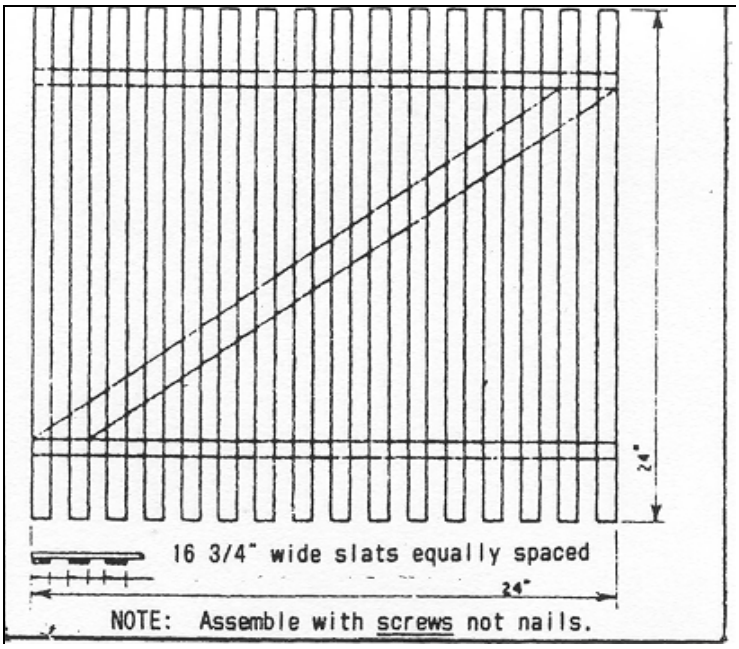


Figure 3-5. Fly counting grill.

c. **Fly Cone Surveys**. Fly cones (see figure 3-6) are superior to baited traps and fly paper strips because they make use of many different natural attractants instead of depending upon standard introduced attractants. The fly cone, made of screen wire, is placed over a natural attractant (garbage, manure, and so forth) and flies are trapped beneath it. A dark cloth is thrown around the cone and the apparatus is carefully agitated. Attempting to escape, the flies move upward toward the light and enter the cage; then the sliding door of the cage is closed and the collection is labeled.

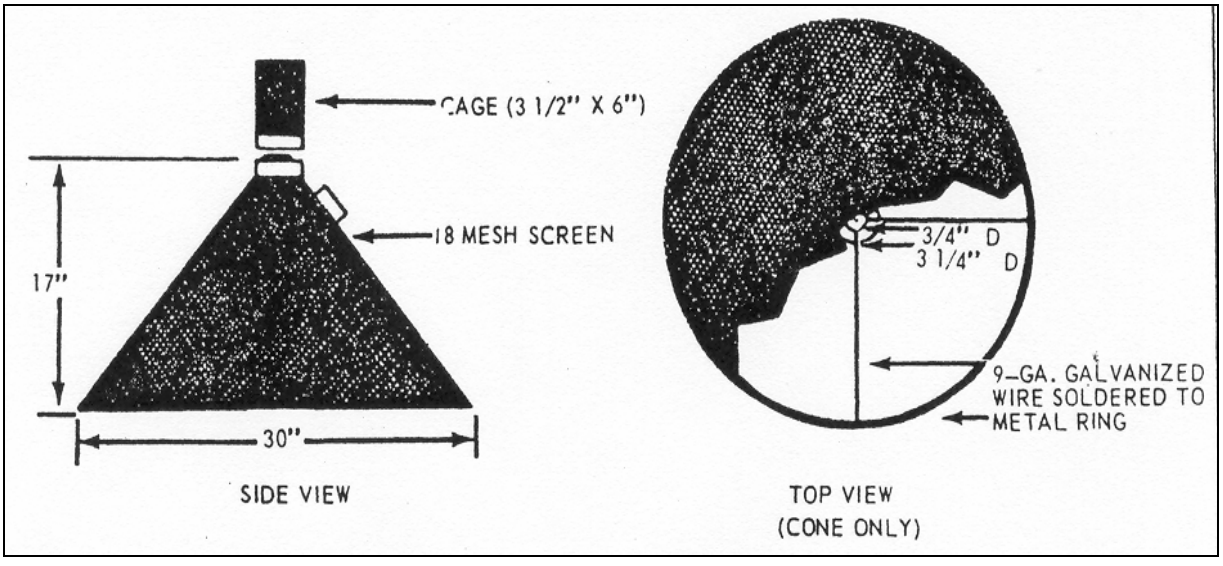


Figure3-6. Fly cone.

d. **Fly Paper Strip Surveys**. Strip surveys are rapid, but the data obtained have little numerical reliability. Only a few kinds of flies present will be captured. Strips of sticky paper are suspended in buildings and outdoors for a definite period of time (usually 4 hours), after which flies are collected, identified, and counted.

3-5. MITE SURVEYS

One of the common ways to survey an area for mites is by the use of the "black plate." This is simply a piece of black plastic, wood, or metal painted black that is of uniform size, usually 8 to 12 inches square. One easy way to make sure that you have a plate with you at all times is to paint a clipboard black and use this to keep your field notes on. You should use a dozen or more plates in your survey because of the patchy distribution of chiggers. All plates should be of the same size and be made of the same material. These plates are placed on the ground in the area to be surveyed and are warmed by the sun. The heat from the plate attracts the mites and they are seen as small yellowish, pinkish, or reddish spots that move rapidly over the surface of the plate. The plates are left in place for 10 to 15 minutes and the chiggers counted on each plate thus allowing a comparison with another area for the same exposure time. A favorite resting place for chiggers are old tree stumps and fallen logs.

3-6. TICK SURVEYS

a. Tick surveys are conducted to determine the following: species of ticks present in an area, infested area boundaries, necessity for control, and effectiveness of control operations. Ticks are more commonly found in brushy, wooded areas where wild or domestic animals are available for food. Such areas include training and maneuver areas.

b. There is no easy or simple method to conduct a survey. As "in all entomological surveys, tick surveys require practice and experience in order to perfect techniques. One of the most successful techniques has been the use of the "tick drag." A "tick drag" is a one-yard square piece of white flannel cloth reinforced at both ends by a rod or stick. A string is attached to each end of one of the rods to allow you to drag the cloth behind you. There are three methods by which the drag or white cloths may be used.

(1) Pull the drag over a predetermined distance, usually 50 yards or 50 steps. Then stop and collect the ticks that have attached themselves to the cloth. Ticks may be collected with forceps or by rolling the drag with a disposable adhesive-type lint roller.

(2) Place the drag on the ground and sit on it for 5 to 10 minutes. Then collect the ticks that crawl onto the cloth. Clothing should be thoroughly examined for ticks and rolled with a lint roller to remove ticks. When clothing is removed, the body should be checked for ticks attached to skin, particularly the legs and the nape of the neck. Any ticks found attached to the skin should be carefully removed with forceps by

grasping the tick as close to your skin as possible and using slow, steady traction to pull their mouthparts from the bite wound.

(3) Place the drag on the ground and place a block of dry ice (2 to 3 inches on a side) on an inverted, disposable pie tin in the center of the drag. Collect ticks as they crawl across the drag or next to the dry ice. The dry ice should be wrapped in paper to avoid damaging the tick specimens.

3-7. COLLECTION OF ARTHROPOD ECTOPARASITES

a. **Trapping**. A reliable ectoparasite index is obtainable through rodent trapping and subsequent combing of the rodent. Ectoparasites will only remain on a live, warm host; therefore, the rodents must be caught in a live trap. When trapped, the rodent, still in the trap, is put into a large box or paper bag that contains wads of gauze or cotton balls that are soaked in chloroform strong enough to stun the animal so it can be handled (see figure 3-7). The rodent is then transferred to a plastic bag into which another wad of chloroformed material is added. This time the rodent is left in the bag long enough so that both it and its ectoparasites are killed. In order for the dead ectoparasites to falloff, the rodent must be combed, washed with detergent, or both.

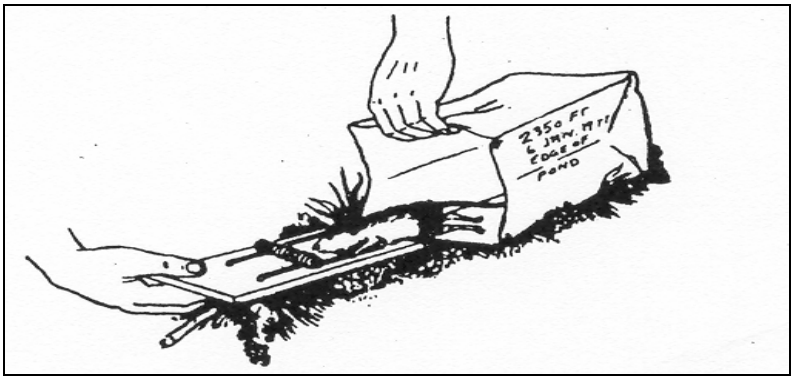


Figure 3-7. Trapped rodent being put into correctly labeled paper bag.

(1) Combing. The combing procedure is carried out while wearing rubber gloves. The rodent is held over a large white enamel pan in order to catch the ectoparasites as they fall from the animal. Use a double-sided, fine-tooth comb to remove ectoparasites from the fur. First, comb the rodent from head to tail to remove ectoparasites near the surface. Then, comb the animal from tail to head against the grain of the fur to remove deep-seated ectoparasites. After the rodent is completely combed, the fur is rubbed with the fingers to make sure all the ectoparasites are detached. The plastic bag is then checked carefully for any ectoparasites that have fallen from the rodent during the killing process. Individual ectoparasites are removed from the pan by use of a camel's hair brush, placed in vials of alcohol, and labeled.

(2) Washing. Another method of collecting ectoparasites from dead rodents is by washing the rodents. The rodent is captured and killed in the manner previously

described. It is then placed in a leak-proof plastic bag that is partially filled with warm water and a small amount of mi ld household detergent. The bag is shaken vigorously. The rodent is then removed and the liquid poured through a funnel lined with filter paper. After all the water has drained through the funnel, the ectoparasites may be collected from the filter paper and put in labeled vials of alcohol. Figure 3-7. Trapped rodent being put into correctly labeled paper bag.

b. **Collecting Nests**. There are many ectoparasites which live in the nests of rodents and birds. In order that the survey be truly representative, it is necessary to collect nests. These nests are placed in large paper bags with the collection data written on the side of the bag. The bag is then tightly sealed with strong rubber bands and transferred to the laboratory. In the lab, the nests are placed in the Berlese funnel (see figure 3-8). The light over the funnel is turned on and the heat from the light drives the ectoparasites from the nest downward into a jar of alcohol. The funnel should be carefully taped at all seams to prevent escape of the ectoparasites into the laboratory. The Berlese funnel is not an instant ectoparasite collector. The nests should be left in the apparatus no less than three days so all the ectoparasites are collected. After the proper time has elapsed, the light is turned off and the specimens removed from the collecting jar. The specimens are then placed in labeled vials of alcohol. The processed nest is placed in a plastic bag, sealed tight, and incinerated.

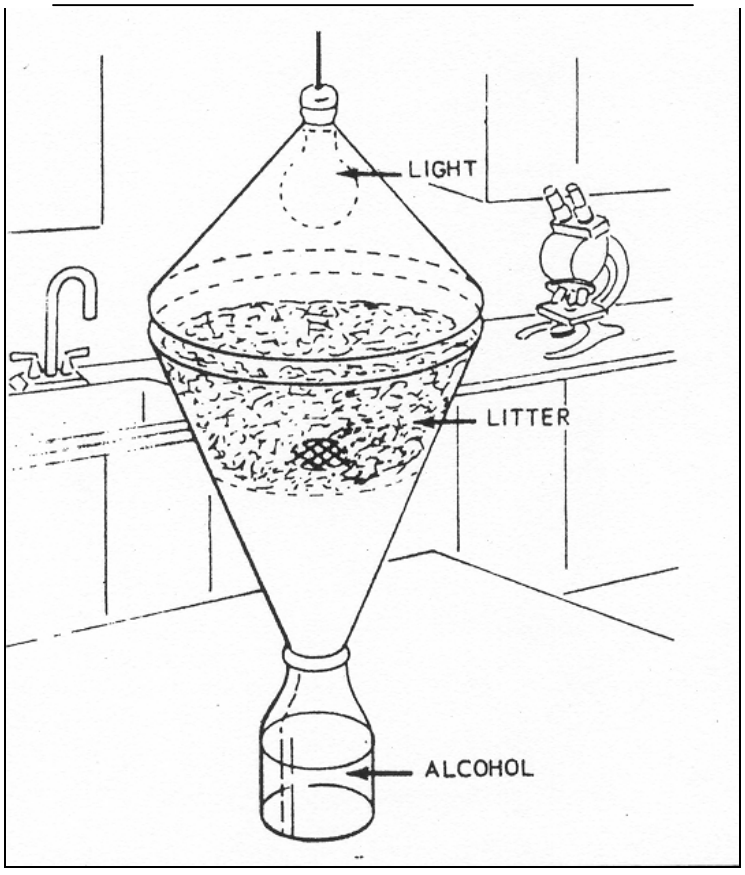


Figure 3-8. Berlese funnel.

3-8. COCKROACH SURVEYS

a. Cockroaches have become well adapted to living with man. Most species prefer warm, moist situations such as cracks and crevices near heated equipment (for example, stoves, steam tables, water heaters, dish washers, and so forth.). A favorite hiding place is around the motors and compressor of refrigerators and freezers.

b. Cockroaches are nocturnal and are usually seen when you enter a room and turn on the light. If cockroaches are seen during the day, there is usually a heavy infestation. One good way to survey a building for cockroaches is by use of an aerosol such as a pyrethrum or pyrethroid insecticide. Cockroaches may be flushed out by spraying the insecticide directly into suspected hiding places. Cockroaches react quickly to this type of material and, if they are present, they will be seen scurrying about. One should not apply aerosol formulations of insecticide to electrical outlets or connections. Another excellent survey technique is the night time survey of a building/room with the lights turned off. Cockroaches do not see yellow or red light, so a lens of one of these colors can be placed on your flashlight to search for cockroaches when they are most active.

c. The presence of egg cases is a sure indication of cockroach infestation, except in the case of the German cockroach. In most species, the female cockroach attaches her egg case to objects such as boxes, walls, curtains, pipes, and so forth. These egg cases are readily identifiable; they resemble a small pouch or purse. The egg case of some species even appears to have a zipper along the top edge. Figure 3-9 shows some of the different types of egg cases. The female German cockroach, on the other hand, does not deposit her egg case but carries it attached to her body until the eggs are ready to hatch (see figure 3-10). The finding of cockroach feces is another sure indication of infestation. Cockroach droppings are usually rod-shaped, almost black in color, and from 2 to 4 mm in length. Droppings of some of the smaller species may be smaller and will appear to be grains of black sand.

d. Roach traps may be used in estimating populations. The trap may be constructed as shown in figure 3-11. The traps are baited with fruit such as bananas or apples, or with greasy food such as bacon grease or peanut butter. Placement of the trap is important to the success of trapping. Place it in the corner, touching walls, equipment, table legs, and cabinets. Roaches may also be collected this way and tested to determine cockroach resistance to insecticides.

e. Commercial type roach traps are available as standard issue items. These very effective traps are equipped with a strong adhesive to capture roaches drawn or attracted by a built in chemical attractant. Placement of these traps is the same described in paragraph d above.

