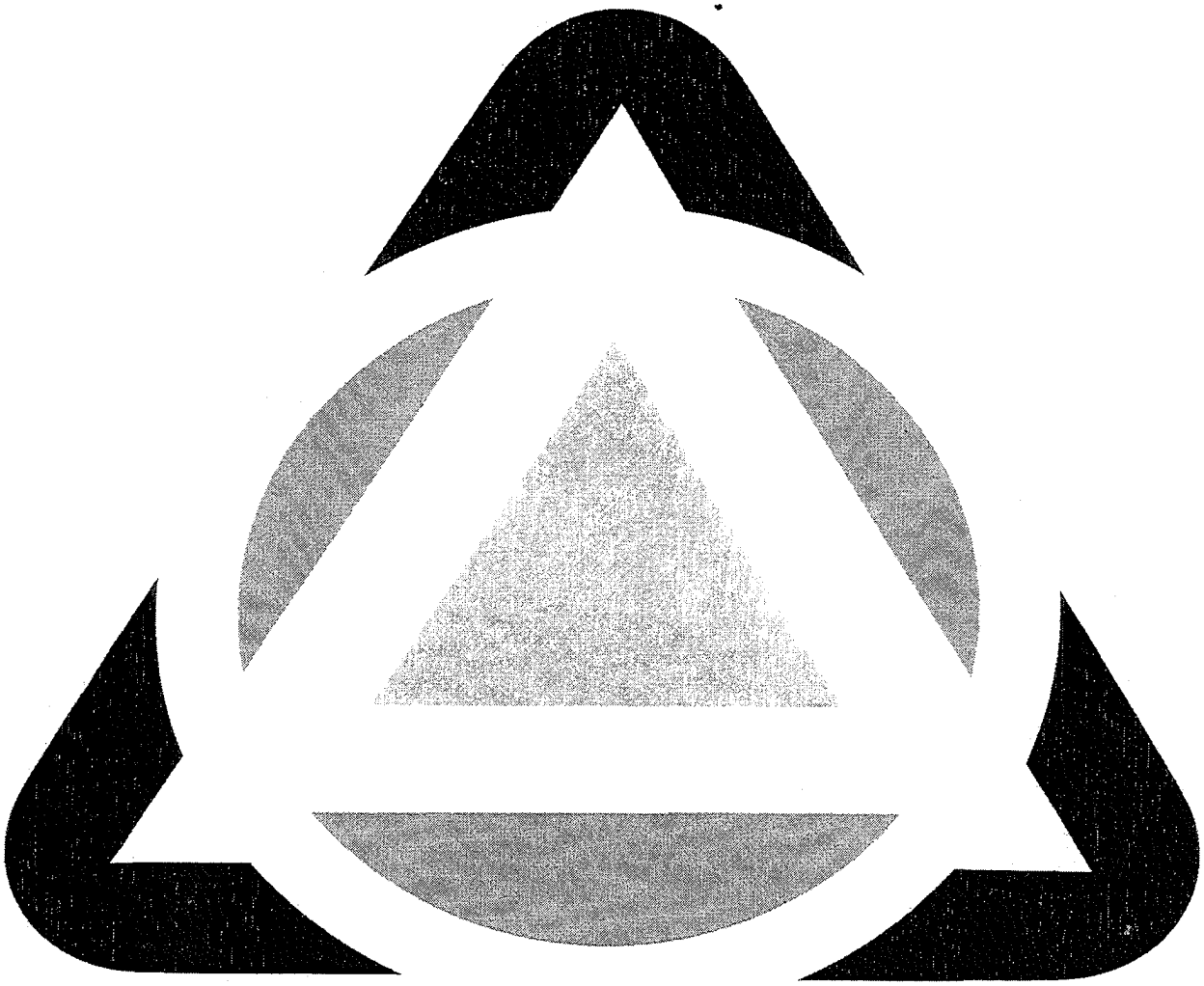

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BRANCH II – Field Rep. Test Prep - Manual

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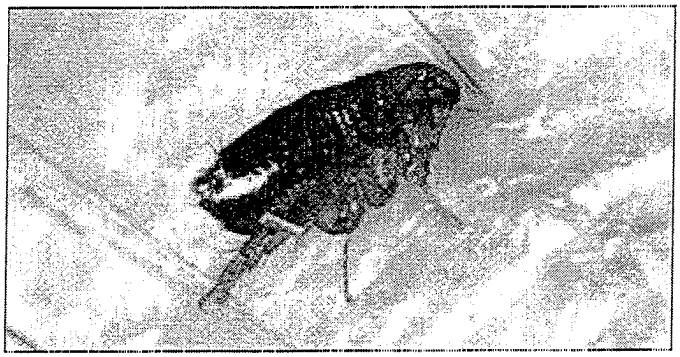
1) FLEAS

Fleas and Disease:



- Bubonic plague, or "Black Death", on at least two occasions in history, has killed off massive populations of people. This disease is caused by the bacteria, *Yersinia pestis*. In the early days, this organism infected mainly the Norway rat, and was carried from rat-to-rat and from rat-to-man by the Oriental rat flea. Nowadays, the disease still exists in California but primarily in wild rodent populations, such as the ground squirrel. The danger is when the rodent dies, and the fleas leave the carcass. In parks and recreation areas in California, residents are warned not to pick up sick or dying ground squirrels, chipmunks and similar animals. The bacterium is in the blood of the animal that is infected with plague. After the flea sucks the rodent's blood, the organism causes a blockage in the flea's intestinal tract. When the "blocked" flea later bites a person, it regurgitates and the infected blood it gets into the bloodstream of the person. For some reason, the Oriental rat flea becomes blocked more readily than other fleas.
- Other species of fleas are involved in the transmission of a form of typhus fever. But this problem is much more prevalent in other countries than in the U.S. The more immediate problem for the PCO is the irritation that comes to individuals from merely being bitten by fleas. The reaction varies a great deal --- from small red bites in some cases to severe rash with itching in others. Close inspection of a flea bite shows a tiny central red spot where the mouthparts pierced the skin; there seldom ever is much swelling.

General Characteristics of Fleas:

- Small, wingless, brown to black, blood-sucking insects. They belong to the Order "Siphonaptera". "Siphonaptera" means that they have piercing-sucking mouthparts that are somewhat like a "siphon"; and that they do not have wings ("a" = without; and "pteron" = wing). Fleas are distinctly flattened laterally, and have spines on the body that are aimed backwards. This enables them to move rapidly and efficiently through the body hair of an animal. Their maximum jumping ability is 7"-8" vertically and 14"-16" horizontally. By far the greatest source of flea infestations that the PCO is called upon to control is a pet dog or pet cat.

Life Cycle:

- Metamorphosis is *complete*: egg, larvae, pupae, adult. The time required to complete a cycle depends on temperature, humidity, and the food available to the developing insect.
- Mating takes place on the host animal. The female must have a blood meal before she can lay fertile eggs. The female mates only once, and lays her light colored eggs loose on the host animal. They immediately fall from the pet's body onto its bedding, onto the ground, or wherever else inside or outside the building where the pet is located at the time. The flea lays her eggs after each blood meal, but not all at once. They have between 1 to 12 days.
- The larvae are worm-like, white, blind, without legs, and have chewing mouthparts. They feed on all types of organic debris as well as flea feces, animal feces, and dried blood. They are rarely seen, but are quite active and can be found in floor cracks, rugs, dog kennels, and in and around the pet's quarters. The larval stage lasts from a week or two in the summer when the temperature and other conditions are right, to several months at other times.