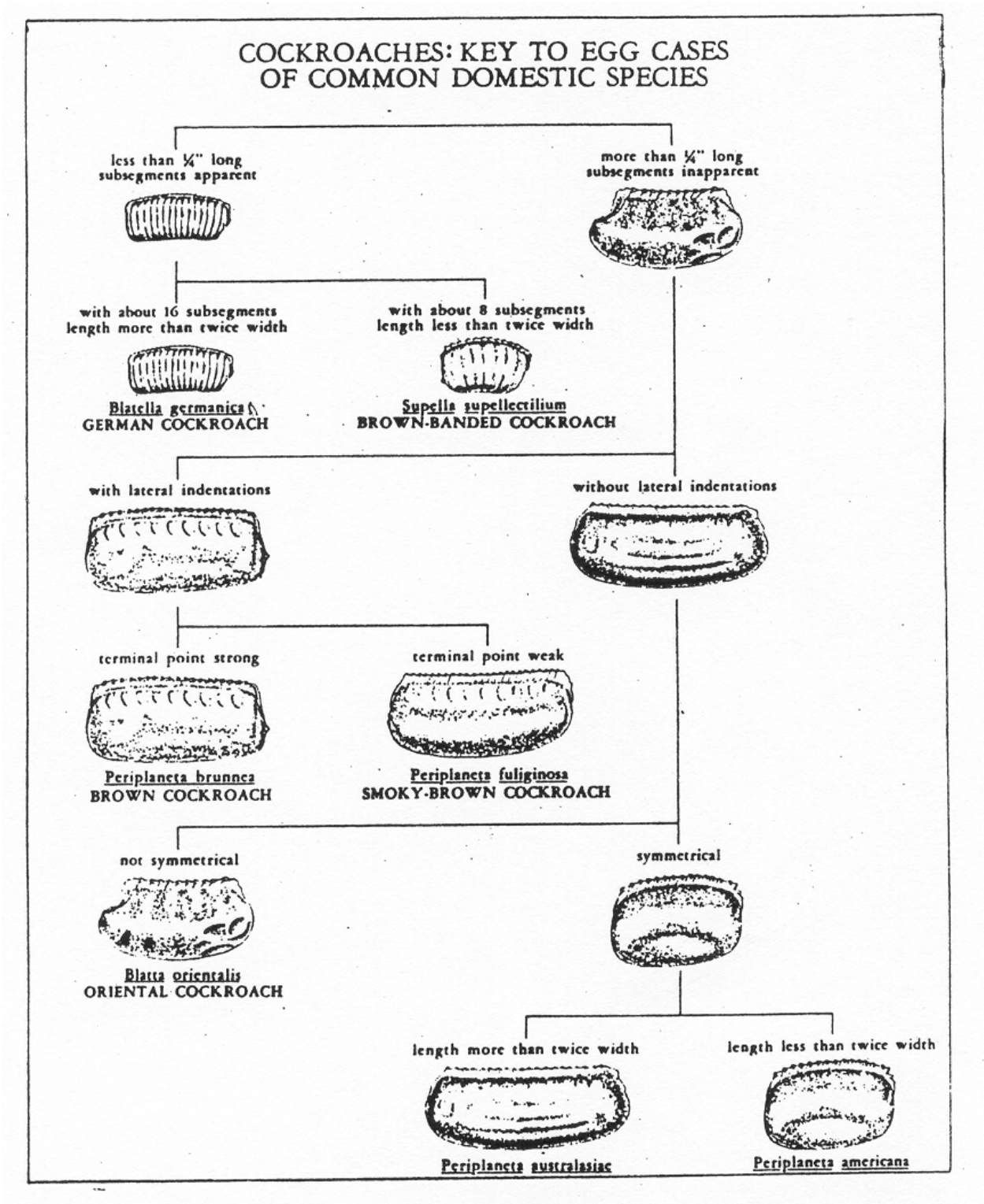


Figure 3-9. Cockroach egg capsules.

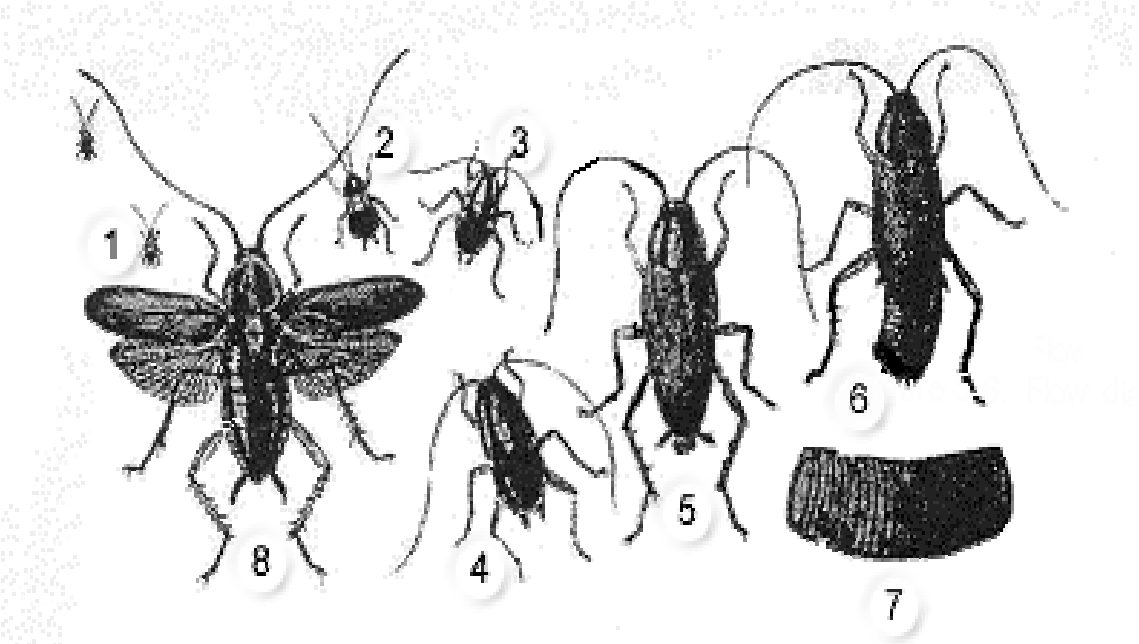


Figure3-10. German cockroaches. (1-4), Nymphs; 5 and 8, Adults; 6, Adult female with egg capsule; 7, Egg capsule)/

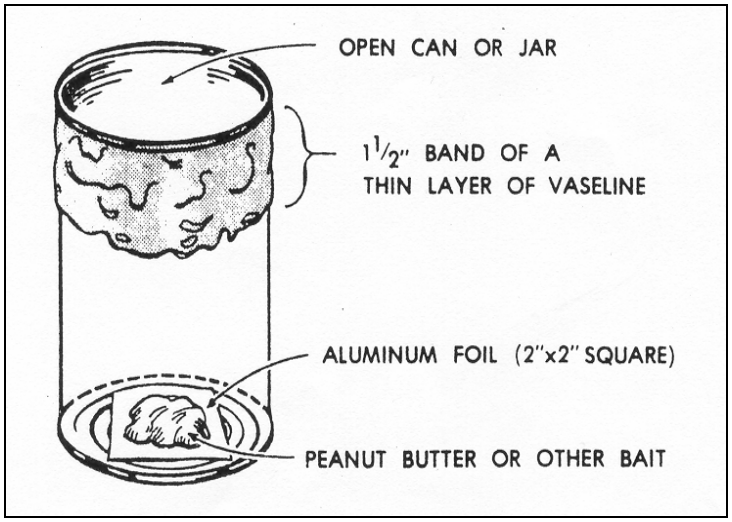


Figure 3-11. Cockroach trap.

f. Sticky boards may also be used in estimating populations. Made of stiff heavy-duty paper and coated with an extremely strong adhesive, these traps are available in a variety of sizes. They are placed in suspect roach harborage areas and will trap roaches on the adhesive. These can be used as is or a bait can be placed in the center to attract roaches. Sticky boards are also useful for trapping mice.

Section II. DATA RECORDING

3-9. ENTOMOLOGICAL SURVEY REPORT

The entomological survey report provides information necessary to conduct an arthropod control program. Specific details such as the location of the arthropod specimens, as well as the identification and the medical importance of the specimens are included in this report. Figure 3-12 shows the general format of an entomological survey report.

3-10. THE SURVEY MAP

a. When preparing the survey map, bear in mind that you are the eyes of those who will have to come in and control what you find. Remember that they will often be completely unfamiliar with the surveyed area. Be neat and use a standard method for marking breeding sites. A proven method is to place site numbers in a distinct geometric shape. The site numbers are placed on the map as close to the actual site as possible. For example, mosquito adult resting stations might be represented by numbers in triangles; larval dipping stations by numbers in circles; light trap sites by numbers in squares; and so forth.

b. Progressive numbers should be used starting at number 1 and continuing—number 2, number 3, number 4, and so forth. Regardless of how many sites are located, or even if they harbor the same category of arthropods, use a single number for each. These same numbers are used for your data sheet(s). If you mark an area 3 on your map, Item 3 on your data sheet will reflect what was found there. The survey map is attached to your report as an annex.

c. Notice the number 1 on the survey map provided (see figure 3-13). The legs of the triangle have been extended. This is done when you wish to emphasize that a large area is infested with a specific category of arthropods. By measuring the length of these lines and checking the scale of the map, the control team can determine exactly the area to be controlled.

d. When possible, two maps of each site should be prepared. One map should be prepared for mosquitoes (mature and immature stages) and another for the other arthropods surveyed (see figure 3-14).

e. Maps should also be prepared of all facilities where you conduct cockroach surveillance. Make a master copy for each building, then photocopy as needed. The location of sticky traps can then be recorded to ensure all traps are accounted for. Additionally, you can prepare a map with the numbers of cockroaches captured at each site placed at the site location. This is very useful for directing spot treatments.

Office Symbol Subject: Main topic of report Date:

Memorandum For: Name of person who requested the survey
Person's organization
Post, camp, station, APO, etc. including zip code

1. General. When, what, why, and who in paragraph form.

2. Finding. This section will be in outline form.
   a. Name of place, coordinates, or other specific term to describe one location.

   b. Identification of the specimen found.

   c. Stage of life cycle specimen was in--egg, larva, pupa, adult.

   d. The medical important of the specimen found.

   e. A brief explanation of the specific habitat of the specimen.

   f. The relative abundance index for each specimen. (For greater detail, refer to the survey map and data sheet).

***Note**: If inclement or seasonal weather preclude finding arthropods, utilize this section for habitats found.

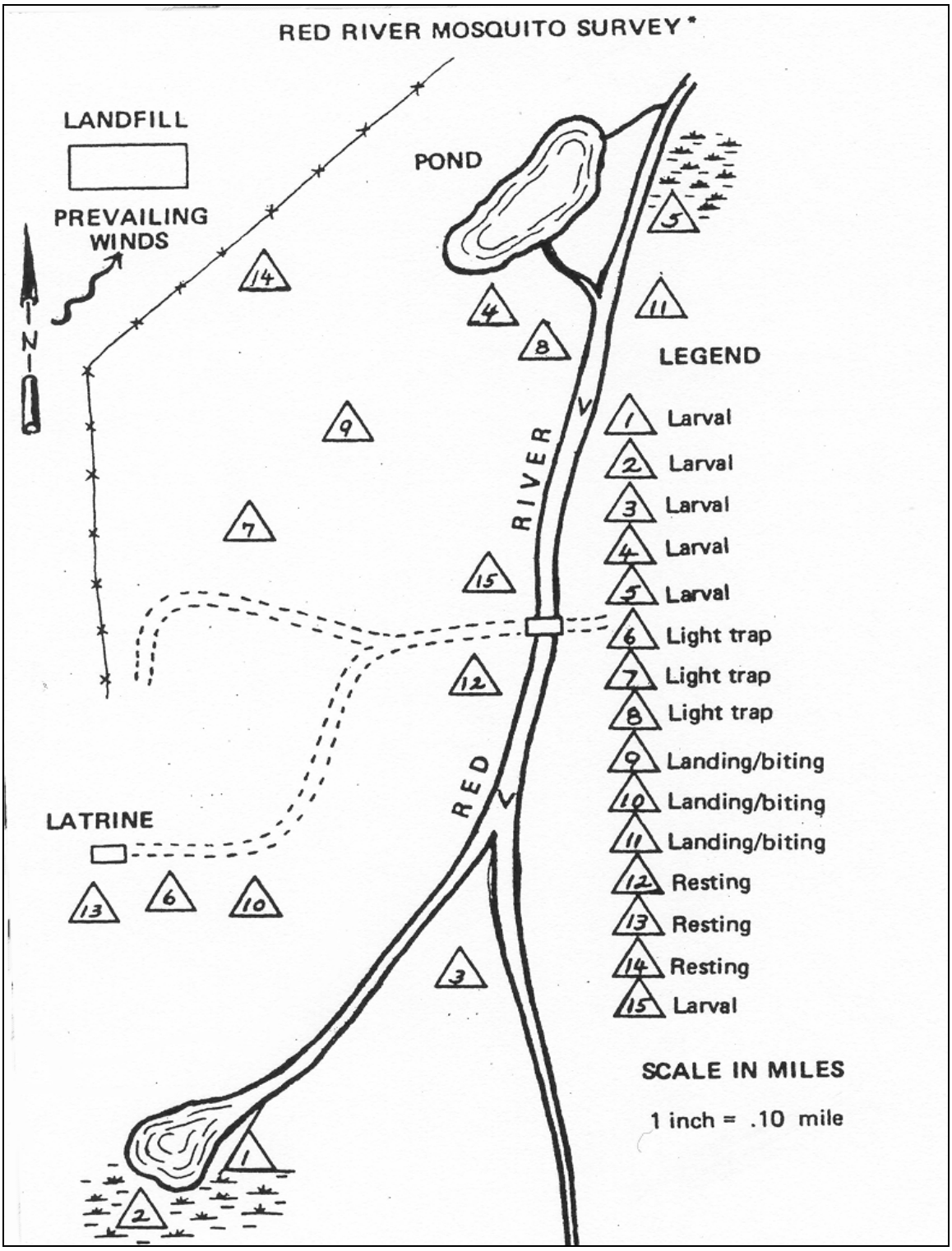
3. Recommendations. This section is used to state whether the area should or should not be used. The basis of this statement should be your finding. You must have a recommendation for each of the findings in your report. These recommendations should be in the same order as the findings. If controls are recommended, they should be specific and include:
   a. The specific control required.
   b. The manpower needed.
   c. Vehicles and equipment required.
   d. The pesticide to be used, its concentration, and its method of application.
   e. Personal protective measures and/or sanitation practices that soldiers can employ, as applicable.

***Note**: These types of recommendations must be compatible with the unit mission. For example, you would not recommend aerial spraying to a unit that has no access to air support. You should consider if the field sanitation team, equipped with two-gallon sprayers, can do the same job.

4. Conclusions. Special notes are used to bring attention to problems, which require immediate attention.

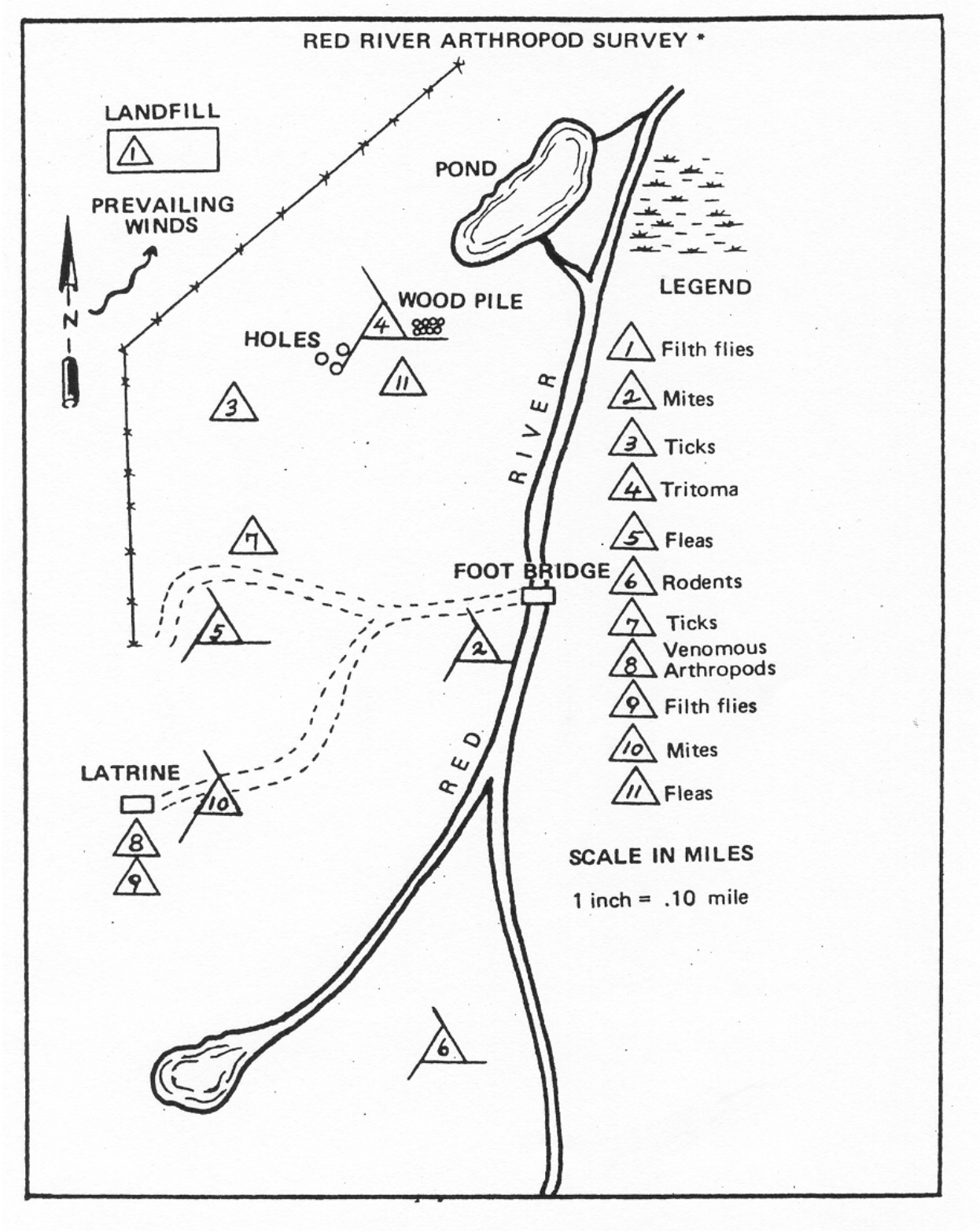
Signature
Name (typed) A
Rank, Section
Organization .

Figure 3-12. Entomological survey report format.



*See data sheet (Figure 3-14) for collection information.

Figure 3-13. Mosquito survey map.



*See data sheet (Figure 3-15) for collection information.

Figure 3-14. Arthropod survey map.

3-11. SURVEY DATA SHEETS

a. Data sheets contain all the pertinent information concerning arthropods found and reported in your report and on your survey map. Included in the data sheet are: names of arthropods, indices of arthropods, methods of collection, and all information considered to be important in dealing with the arthropod's specific habitat and environment. See figures 3-15 and 3-16 for examples of data sheets.

b. Indices deal with the relative abundance or population density of the arthropods found. There are various methods used to determine and record indices. An example is provided in figure 3-17.

Data Sheet — Red River Mosquito Survey

No. of survey	No. of specimens	Name of specimens	Location habitat	Survey method	No. males	Index
1*	2	Aedes vexans	marsh	dipper	NA	2/10 dips
2*	0		marsh	dipper	NA	0/10 dips
3*	4	Anopheles crucians	river	dipper	NA	4/10 dips
4*	2	Culex tarsalis	pond	dipper	NA	2/10 dips
5*	10	Culex salinarius	marsh	dipper	NA	10/10 dips
6	3	Culex quinquefasciatus	latrine	light trap CO_2	0	3/trap/ night
7	8	Culex spp.**	open field	light trap CO_2	2	2/trap/ night
8	30	Culex spp.	near pond	light trap CO_2	8	8/trap/ night 4/trap/ night
9	1	Culex spp.	open field	landing/ biting	0	1/10 min.
10	0	—	—	landing/ biting	0	—
11	0	—	—	landing/ biting	0	—
12	2	Culex spp.	under bridge	aspirator resting	1	2/20 min.
13	0	—	latrine	aspirator resting	—	—
14	0	—	open field	aspirator resting	—	—

* immature
** species plural

Figure 3-15. Mosquito survey data sheet.

Data Sheet — Red River Arthropod Survey					
No. of survey	No. of specimens	Name of specimens	Location or habitat	Survey method	Relative abundance Relative index
1	30	Filth fly	Landfill	Grill	30/landing/10 min.
9		Filth fly	Latrine	Grill	21/landing/10 min. 16/10 min./area
2	5	Mite	Open field	Black plate	5/5 min.
10	7	Mite	Path to latrine	Black plate	7/5 min. 6/5 min.
3	20	Hard tick	Open field	Tick drag	20/100 sq. yd.
7	40	Hard tick	Foot path	Tick drag	40/100 sq. yd.
5	2	Fleas	Open field	Rodent trap	2/rodent
4		Kissing bug	Wood piles holes		4/area
8	3	Venomous Arthropods	Latrine		3/area
6	1	Feral rodents	Hole by river	Live traps	rodent/trap /night
11	8	Fleas	Nest	Berlese Funnel	8/nest

Figure 3-16. Arthropod survey data sheet.

COLLECTION INDICES	
A. Mosquitoes	
1. Adults	
a. Light trap	No./trap/night
b. Biting counts	No./15–30 min.
c. Sweep net	No./100 sq. yd. area
d. Aspirator (wall of bldg.)	No./sq. ft.
2. Larvae	
a. Dipping	No./dip
b. Artificial container	No./estimated capacity of container in gallons/ quarts
B. Filth flies	
1. Fly grill	No./landing/10 min.
2. Baited trap	No./trap/hour
C. Fleas	No./animal or average No./animal
D. Ticks	No./100 sq. yd. drag
E. Mites	No./black plate/10 min.
F. Venomous arthropods	No./nests/No./mounds; etc./area

Figure 3-17. Example of indices.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS. Answer the following exercises by marking the lettered response that best answers the question, by completing the incomplete statement, or by writing the answer in the space provided at the end of the question.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which type of mosquito survey determines the species, source, location, densities, and flight range of mosquitoes?

   a. The original basic survey.

   b. The operational survey.

   c. The adult survey.

   d. The larval survey.

2. A map of the area to be surveyed for mosquitoes should show as a minimum the location of:

   a. Larval, bait, biting, and light trap stations.

   b. Larval, resting, biting, and light trap stations.

   c. Nymphal, resting, biting, and light trap stations.

   d. Larval, emerging, mating, and light trap stations.

3. _____ are conducted using traps, resting station collections, and biting/landing rates.

   a. Mosquito larval surveys.

   b. Adult mosquito surveys.

   c. Adult filth fly surveys.

.

   d. Adult flea surveys.

4. Most mosquito larvae collections are done with a/an:

   a. White enamel dipper.

   b. Light trap.

   c. Aspirator.

   d. Sweep net.

5. In order to collect mosquitoes at a resting station, you need:

   a. Flashlight, light trap, kill jar, pi ll boxes.

   b. Dipper, baster, jars.

   c. Searchlight, sweep net, pi ll boxes, notebook.

   d. Flashlight, aspirator, kill jar, pi ll boxes.

6. The "black plate" is used to survey an area for:

   a. Ticks.

   b. Mites.

   c. Cockroaches.

   d. Fleas.

7. Which survey method is used primarily with day biting species of mosquitoes, is practical when mosquito populations are very high, and is a way of rapidly detecting mosquito abundance before and after control work has been done?

   a. Biting collections.

   b. Light traps.

   c. Landing rates.

.

   d. Resting station collections.

8. _____ are used to gently separate mosquitoes from other arthropods in the killing jar.

   a. Camel hair brushes.

   b. Pencils.

   c. Forceps.

.

   d. Fingers.

9. A rodent is held over a large white enamel pan while being combed with a double-sided, fine-tooth comb to remove fleas from it's body. A camel's hair brush is used to:

   a. Remove the individual fleas from the pan to be placed in vials of alcohol.

   b. Brush the rodent from head to tail in order to remove fleas.

   c. Scrub the rodent while washing it with a detergent that kilis fleas.

   d. Apply the soap solution to the rodent before washing it.

10. Certain persons are more attractive to mosquitoes than others.

   a. True.

   b. False.

11. Two signs of the presence of cockroaches are:

   a. Cockroach food and droppings.

   b. Cockroach rubmarks and egg cases.

   c. Cockroach egg cases and fecal droppings.

   d. None of the above.

12. Mosquito resting stations may be divided into general types:

    a. Landing and biting.

    b. Natural and artificial.

    c. Day and night.

    d. None of the above.

13. Which of the statements below is true?

    a. Fly surveys determine the precise number of flies in an area.

    b. The CDC miniature light trap collects more male mosquitoes than female mosquitoes.

    c. Light traps should not be placed near other lights.

    d. Three collections of mosquitoes per week from each station is sufficient for a routine survey and control operation.

14. What device, made of screen wire, is placed over a natural attractant (that is, garbage, manure), and flies are trapped beneath it?

    a. A fly trap.

    b. A fly grill.

    c. A fly cone.

    d. A fly jar.

15. In order to detect uncommon species of mosquitoes, which are attracted to light, light traps should be operated:

    a. Two nights a week.

I

    b. Three to four nights a week.

    c. Five to six nights a week.

    d. Seven nights a week.

16. The status of the fly population as compared with previous surveys can be maintained on a:

    a. Tape recorder.

    b. Bar graph.

    c. Note pad. ,

    d. Bathroom wall.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. a (para 3-3a)
2. b (para 3-3b)
3. b (para 3-3d)
4. a (para 3-3c)
5. d (para 3-3f(2))
6. b (para 3-5)
7. c (para 3-3g(3)
8. c (para 3-3e(3))
9. a (para 3-7a(1))
10. a (para 3-3g(2))
11. c (para 3-8c)
12. b (para 3-3f)
13. c (para 3-3e(2))
14. c (para 3-4c)
15. d (para 3-3e(2)
16. b (para 3-4)

End of Lesson 3

LESSON ASSIGNMENT

LESSON 4	Arthropod Preservation, Mounting, and Shipping.
TEXT ASSIGNMENT	Paragraphs 4-1 through 4-19.
LESSON OBJECTIVES	After completing this lesson you should be able to:

4-1. Identify the proper technique for killing, preparing, mounting, labeling, and shipping arthopods.

4-2. Identify the names and the functions of equipment and materials used in killing, preparing, mounting, labeling, and shipping arthropods.

4-3. Select the types, sizes, placements, and formats of the labels necessary for a mounted arthropod and list, in the proper order, the information required for each label.

4-4. Choose the correct method for attaching the necessary labels to a mounted specimen.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 4

ARTHROPOD PRESERVATION, MOUNTING, AND SHIPPING

Section I. INTRODUCTION

4-1. GENERAL

No discussion of arthropods would be complete without a description of the proper way to preserve, mount, and ship specimens. The purpose of proper arthropod preservation and mounting is to facilitate arthropod handling, to aid in identification, and to ensure proper storage. In this lesson you will also learn the correct way to prepare arthropod specimens for shipment to another person or to another laboratory.

4-2. SUPPLY ITEMS

You may see references to many supply items that are unfamiliar to you, but these items are all available through normal supply channels. Appendix B lists some of the supplies and equipment that are used in arthropod preservation, mounting, and shipping. For standard supply items, the national stock number is given. Nonstandard items may be purchased locally.

Section II. PIN MOUNTS

4-3. INSECT PIN MOUNTS

Hard-bodied arthropods the size of an average housefly or larger are mounted directly on insect pins. Such specimens include the larger Diptera (filth flies, houseflies, blowflies, etc.) as well as insects of the orders Hymenoptera, Orthoptera, Coleoptera, and Hemiptera. Standard, number 2 and 3 pins are best for mounting hard-bodied arthropods. For efficient pinning, the specimen should be grasped with the thumb and forefinger and the pin inserted with the other hand. Specimens may be killed in killing jars or by freezing, when possible. Be sure to thaw frozen specimens thoroughly before handling. Specimens are pinned as follows.

a. The large Diptera and Hymenoptera are mounted by placing the pin through the right dorsal thorax (see figure 4-1).

b. Orthoptera and Coleoptera are pinned through the right thoracic wing cover (see figure 4-2).

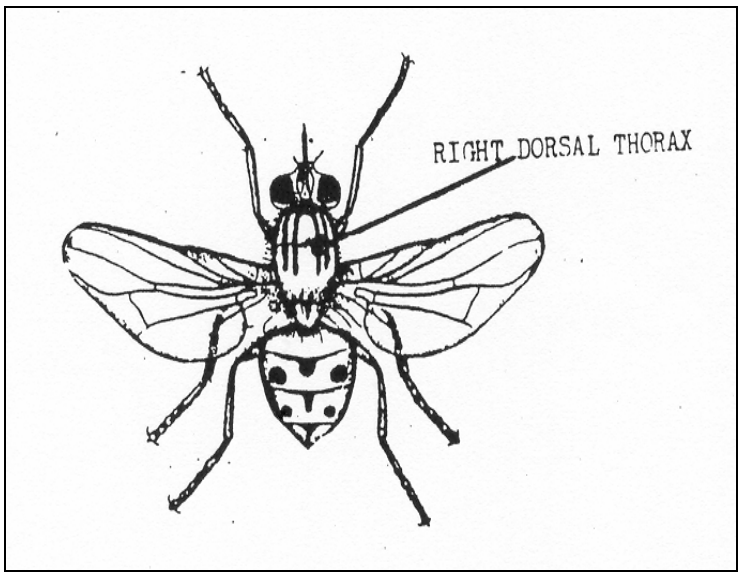


Figure 4-1. Correct mounting position for adult fly, order Diptera.