- The pupa is formed by the larva during its last *instar*. The larva spins a cocoon around itself, and then encrusts itself with various types of debris, including sand if it's available. This camouflages the cocoon and makes it hard to find. The pupal stage lasts from 1 to 2 weeks. But sometimes a new adult will remain inside the pupal case awaiting a proper stimulus – staying in the pupal stage as long as several months. For example, most fleas that infest buildings are very sensitive to vibration.
- Oftentimes, people returning to their home from vacation are greeted by numerous biting fleas soon after the floor has been walked on (causing vibration). The fleas then promptly emerge from their cocoons and search for a blood meal. Certain fleas on wild rodents will emerge from their cocoons only when proper humidity conditions occur. This might be only once per year in dry desert areas. The adult female flea will lay eggs only after she has obtained a blood meal, even though she has been mated.
- It is in the *pupa stage of the fleas' life cycle that pesticides are ineffective.*
- **Sand Fleas:** These are small crustaceans commonly found on beaches. They are not insects. Many so called "sand fleas" in California are believe to be merely cat flea or human flea infestations that are located in or around buildings located near sandy beaches.

The Main Kinds of Fleas Attacking Man:

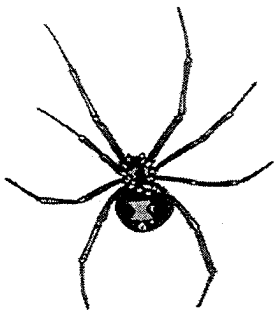
- Each species of flea usually has its own preferred host. But many will suck a blood meal from a variety of hosts, including man, even when the preferred host is present. For example, the **cat flea** (*Ctenocephalides felis*), and the **dog flea** (C. *canis*) are the two fleas most commonly associated with man in the U.S. However, they must have access to a dog or cat or other animal for the infestation to be maintained. And the **human flea** (*Pulex irritans)* also feeds on ground squirrels, dogs, and other animals in addition to people. This flea is known for its rapid blood sucking on humans and leaving blood spots. These blood spots are used by flea larvae for food. A fourth important flea is the **Oriental rat flea** (*Xenopsylla cheopis*). It is the principal vector of bubonic plague from rat to man.

Control of Fleas:

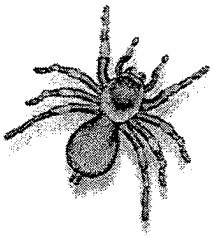
- An increase in flea bites to people usually means the normal host has been absent for some time.
- Most flea infestations in buildings will be either cat fleas or dog fleas. Ask the owner details about the animal's habits, explaining that fleas usually are most abundant around the pet's resting area.
- The owner should wash the pet's bedding and vacuum the rugs, furniture and baseboards before the pest treatment; and remove, seal up and immediately dispose of the vacuum cleaner bag.
- Pets are not always the source of a flea infestation. The source can be wild animals in the crawl space.
- Methoprene is very effective as an insect growth regulator (IGR) for the control of fleas
- It is usually necessary to treat both inside and outside premises to achieve control of a flea infestation.
- A PCO should not treat the host animal for fleas. A veterinarian or the homeowner should do this. And it should be done on the same day the premises are treated.
- It is a good practice to treat premises for rodent ectoparasites (fleas, mites, sometimes lice) in conjunction with rodent control, in order to prevent problems of the ectoparasites abandoning the dead carcasses and attacking people.
- Flea larvae are most likely to be found in the carpet of a residence & when treating one should use a *fan spray.*
- It is important to *remove any objects from the floor before treating for cat fleas.*
- Fleas are most active when the weather is *warm and humid.*
- Effective control measures in buildings include (1) *recommending sanitation and cleaning to the occupant* (2) *using pesticides registered for flea control.*
- If the homeowner has a cat or dog it would be wise to recommend they treat their pet/s for fleas the same time the residence is being treated in order to prevent reinfestation.

- If fleas are in the *pupa stage pesticides are virtually totally ineffective*. Because of this fact, it is important to inform the homeowner to vacuum after the treatment of fleas so that the pupa will turn into an adult.
- The quickest means of knockdown for the control of fleas in a lawn area is to use a *power spray.*
- *Pupae are most likely to be found in undisturbed dust, lint, and debris in carpet and flooring.*
- IGR's (Insect Growth Regulators) are good to use with fleas because they prevent fleas from reproducing.
- Once all the *spray residues have dried* (unless stated otherwise on the pesticide label) after treatment it is considered safe for pets to return to the residence.
- It is the *responsibility of the company giving treatment to schedule the reentry time* after the treatment.