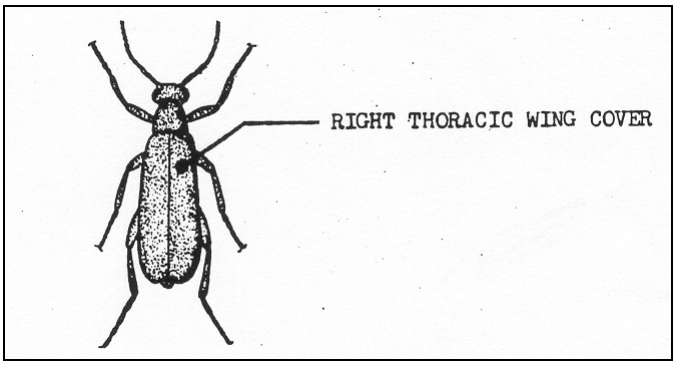


Figure 4-2. Correct mounting position for beetle, order Coleoptera.

c. Hemiptera are pinned through the central dorsal scutellum. In case the specimen is large, such as a large assassin bug, the abdomen may have to be supported to prevent sagging (see figure 4-3).

d. In all cases of pin mounts, the pin is inserted through the specimen until 1/4-inch of the pin is showing above the specimen.

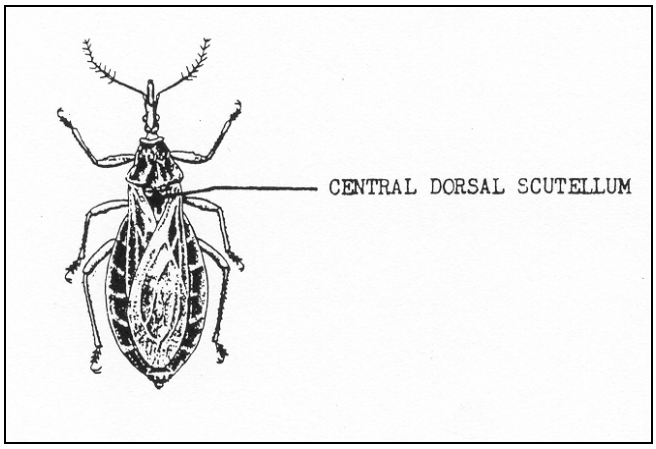


Figure 4-3. Correct mounting position for kissing bug, order Meniptera.

4-4. MINUTEN PIN MOUNTS

In the case of hard-bodied arthropods smaller than a housefly, the minuten pin mount may be used. Equipment includes number 3 insect pins, small blocks of soft wood or cork known as fixation blocks, and small pins known as minuten pins or minuten nadel (German for small needle).

a. The insect pin is pushed through the transfixion block until the transfixion block is one-fourth inch from the head of the pin. The pin is not placed through the center of the transfixion block but slightly off center.

b. Using a pair of forceps, the blunt end of the minuten pin is pushed into the end of the transfixion block.

c. The specimen is placed on a hard surface, with its ventral side up.

d. The sharp end of the minuten pin should pierce the specimen half way through the central, ventral thorax. The legs of the mosquito should be toward the pin, the right lateral surface visible from above. The specimen should be to the left of the No.3 pin.

e. The specimen should be handled as much as possible with forceps, needles, or pins so important characteristics (body appendages, etc.) that are necessary for specimen identification are not lost. An example of a minuten pin mount is shown in figure 4-4.

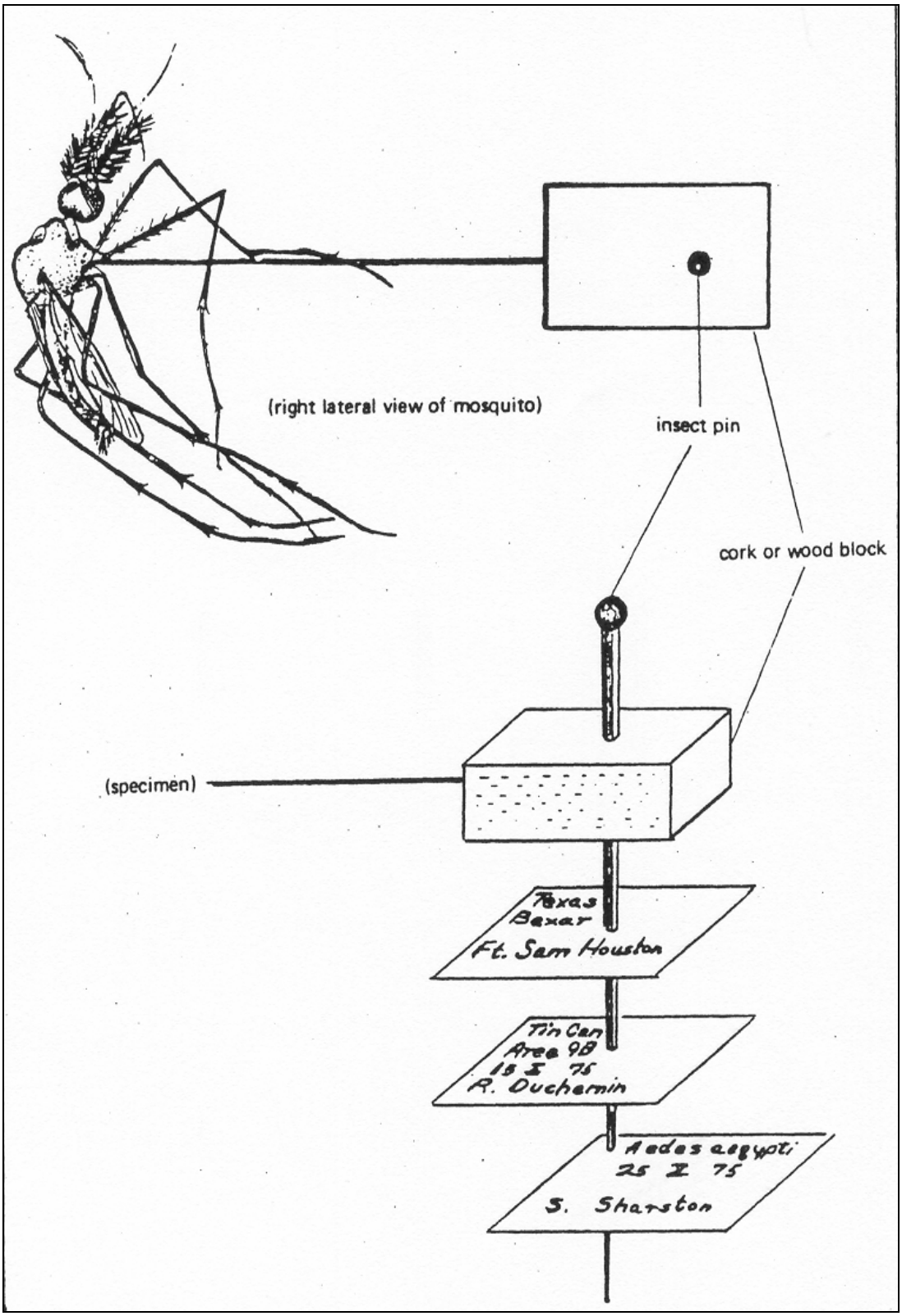


Figure 4-4. Minuten pin mount, top view and front view.

4-5. PAPER POINT MOUNTS

a. The paper point mount is used as an alternate technique for the minuten pin mount and is the preferred method for mounting small insects including mosquitoes. Small paper triangles, or "teardrop" shapes, and an adhesive are the standard pieces of equipment. The triangles may be punched out of 100 percent rag card stock (for example, insect labels) with a paper point punch, cut with scissors to a suitable size, or obtained directly from supply houses. Do not use index cards unless card stock is unavailable. Index cards are too acidic a material and will degrade over time. Clear fingernail polish is the preferred adhesive. An insect pin is put through the base of the paper point. The left lateral thorax of the specimen is attached to the tip of the paper point with a small amount of adhesive. (Too much adhesive may obscure the body parts of the specimen, so as little of the adhesive as possible should be used.)

b. Since the point of attachment is the left lateral thorax, the view of the specimen on a paper point mount is exactly the same as that of one on a minuten pin mount. Figure 4-5 shows an adult mosquito mounted on a paper point. The disadvantage of this mount is the necessity of obscuring one side. However, the paper point mount is generally more stable than the minuten pin mount, and can be tube mailed effectively.

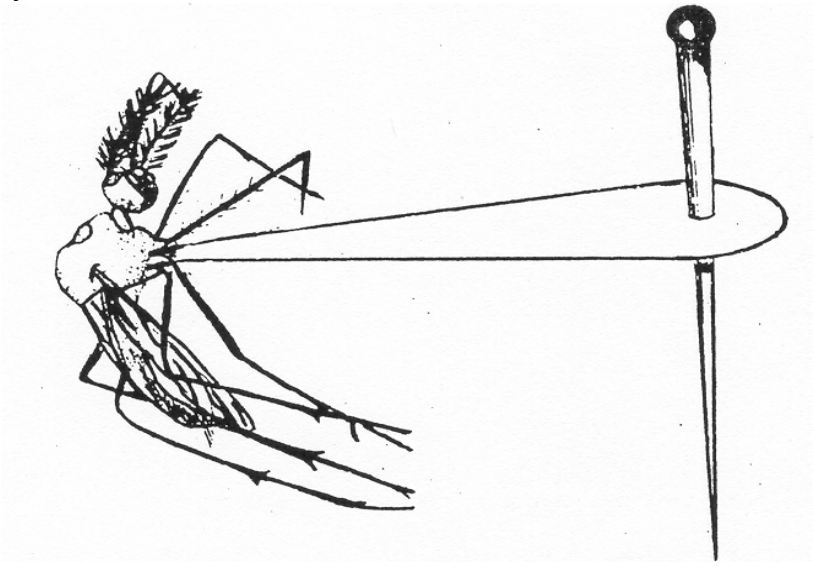


Figure 4-5. Paper point mount.

4-6. LABELING PROCEDURES FOR PIN MOUNTS

Labeling is important in the mounting procedure. A specimen that is not labeled correctly is useless. Three standard labels are used on pin mounts. The labels are made of bond or any other good quality paper and they measure one-fourth by one- half inch. Data are written on the labels by using a fine crow quill pen and India ink. They are placed at increments of one-fourth inch on the insect pin in the following order:

a. **Locality**. The first label is the locality label. The following information should be recorded: state, county, city, or military installation where collection is made. If the collection is made outside the United States (OCONUS), the appropriate information as pertains to the foreign country should be recorded. In all labeling procedures, only standard abbreviations should be used.

b. **Habitat**. Directly below the locality is the habitat label. On this label should be recorded information on the habitat of the arthropod, such as tree hole, tire track, slow-moving stream, and so forth. The date of the collection with the month in Roman numerals and the first initial and last name of the collector must be included.

c. **Determination**. The next label is the determination label. The genus and species of the arthropod, the date of determination, and the determiner's name are placed on this label.

Section III. ALCOHOL PRESERVATION

4-7. TEMPORARY ALCOHOL MOUNTS

Arthropods such as scorpions, spiders, mites, ticks, and ants cannot be mounted on pin mounts because their bodies will shrivel or become distorted. These specimens are usually mounted in temporary alcohol mounts.

a. **Killing Procedures**. Soft-bodied adult arthropods can be killed by freezing, or 95 percent ethyl alcohol (ethanol). When the volume of alcohol is great compared to the size of the arthropod (mites, ticks, lice, and so forth.), the specimen should be killed in 75-80 percent ethyl alcohol. The specimen should be left in the alcohol for 24 hours before transferring it to the preserving media. Mosquito larvae should not be killed in alcohol because they tend to become distorted. The correct way to kill mosquito larvae is to place them in hot water (greater than 65 degrees Celsius).

b. **Mounting Procedure**. Temporary alcohol mounts are made in appropriately sized jars or other glass containers. The container should allow easy viewing, insertion, and removal of the specimen. A very large jar for a small specimen is a waste of medium and space.

(1) The jar should be filled with selected medium. For adult arthropods, 70-75 percent ethyl alcohol is generally used. Small, soft-bodied arthropods may be mounted in 75-80 percent ethyl alcohol. Larvae killed in water should be preserved in 75 percent alcohol. Spiders should be preserved in 95 percent ethyl alcohol. When using ethyl alcohol, one part glycerin must be added to every nine parts of alcohol. The glycerin coats the specimen and protects it from desiccation.

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(2) Once the composition of the medium is determined, the jar should be filled and the specimen added. If the killing media is the same as the preserving media, the specimen can be kept alive until preservation. Specimens of the same species and

habitat may be preserved in the same jar. Labels should then be placed on the jar and the jar capped. The alcohol mount should be air-tight and without air pockets. A screw cap or rubber stopper is excellent, but cork stoppers allow too much evaporation. Vials with rubber stopper lids must be "burped" to remove any air from the container as it is closed. Place the tip of a probe needle along side the stopper as you gently push the stopper into the vial. The probe will create a channel through which excess air/preservative is forced as the stopper is seated. Once the stopper is seated, remove the probe to seal the container.

c. **Labeling Procedure**. Labels for this type of mount are placed inside the jar. If the label is placed outside the container, constant handling and examination will soon smudge or tear the label. The label is written in India ink on waterproof bond paper. The size of the label depends on the size of the specimen and the jar. Obviously, the label should be legible, but it should never obscure the specimen. Locality and habitat information and the type of medium is printed on the bottom half of the label. If India ink is unavailable, a pencil should be used to make temporary labels. Ballpoint pen ink runs in most preservative solutions and should not be used.

d. **Alternate Mounting Medium**. In some cases, an alternate mounting medium may be used. Most of these alternates are acceptable for all types of soft-bodied arthropods. One alternate medium is known as AGA. It is especially recommended for caterpillars.

AGA medium:	9 parts 95 percent ethyl alcohol'
	5 parts distilled water
	1 part glycerin
	1 part glacial acetic acid

4-8. PERMANENT ALCOHOL MOUNTS

For shipping or permanent storage, the permanent alcohol mount is used. A jar is padded with cotton or gauze. A properly prepared temporary alcohol mount is inserted into the padded jar. More than one temporary mount may be placed in the same jar if padding is placed between them. "Windows" should be left in the padding for viewing the specimen. The jar is filled with the same media or one compatible with the media in the temporary mount. It is not necessary to add glycerin to the permanent mount, nor are labels required since the labels of the temporary mount should be legible through the windows. The jar is capped with a screw cap and sealed with paraffin.

Section IV. SLIDE MOUNTS

4-9. GENERAL

The kinds of arthropods that may be mounted on slides are: immature Diptera such as mosquito larvae and pupae; small adult Diptera such as Phlebotomines and Culicoides; and adult ectoparasites such as fleas, mites, and lice. Either temporary or

permanent slide mounts can be made. For reference collections, permanent mounts are preferable; but for rapid survey work, temporary mounts are frequently prepared. Berlese's medium, Hoyer's medium, and methylcellulose are examples of temporary mounting media. Permanent mounting media include Canada balsam, euparal, clarite, piccolyte, and permount.