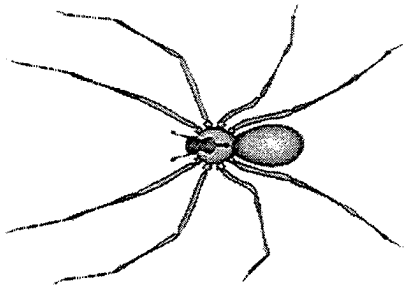
2) SPIDERS



Black Widow



Tarantula



Brown Recluse

- There are two kinds of spiders that bite and can cause painful poisoning in humans; and there are several other species that are merely household nuisances. The **poisonous spiders** are the *Black Widow Spider* and the *Brown Recluse Spider.* Although there are several species or varieties of these two spiders, a detailed understanding of them is not necessary to serve the purposes of this course.
- Spiders, like most other small pests covered in this course, are Arthropods. They belong to the Class Arachnida (rather than class Hexapoda, the insects); and are commonly called "Arachnids". Arachnids have only 2 body regions, no antennae, no compound eyes, and are most quickly recognized by their having 4 pairs of legs. But, unlike ticks and mites, spiders have a slender waist dividing the body regions.
- Spiders usually are considered *beneficial animals because they feed on undesirable insects.* A large population of spiders usually indicates a hefty supply of insects as a food source.
- **How to Know if It's a Spider:** In addition to the aforementioned 2 body regions connected by a restricted waist, no antennae, no compound eyes, 4 pairs of legs, the Arachnids have a sac-like abdomen without segmentation, and in some species the males and females look entirely different (sexual dimorphism).

Biology and Habits of Spiders:

- After the female is fertilized, she lays her eggs either in a dark retreat or in "egg sacs", depending on the species. (Both the black widow and the brown recluse have egg sacs.) The young hatch from the egg and undergo the first molt inside the sac. These young "spiderlings" emerge from the sac and remain together for several days before dispersing.
- Most common species mature in less than one year and go through several molts.
- The time of year for mating and egg laying, and in what stage the spider overwinters, depends on the species. The adults of the more common species normally live only one season. But some of the tarantulas do not even mature until their eighth or ninth year.

- Many spiders, especially young spiders, travel great distances by "ballooning". The spider climbs to the top of a roof or fence post and releases a strand of silk into an air current. The spider continues to send out silk until there is enough of it airborne to lift the spider into the air. Some spiders are known to have been carried in this manner for distances of 60 miles and upwards of 5,000 feet.
- Their webs are used to entrap prey, usually insects. But some spiders use their web spinning ability only to make egg sacs or "retreats" (a place to lay their eggs). And most spiders lay down threads of silk, used as draglines, wherever they walk. These draglines are attached to surfaces at intervals.

How They Obtain Food and Water:

- Spiders are divided into **two groups based on how they capture their prey**: (1) *The cobweb spiders spin webs to catch insects and live either in the web or in a nest near the web.* (2) *The hunting spiders hunt and capture insects on the ground, or waiting among leaves and flowers until insects come within their reach.* Spiders that both live in and reproduce in buildings are cobweb spiders.
- **Spiders eat live prey.** Almost always this prey is insects and similar arthropods. The spider kills them by injecting venom through its fangs. Spiders cannot eat solid food. So they inject enzymes into the prey's body. They predigest the body contents of the prey and enable the spider to suck out the digested material. Spiders can go for weeks or months without food. Brown recluse spiders have survived six months without food or water.
- **All spiders require water**; but some require very little and can live in dry environments. Others need a regular source of drinking water and can live only in humid environments. Therefore, when trying to determine the source of an indoor infestation, some first places to look are areas around water pipes, floor drains, and air-conditioning; and in basements, crawl spaces, and other damp areas.
- Most species found indoors hide in cracks, in darkened areas or in their webs. Most outdoor species do not adapt to indoor conditions, although some may live in attics or main living areas.