4-10. TEMPORARY SLIDE MOUNTS

Thin, translucent arthropods too small to be studied without the aid of a microscope should be mounted on slides. Such specimens include small larvae, adult fleas, lice, mites, bedbugs, ticks, and male genitalia of mosquitoes. The temporary slide mount is easy and efficient. It is important that the arthropod be killed properly; most soft-bodied, immature arthropods are killed in hot water (65º C). Larvae should never be boiled since this procedure introduces air bubbles into the body of the larva and destroys delicate structures necessary for identification. Most arthropods should be kilied and preserved in alcohol until ready for slide mounting (but see para 4-7a for mosquito larvae). When mounting such specimens as fleas, ticks, lice, and mites, it is necessary to decolor or dissolve nonchitinous tissue in order to observe internal or obscured structures. The decoloring procedure may be accomplished by mechanical or chemical means. Some mosquito larvae may be adequately studied without decoloring.

a. **The Mechanical Procedure**. This procedure can be accomplished by puncturing the body wall of the specimen with a fine needle. The membrane punctures should be made in the membranous areas between the segments. The body fluids and contents are then "pumped out" by slight intermittent pressure with a brush or a small blunt probe. Unremoved fragments are especially annoying if the specimen is to be stained, since specimens often stain intensely. The "pumping out" process is best accomplished in a shallow dish of water under a dissecting microscope. Care should be taken to avoid destruction of internal taxonomic structures used in identification.

b. **The Chemical Procedure**. This procedure is accomplished by soaking the specimen in a mild caustic solution. Either sodium hydroxide (NaOH) or potassium hydroxide (KOH) (1 KOH pellet per 5 ml water) can be used in concentrations of 5 to 10 percent. Bleaching agents such as sodium hypochlorite (bleach) may also be used. High concentrations of any clearing agent should be avoided as they will result in damage to the specimen. The specimens may be left in the solution for several hours at room temperature. Clearing may be accelerated by heating the solution. Care should be taken to preclude specimens from becoming too pale. In any case, observation should be clearing time will vary greatly from specimen to specimen. On occasion air bubbles may get into the specimen being treated; therefore, the specimen should be removed. This is best accomplished under a microscope in the same manner used for "pumping out" the body contents. Unless the caustic solution is neutralized, the tissues will continue to deteriorate after the specimens are mounted. Therefore, after the specimens have been sufficiently cleared or depigmented, the next step should be to transfer them to a small dish of distilled water that has been acidified with a drop or two of glacial acetic acid or 15 percent hydrochloric acid.

c. **Mounting Procedures**. Once the decoloring procedure has been done, the specimen is ready to be mounted. First of all, the center of the slide should be determined. This is done by laying a blank glass slide on a sheet of paper and drawing an outline of the slide on the paper. Then the slide is removed and diagonal lines are drawn from corner to corner of the slide. Where these lines cross is the exact center of the slide. (See figure 4-6 for an example of how to center a glass slide). After these preliminary procedures are completed (that is, the decoloring procedure and the determination of the center of the slide), a temporary mounting medium is chosen. There are three types in general use: Hoyer's medium, Berlese's medium, and methylcellulose. Of the three, Hoyer's is preferred as it will last one to three years. The arthropod specimen is mounted in the following manner:

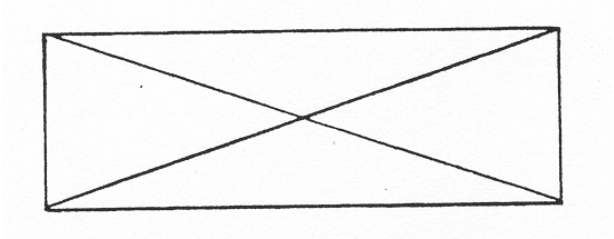


Figure 4-6. Finding exact center of a glass slide.

(1) Place several drops of mounting medium on the center of the slide.

(2) Position the arthropod on the slide being sure to center it properly.

(3) Add enough media to cover the specimen as well as the area that the glass slip will cover.

(4) Paint one edge of the cover glass with medium. This allows increased surface cohesion between the medium on the cover glass and the slide.

(5) Gently lower the cover slip on the slide. (If air bubbles occur in the medium, they may be removed by gently tapping the cover slip or by heating the slide over a bunsen burner. Be careful not to crush the specimen when tapping the glass).

(6) Dry the slide in an incubator at 40º C for four days and air dry for an additional two weeks.

(7) If the media shrinks, add more media around the cover slip edge, and it will be drawn under the glass. The cover glass must be ringed with shellac or fingernail polish to prevent drying and cracking of the medium.

4-11. PERMANENT SLIDE MOUNTS

In making permanent slide mounts, the killing and decoloring procedures described for temporary mounts may be used. However, unlike temporary media, permanent mounting is not soluble in water; so, specimens must be dehydrated by placing them in ascending series of ethyl alcohol concentrations of 70 percent,

90 percent, and 95 percent. The choice of alcohol concentrations and the sequence of dehydration are dependent on the delicacy of the specimen. For example, specimens with soft-body walls will not collapse if processed gradually through the entire alcohol series in ascending order of concentration. Specimens with hard integuments can be dehydrated by placing them directly into high alcohol concentrations without causing any damage to the specimens. Following the dehydration series, the specimen should be rinsed in xylene that is miscible (capable of being mixed) in permanent mounting media.

a. **Preliminary Procedures**. Preliminary procedures for permanent mounts are the same as those described for temporary mounts. There are several permanent mounting media available. Canada balsam is probably the most widely used. After the desired media has been selected, the mounting procedures are conducted in the same manner as described earlier; however, permanent mounts should' be dried at 50º C for two weeks.

b. **Correct Mounting Positions**. For easy examination, specimens mounted on slides must be properly oriented.

(1) Fleas are placed ventral side up with the head to the right. Lice, bedbugs, and mites are placed ventral side up, with the head pointing down, toward the mounter. If desired, two specimens of the same species may be mounted on one slide- one with dorsal side up, and the other with ventral side up. Correct mounting position for a flea, a louse, and a mite are shown in figure 4-7.

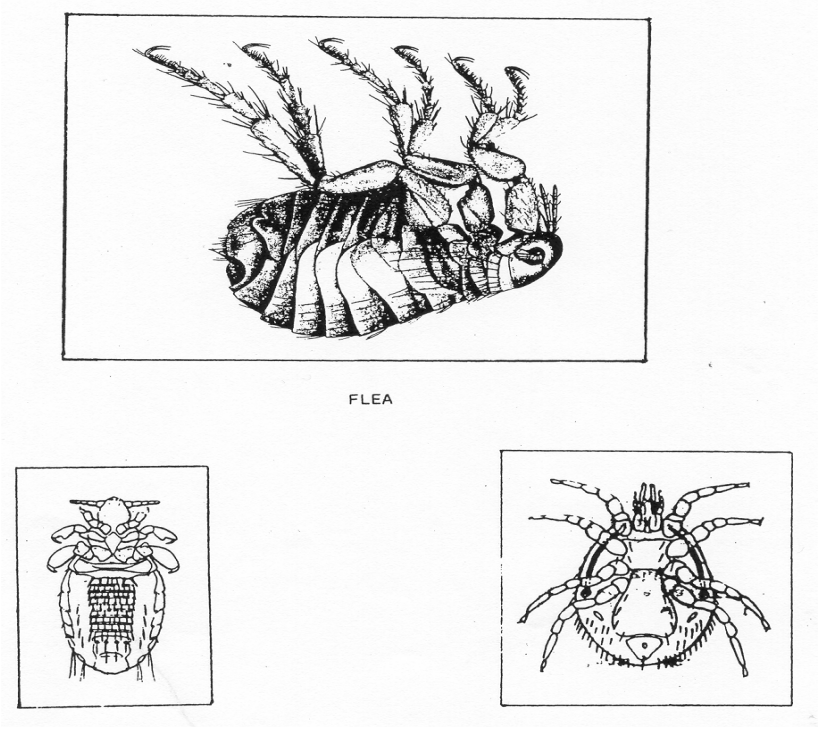


Figure 4-7. Correct mounting positions for a flea, a louse, and a mite.

(2) Culicine mosquito larvae (those having air tubes) require special preparation to mount on a slide. After killing in hot water, the larva should be partially severed between the 6th and 7th abdominal segments, using a sharp scalpel or dissecting pins. The larva is carefully oriented dorsal side up (the head hairs should be showing), with the head pointing down toward the mounter. The air tube is then carefully laid out to the left, at a 45-degree angle to the body. Mounting medium is then carefully applied. Anopheline larvae (those with no air tubes) do not require cutting, but they should be oriented similar to Culicine larvae in all other respects. Correct mounting position for Culicine larva is shown in figure 4-8.

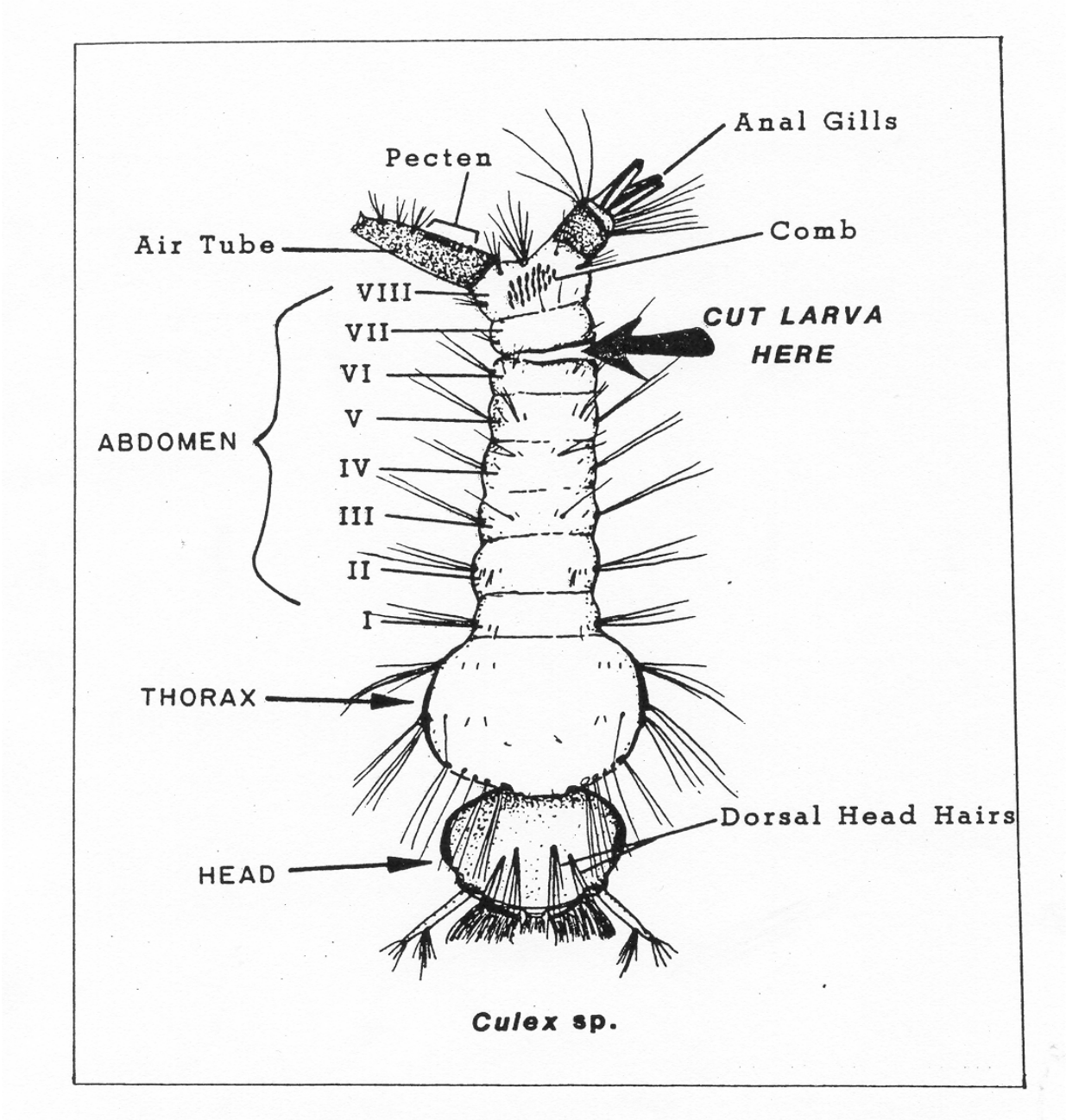


Figure 3-8. Correct mounting position for a culicine mosquito larva.

(3) Professional entomologists involved in taxonomy may require special techniques for the orientation and presentation of specific morphological structures on slide mounts. For example, some genitalia of male mosquitoes need to be removed from the pinned specimens, dissected, and mounted to make identifications of some species.

c. **Labels**. As with all mounted arthropods, slide mounts must be properly labeled. Gummed labels that fit the slides are available. The locality and habitat label are placed to the left of the specimen and the determination label to the right. As with alcohol mounts, the medium used should be specified on the label. Shown in figure 4-9 is an example of a correctly labeled slide mount.

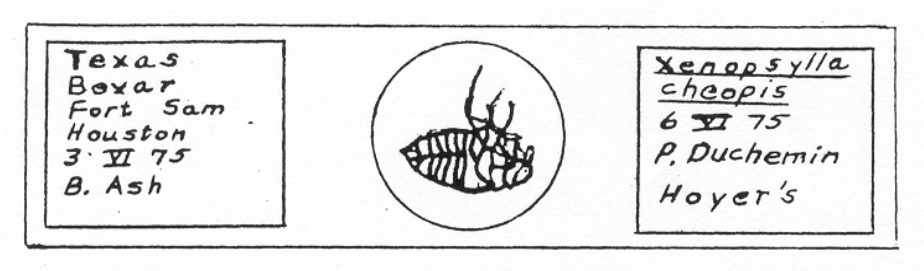


Figure 4-9. Correctly labeled slide mount.

Section V. SPECIFIC MOUNTING PROCEDURES

4-12. MOUNTING MITES IN METHYCELLULOSE

a. Kill the specimen in 70 percent alcohol. Immerse the specimen in a solution of 10 percent lactic acid from 10 to 30 minutes depending upon the size of the specimen. As many as ten specimens can be handled at one time conveniently.

b. Remove the specimen to the methylcellulose medium and heat, being careful not to boil. The heating procedure may be repeated a number of times until the desired clearing, relaxing, and straightening of the legs have been obtained.

c. Transfer the specimen to a slide containing methylcellulose. Arrange the specimen ventral side up, head down, and apply the cover slip. It is desirable that only one specimen be mounted per slide.

4-13. MOUNTING FLEAS AND SUCKING LICE IN BALSAM

a. Kill the specimen in 70 percent alcohol and transfer it to a shallow dish containing water.

b. Place the specimen under water and puncture it between the second and third abdominal segments. Great care should be taken to avoid tearing of the

specimen. Flea specimens should be in 10 percent potassium hydroxide (KOH) (1 KOH pellet per 5 ml water) for at least 24 hours. Punctured I ice specimens should be left in 10 percent KOH for approximately 4 to 6 hours depending on the size of the specimen. In order to remove the contents of the digestive tract, gentle pressure should be applied to the abdomen. If the contents are not easily removed, it may be necessary to heat the specimen in the 10% KOH for 1 or 2 minutes until the abdominal contents are soft.

c. Transfer the specimen from KOH to distilled water and leave for 20 percent minutes. Remove the specimen from the water to a solution consisting of 30 to 50 percent alcohol plus 1 percent hydrochloric acid (HCL). Leave the specimen in this solution for about 20 minutes. Then transfer it to 70 percent, 90 percent, and 100 percent alcohol consecutively, allowing 20 minutes in each concentration.

d. Remove the specimen from 100 percent alcohol to 100 percent cellosolve for at least one-half hour.

e. Place the flea specimen horizontally in balsam with the head to the right of the slide and the legs up. If the species of specimen is known before mounting, the specimens may be mounted in pairs on the same slide, placing the male above the female. Add a small drop of xylol to the medium and then apply the cover glass. The slide may be air-dried or placed in a drying oven to harden as described previously.

4-14. MOUNTING MOSQUITO LARVAE AND PUPAE IN BALSAM

a. KiII the specimen in hot water (65° C) or 95 percent alcohol.

NOTE: Minimize the handling of specimens by removing various fluids described from the specimen container using a pipette or dropper rather than transferring the insects from container to container.

b. Replace the killing fluid with fresh 95 percent alcohol for 10 minutes. Replace with a 1:1 mixture of cellosolve and 95 percent alcohol for 10 minutes. Replace with 100 percent cellosolve for 10 minutes to the mount specimen.

c. The abdomen of a culicine larva should be partly severed between abdominal segments six and seven with a sharp needle.

d. Mount the specimen in balsam with dorsal side up. When mounting culicine mosquito larvae, the severed terminal segments should be mounted with the left side up. For all pupae, the cephalothorax is separated from the metanotum and the abdomen and mounted with the left side up.

Section VI. SHIPPING PROCEDURES

4-15. GENERAL

There will be times when it may be necessary to ship specimens to another person or laboratory. All the work done in collecting, identifying, and mounting will be wasted if the specimens arrive at their destination in poor condition. The procedures listed next have been found to be excellent methods for shipping mounted specimens and are highly recommended.

4-16. PIN MOUNTED SPECIMENS

a. Most pin mounted specimens are shipped in Schmitt boxes. A Schmitt box is a wooden box with a hinged lid, lined with white paper. The bottom of the box is padded with a material that can be pierced with an insect pin. Figure 4-10 shows an empty Schmitt box. An empty cigar box will suffice in case a Schmitt box is not available.

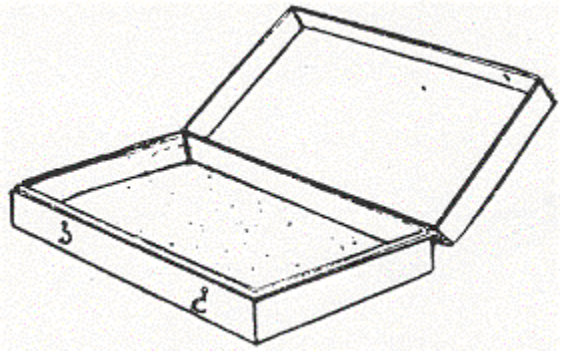


Figure 4-10. Empty Schmitt box.

b. Specimens are pinned firmly to the bottom of the box using pinning forceps or needle-nosed pliers. Specimens should be pinned far enough apart so they will not touch each other in case they turn or swing. Long appendages or long abdomens should be braced and supported by extra pins. Two or three additional pins are placed in the corner of the box; the pins should be of the same height. A piece of cardboard cut to the exact inner dimensions of the box is placed over the pins. The space between the cardboard and the lid of the insect box is padded with folded newspapers, cotton, or gauze. Repellent flakes or crystals should not be placed in the Schmitt box with the specimens being shipped because the repellent can damage specimens if it moves around in the box.

c. An inventory of the box contents should be taped inside the top left corner of the box lid. This inventory should be as detailed as possible. The specimen should always be identified by genera and species. If unable to identify specimens, it is permissible to use common names.

d. After inserting the inventory, the Schmitt box is closed and secured with tape. It is then placed inside a larger box and the space between the two boxes (at least 3-4 inches all around Schmitt box) is padded with cotton or newspaper. The outer box should be sealed with strong paper tape. The box is then addressed, using a Department of the Army mailing label, DA Label 18. It is advisable to label the Schmitt box also before packing it into the outer box.

4-17. ALCOHOL MOUNTED SPECIMENS

a. When shipping alcohol mounts, all temporary mounts should be converted to permanent mounts. Tube mailers are used to ship permanent alcohol mounts. Tube mailers consist of two parts, the inner and outer tubes, and are available in different sizes. A size appropriate to the size of the mount to be mailed should be chosen. The inner tube is padded with gauze or cotton. The mount is then inverted into the tube and the tube is capped. The packing material should prevent any movement of the mount.

b. The aluminum tube is addressed using the proper form and an inventory is taped on the opposite side. After the tube is capped tightly, it is inverted into the larger cardboard tube. The tube is capped, addressed, and mailed.

c. If tube mailers are not available, the permanent alcohol mount may be individually wrapped and packed together in a wood or a cardboard box. The individual mounts are separated and completely surrounded by packing material such as cotton, gauze, or tightly wadded newspaper.

4-18. SLIDE MOUNTED SPECIMENS

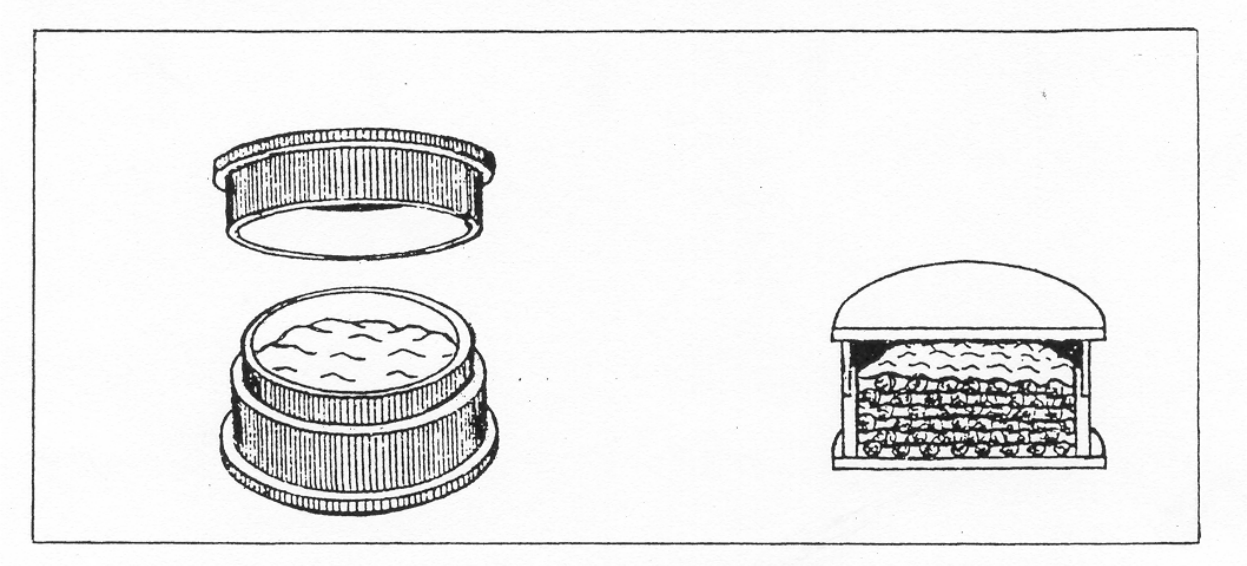
a. Slides to be shipped are wrapped in tissue paper and individually inserted into slide mailers, (slotted cardboard containers designed especially for slides). The mailer is taped shut, addressed, and the name of the specimen put on the opposite side of it. If three slide mailers or less are being shipped, they may be wrapped in heavy paper, addressed, and mailed. If more than three are being shipped, they should be shipped in a well-padded box.

b. If a large number of slides are to be shipped, heavy cardboard or wooden boxes with slots should be used. Strips of packing material should be placed between the slides and l id of the box so that the slides will not rattle or bounce. The slide box should then be packed in a larger, well-padded box, addressed, inventoried, and mailed.

4-19. UNMOUNTED SPECIMENS

a. Sometimes it is necessary to ship unmounted specimens. In this case, the pillbox method is used. These boxes come in three sizes. First of all, the smallest of the three boxes is lined with a layer of tissue. The specimens are placed on the tissue and covered with another tissue layer. With tissue between each layer, as many as

three layers may be placed in each pillbox. In the case of small specimens, as many as five specimens may be put in each layer. Large specimens such as flies and cockroaches may be limited' to one or two specimens per layer. In all cases, the pillbox should never be over-packed. See figure 4-11.



Adult mosquitoes and other fragile Insects are placed in a pillbox between layers of lens paper or facial tissue cut slightly larger than the pillbox. Fill with layers of tissue.

Cross section of pillbox showing insects placed between layers of lens paper or facial tissue.

Figure 4-11. Specimens in pillbox.

b. When the first box is packed, the edges are sealed with tape and it is addressed. This box is placed in a second box that is also taped and addressed. This box may then be packed in a well-padded cardboard box with other packed specimens and mailed. A complete inventory must be included.

c. Whenever possible, specimens should be mailed through military postal facilities by ordinary mail if within the United States (CONUS) or within an overseas command. Overseas shipments should always be made by air mail, provided local postal regulations permit it. Mailing labels should indicate that the contents consist entirely of scientific specimens without commercial value and should be marked "Fragile." No difficulty should be encountered provided all postal and customs regulations are complied with.

Continue with Exercises

EXERCISES, LESSON 4

INSTRUCTIONS. Answer the following exercises by marking the lettered response that best answers the question, by completing the incomplete statement, or by writing the answer in the space provided at the end of the question.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which of the following are mounted directly on insect pins?

   a. Blowflies.

   b. Mosquitoes.

   c Fleas.

   d. Ants.

2. _____ are usually mounted on the paper point mount.

   a. Adult mosquitoes.

   b. Adult fleas.

   c. Adult ticks.

   d. None of the above.

3. When using the minuten pin mount, the sharp end of the minuten pin should pierce the specimen:

   a. On the central dorsal thorax.

   b. On the central ventral thorax.

   c. On the right lateral surface.

4. When using the paper point mount, the point of attachment of the specimen is:

   a. The right lateral thorax.

   b. The central ventral thorax. ~

   c. The left lateral thorax,

   d. The central dorsal thorax.

5. The _____ is generally more stable than the minuten pin mount.

   a. Inverted minuten in mount.

   b. Paper point mount.

   c. Bulk mount.

   d. Concrete mount.

6. Labels used on pin mounts measure:

   a. 1/2" x 1/2".

   b. 1/4" x 1/4".

   c. 1/4" x 1/2".

7. The date of the collection should have the month:

   a. Written out in longhand.

   b. Printed in Arabic numbers.

   c. In Roman numerals. ,

8. Which of the following arthropods are usually mounted in temporary alcohol mounts?

   a. Scorpions.

   b. Flies.

   c. Mosquitoes.

   d. Cockroaches.

9. The correct way to kill mosquito larvae is to place them in:

   a. Balsam.

   b. Boiling water.

   c. Glycerin.

   d. Water (65º C).

10. Spiders should be preserved in:

   a. 70-75 percent ethyl alcohol.

   b. 75-80 percent ethyl alcohol.

   c. 95 percent ethyl alcohol.

11. Which of the following is <u>not</u> recommended for capping the jar of an alcohol mount?

   a. A cork stopper.

   b. A screw cap.

   c. A rubber stopper.

12. Labels for the alcohol mount are placed _____ the container.

    a. Outside.

    b. Inside.

13. Labels can be written with a ballpoint pen.

    a. True.

    b. False.

14. One alternate medium known as AGA is especially recommended for:

    a. Caterpillars.

    b. Spiders.

    c. Mosquitoes.

    d. Flies.

15. It is not necessary to add glycerin to:

    a. Temporary alcohol mounts.

    b. Alternate mounting mediums.

    c. Permanent alcohol mounts.

16. Which of the following may be mounted on slides?

    a. Fleas and I ice.

    b. Caterpiliars.

    c. Adult mosquitoes.

    d. All of the above.

17. Permanent mounting media include:

    a. Balsam, Hoyer's, Berlese's.

    b. Balsam, Methyl cellulose, Permount.

    c. Balsam, Euparal, Permount.

    d. Hoyer's, Berlese's, Methyl cellulose.

18. Decoloring is used to enable you to:

    a. Kill soft-bodied adult arthropods.

    b. Protect arthropods from desiccation.

    c. Observe the internal or obscured structures of arthropods.

    d. Dehydrate specimens before mounting them.

19. Of the following temporary mounting mediums, which is the best recommended?

    a. Hoyer's medium.

    b. Berlese's medium.

    c. Methyl cellulose.

    d. None of the above

20. Of the following microscope slide media, which are soluble in water?

    a. Temporary media.

    b. Permanent mounting media.

21. Match the arthropod with its correct slide mounting position.

Mites	_____	a. Dorsal side up, with head away from mounter.
Bedbugs	_____	b. Ventral side up with the head to the right.
Culicine larvae		c. Ventral side up with the head to the mounter.
		d. Dorsal side up with the head down toward the mounter.

22. _____ should be placed in 10 percent potassium hydroxide (KOH) for at least 24 hours

a. Flea specimens.

b. Stinging caterpiliars.

c. Cockroaches.

d. Flies.

23. Most _____ are shipped in Schmitt boxes.

a. Pin mounted specimens.

b. Alcohol mounted specimens.

c. Slide mounted specimens.

d. Unmounted specimens.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES. LESSON 4

1. a (para 4-3)
2. a (para 4-5)
3. b (para 4-4d)
4. c (para 4-5b) L
5. b (para 4-5b)
6. c (para 4-6)
7. c (para 4-6b)
8. a (para 4-7)
9. d (para 4-10)
10. c (para 4-7b(1»
11. a (para4-7b(2))
12. b (para 4-7c)
13. b (para 4-7c)
14. a (para 4-7d)
15. c (para 4-8)
16. a (para 4-9)
17. c (para 4-9)
18. c (para 4-10)
19. a (para 4-10c)
20. a (para 4-11)

21. Mites--c
Bedbugs--c
Culicine larvae--d (paras 4-11b(1), (2))

22. a (para 4-13b)

23. a (para 4-16b)

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End of Lesson 4

APPENDIX A

INTRODUCTION TO MOSQUITO IDENTIFICATION

A-1. GENERAL DESCRIPTION

a. Mosquitoes are small, fragile insects with long, slender legs, one a pair of wings, and hind wings reduced to knoblike halters (figure A-1). They are distinguished from midges, craneflies, and other flies by:

(1) Mouthparts characterized by a long proboscis or beak.

(2) Wings with at least some of the veins clothed with scales.

(3) The presence of long, conspicuous antennae.

b. About 167 species of mosquitoes belonging to 13 genera have been described from North America, north of Mexico. Many of these species are relatively rare and of little or no medical importance. Mosquitoes in the genera Toxorhvnchites, Wyeomvia, Orthopodomyia, Deinocerites, and Haemogogus are usually uncommon, and are marked in the following key with an asterisk (*) with the exception of Haemogogus that is omitted altogether.

c. Female mosquitoes are the blood-feeders and the only sex of medical/economic importance, thus the following key is designed primarily for females. To distinguish between the sexes see figure A-2):

(1). Males have antennae hairier (more plumose) than do the females.

(2). Often, palpi of males are long, as long as the proboscis; whereas, in most genera (except Anopheles), palpi of females are short, distinctly shorter than the proboscis.

(3). Some mosquitoes have short palpi in both sexes, and distinguishing between the sexes can be confusing for the beginner. The following key allows for this, and it is possible to correctly determine females to genus. Certain characteristics apply only to females and are so designated.

A-2. IDENTIFICATION

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a. A pictorial key of the common genera of adult mosquitoes is presented in figure A-3. Figure A-4 shows the yellow fever mosquito.

b. Some of the common structures used in identification of mosquito larvae found in the U. S. is presented in figure A-5.

ADULT FEMALE

Chester J. Stojanovich and Harold George Scott

DORSAL VIIEW

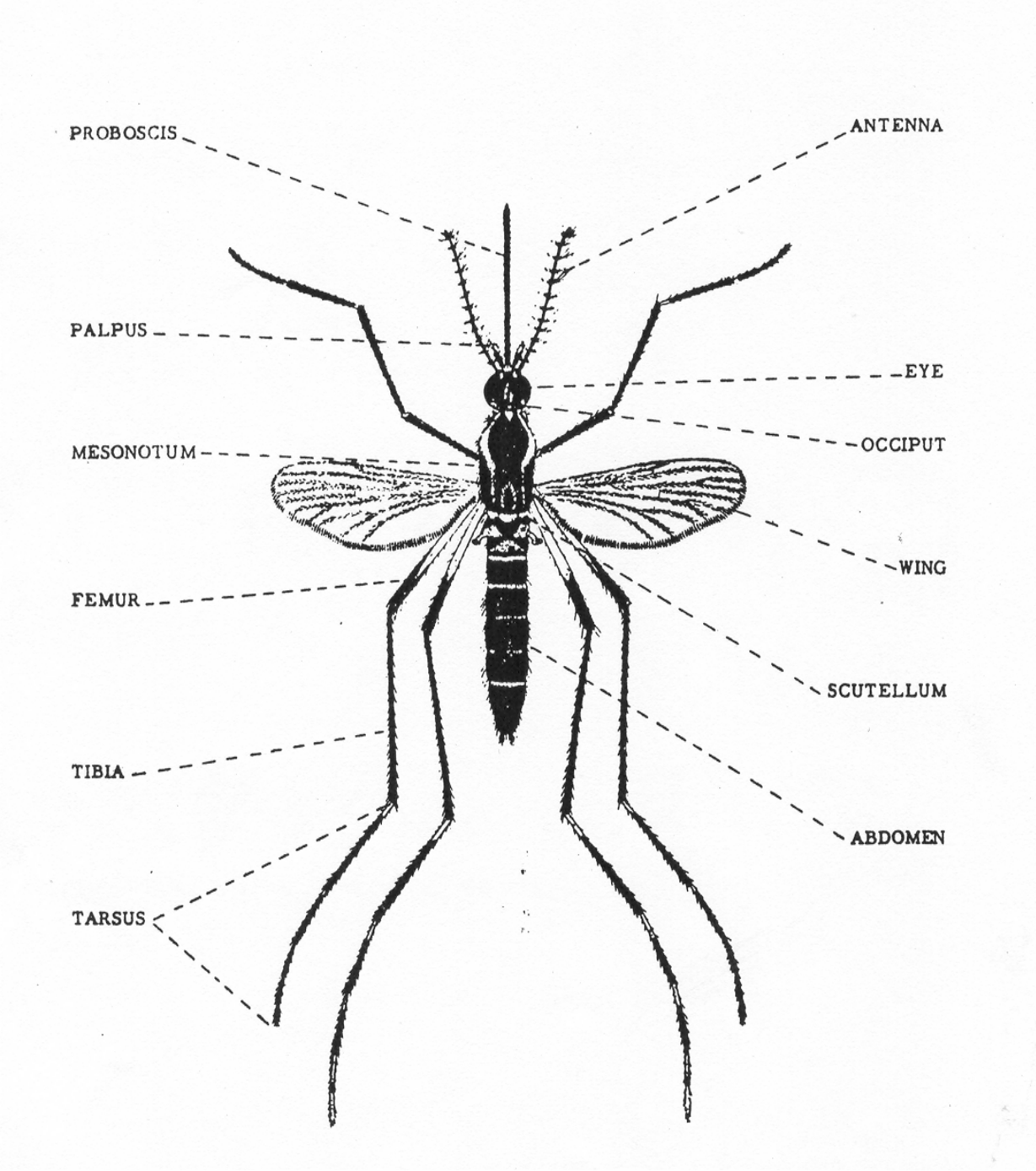
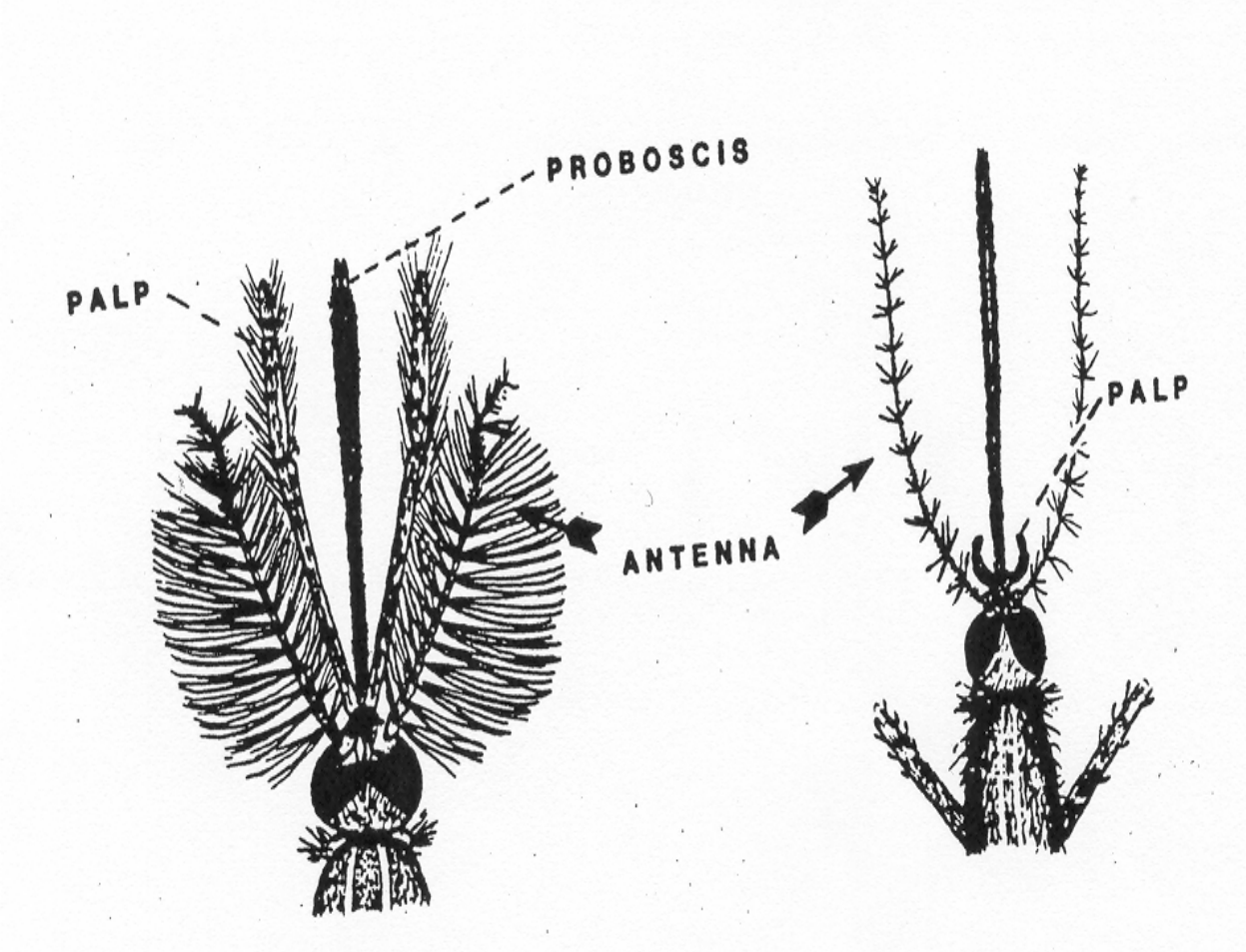


Figure A-1. Characteristics of an adult female mosquito



a. Male of Culex b. Female of Culex

Figure A-2. Head of male vs. female culicine mosquito.

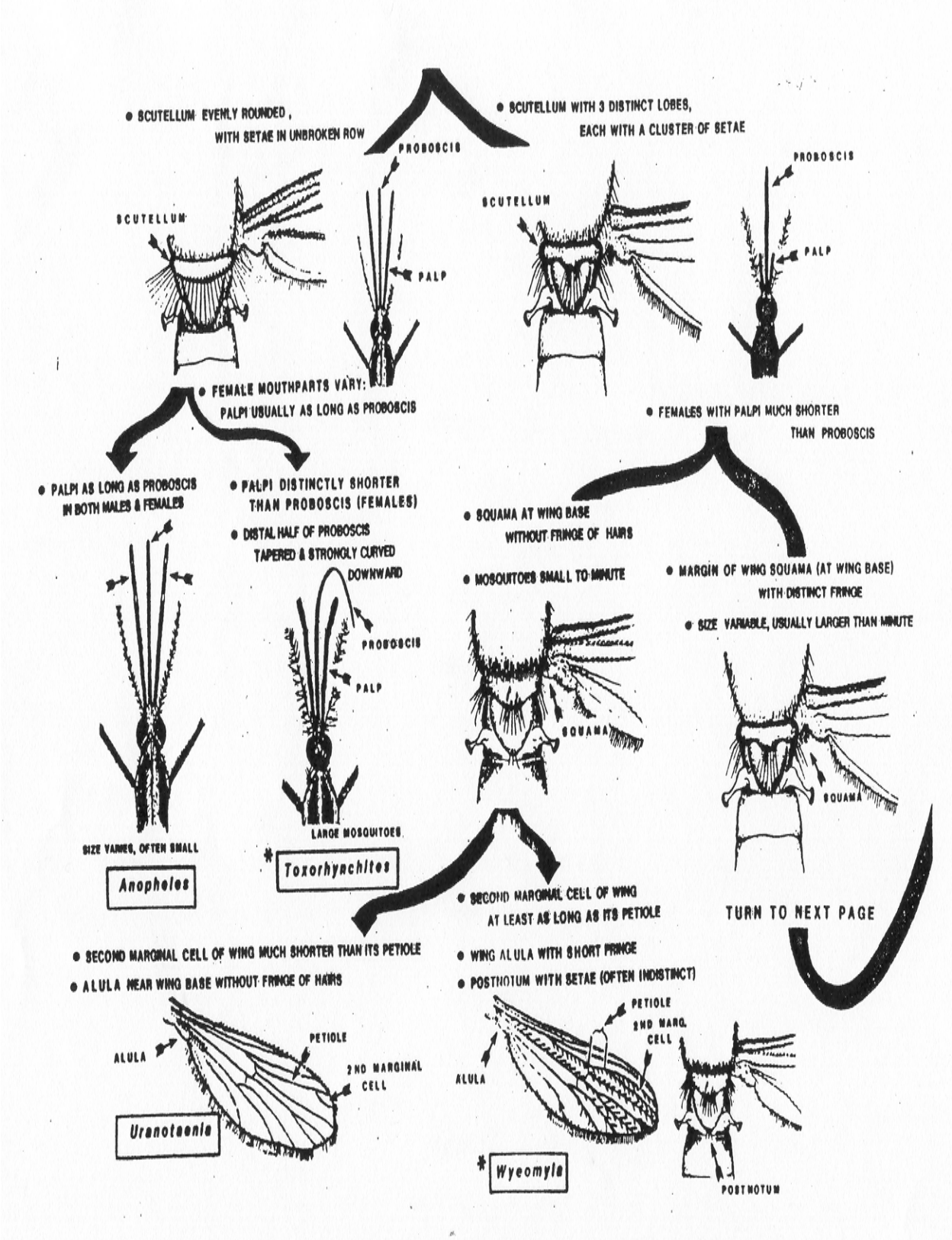


Figure A-3. Pictorial key to common genera of adult female mosquitoes in the US.

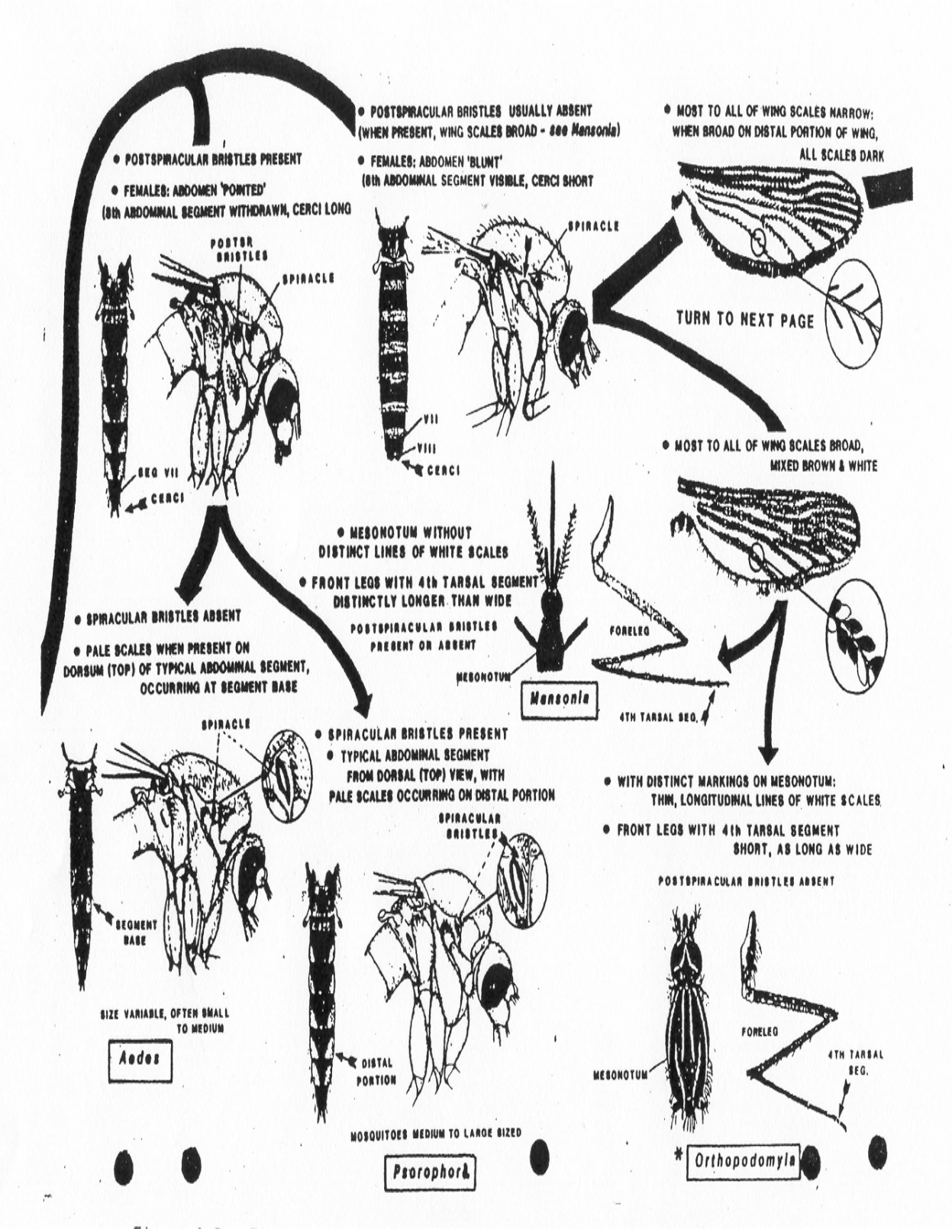


Figure A-3. Pictorial key to common genera of adult female mosquitoes in the US. (continued).

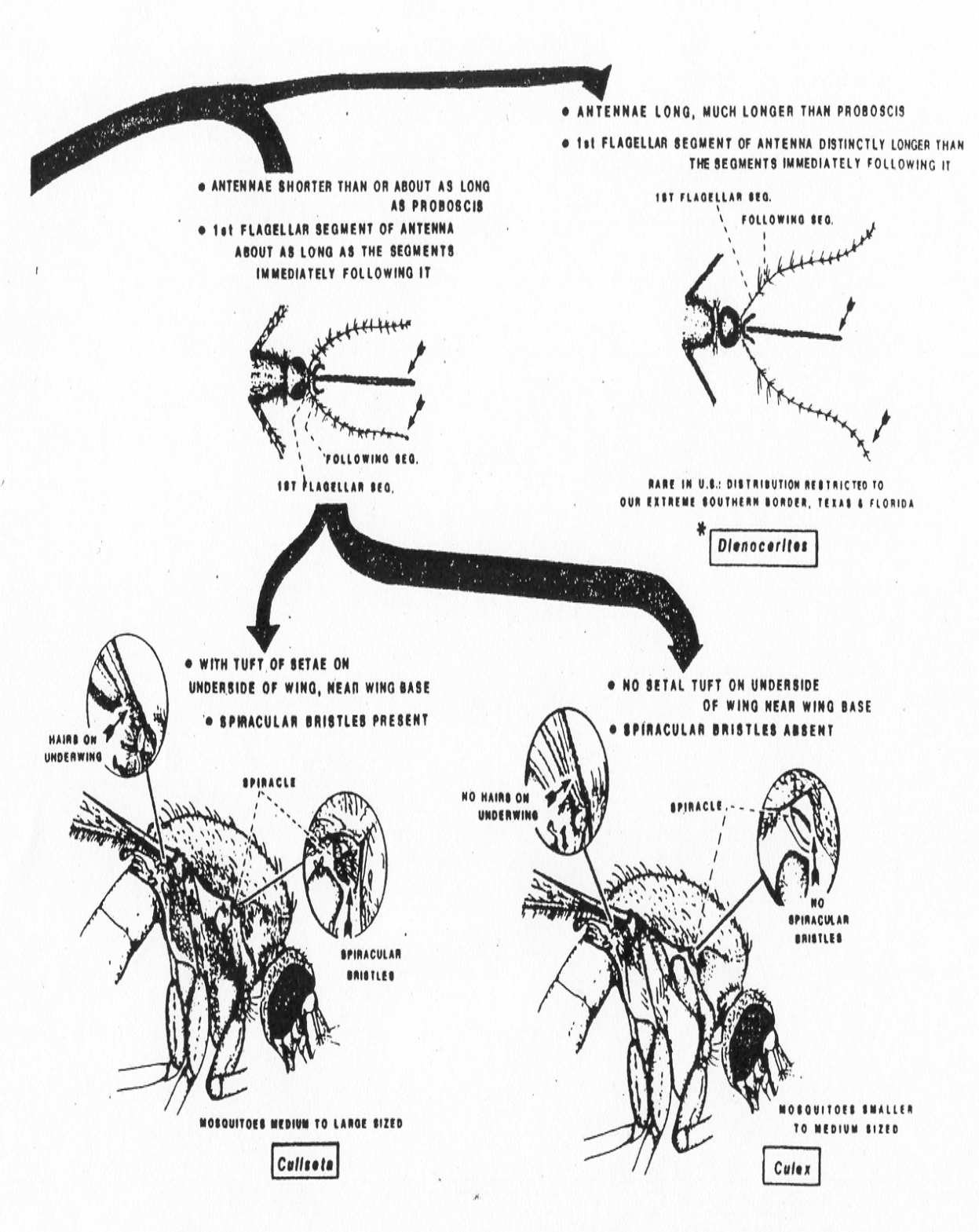


Figure A-3. Pictorial key to common genera of adult female mosquitoes in the US. (concluded)

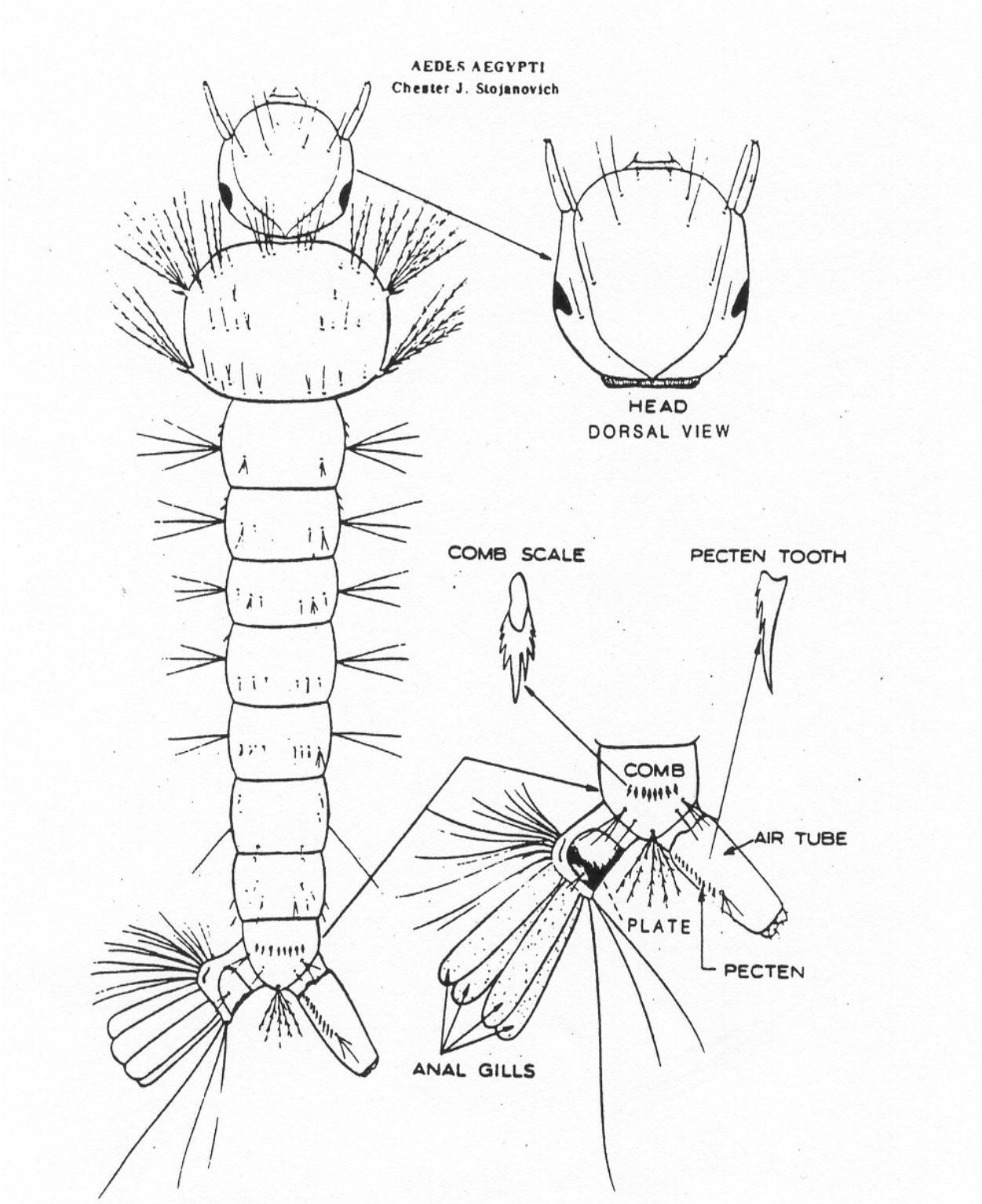


Figure A-4. The yellow fever mosquito, Aedes aegypti (L)

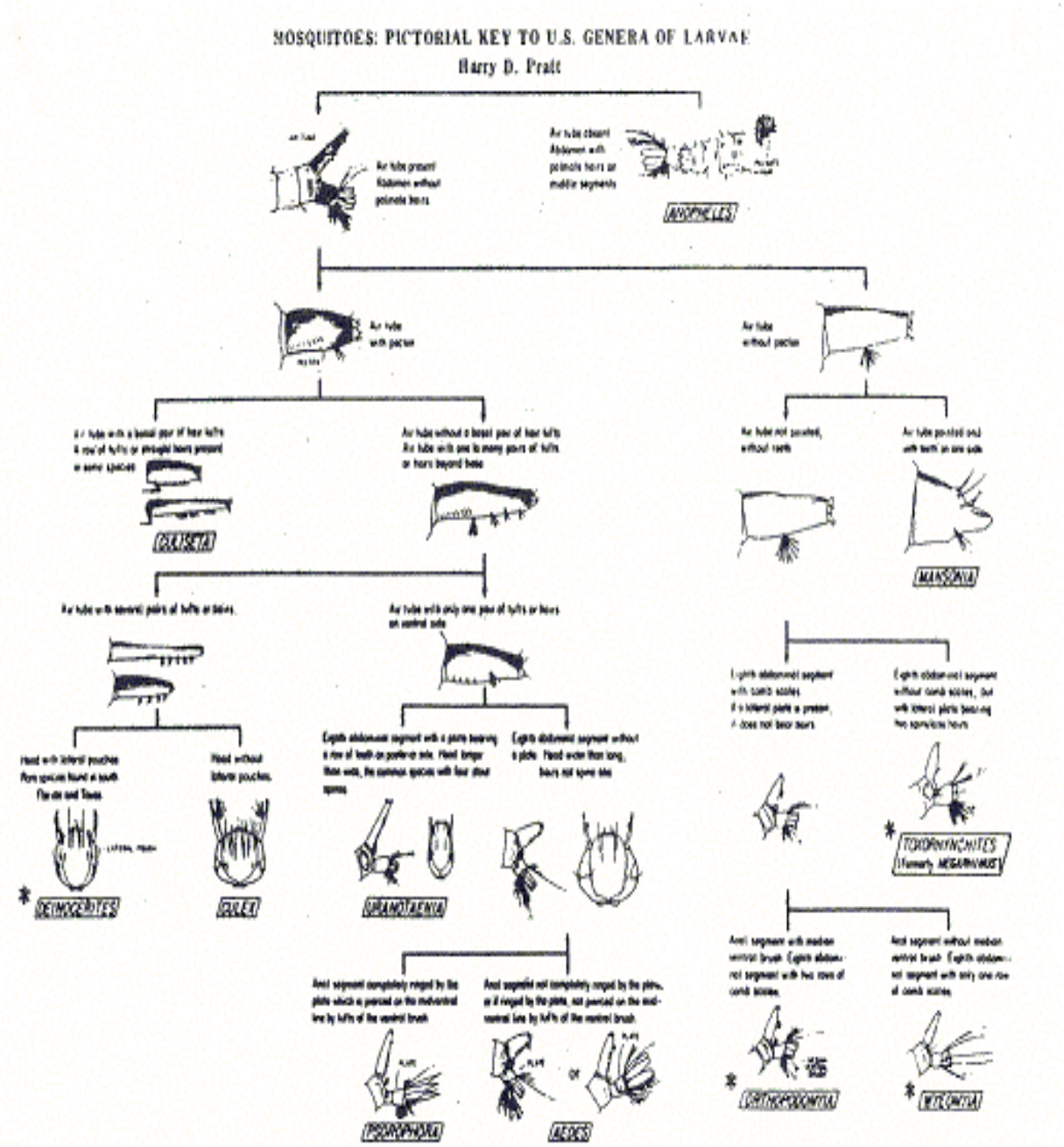


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Figure A-5. Mosquitoes: Pictorial key of US genera of larvae.

End of Appendix A

APPENDIX B

SUPPLIES USED IN ARTHROPOD SURVEYS

SUPPLIES--STANDARD ITEMS

National Stock Number	Item	Unit of Issue
6640-00-403-1500	Beaker, Laboratory, 50ml	ea
6640-00-851-6724	Bottle, Dropping, 60ml, Amber	ea
6640-00-430-1212	Bottle, Screen, Cap, Specimen, 9m l 72' s	bx
6640-00-408-9820	Box, Insect Specimen	ea
6640-00-074-4191	Slide, Microscopic	pg
6640-00-618-0066	Coverglass, Micro, 22mm Sq	pg
6640-00-422-4000	Dish, Biological Preparation, 12's	ea
6640-00-436-1500	Paper, Filter, Quantitative, 150mm	bx
6640-00-436-5285	Pin, Minuten 500's	pg
6640-00-436-5288	Pin, Insect, No.3, 100's	pg
6640-00-404-2100	Block, Insect, Fixation Cork, 100's	bx
6640-00-299-8493	Wash, Bottle, Lab, 250ml	ea
6515-00-660-0010	Blade, Surgical Knife, No 21	bx
6810-00-174-1824	Paradichlorobenzene, 1 lb can	cn
7510-00-223-0400	Crowquill Pen	ea
6515-00-364-4800	Scissors, Iris	ea
6810-00-753-7480	Acetone	bt
7510-00-233-0384	Black ink, waterproof	bt
6505-00-104-9000	Ethyl Alcohol	dr
6640-00-408-2200	Bottle, 23ml, 72's	bx
6810-00-734-4787	Xylene	bt

National Stock Number	Item	Unit of Issue
7510-00-161-6217	"Rule,Laboratory 18"	ea
6015-00-344-7800	Handle, Surgical Knife number 4	ea
6640-00-408-9150	Bottle, 84ml 48's	bx
6810-00-264-6609	Chloroform, 1 pt	bt
6505-01-162-1337	Ethyl Acetate, 1 pt	bt

SUPPLIES--NONSTANDARD ITEMS*

Item

Cloth, Cheese--Pkg of 10 yds

Dishes, Culture Petri, 150mm x 20mm Pkg of 24 pairs

Desiccator, with coor plate Dia 250mm

Coverglass Round No.1 22mm ounce

Coverglass Round No.1 18mm ounce

Coverglass, No 1 Round, 12mm ounce

Dissecting Needles, Cedar Wood Handles Package of 144

Dissecting Needles, Package of 144

Mounting media
- Euparol Essence
- Euparol
- Permount

Cellusolve 3K6, btl

Forceps, Swiss Watchmakers 4 1/2 oz

"Point punches "

Insect Pins #2 1000's in lots of 1000--5900

Forceps, Pinning

- Nonstandard items may be purchased locally.

End of Appendix B