Spider Bites:

- Taxonomists have created confusion over the naming of the two "groups" of spiders that bite and poison humans, i.e., the black widow spider is said to be only one of a "group" of species. The same is said of the brown recluse "group". For our purposes in this course, however, there are two and only **two poisonous spiders of concern**, the *black widow spider* (Lactodectus mactans) and the *brown recluse spider* (Loxoscele recluse).
- *Nearly all spiders have venom glands.* But the venom of almost all U.S. species is so low in toxicity to humans that its brief effects are insignificant. This also applies to the venom of the fearsome looking tarantula.
- The **black widow spider** *venom is necrotic* (affects the nervous system) and can, though rarely, cause death, if the individual is particularly allergic.
- A spider bite may be distinguished from an insect bite by *two small puncture marks.*
- **First aid for spider bites:** (1) *Apply tincture of iodine to prevent infection of the wound* (2) *Apply ice or ice water to relieve pain and help slow absorption of the venom* (3) *Get patient to a physician if the bite is from a black widow or brown recluse spider, or, if the pain increases seriously or swelling is extreme.* (An antivenin specific for black widows is readily available to most physicians.)
- **Black Widow:** Usually found in garages, around drain pipes, and basements or similar places. Female is a shiny black with red hour glass mark on the underside. Body ½" long. Male much smaller and conspicuously marked, but usually is not recognized as a black widow. The male is not dangerous to humans. They construct a very strong and *distinctively irregularly shaped web.* These webs are typically found in or around garages, drain pipes, and water heater closets.
- **Brown Recluse:** Sometimes called "*fiddleback*" or "*violin*" spider because of the fiddle-like marking on the cephalothorax. It is recluse by nature, very non-aggressive. Most bites come from brushing against the spider. The brown recluse is said to be readily moved about the country because it does not jump out of hiding and remains secluded in transported materials. Same size as black widow

(1/2") or slightly smaller. Yellowish brown with violin-shaped mark on the cephalothorax. The brown recluse venom is cytotoxic (kills the flesh in the area immediately surrounding the bite. This is called "necrosis."

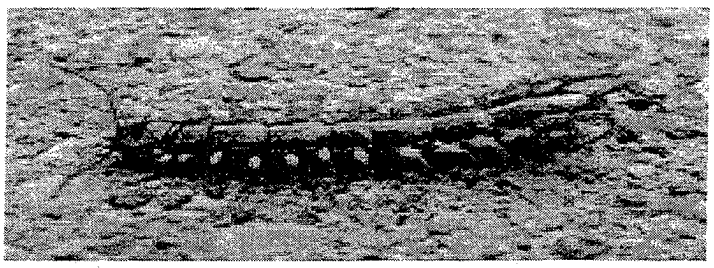
- The **yellow house spider** – Moves rapidly. Small white web indoors.
- The **wolf spider** – Large ½" to 1-1/2", hairy, quick moving spiders. Usually outdoors but sometimes wander inside. The most effective treatment for the wolf spider is to use a surface treatment.
- The **jumping spider** – Usually black and hairy with vivid markings – No webs
- The **orb weaver spider** – Many species. Has an easily identified circular "bull's eye shaped" web. Web is placed close to areas where insects will fly or visit such as lighted windows, lights, doorways, etc. Can be large. Usually hide during the day and make their webs in the evening. Sometimes a problem in high rise condos, building webs on the balconies, across sliding glass doors, etc.
- The **tarantula** – Large (body alone about 1-1/4"; 4" including extended legs); hairy brown to brownish black; lives in holes in ground and under rocks; ferocious looking, but practically harmless. Now sold as pets. They live from 10 to 20 years.

Control of Spiders:

- During inspection, note any unusually large numbers of flies, roaches, ants. Controlling this food source sometimes aids in spider control.
- Improve sanitation outside to prevent spiders that wander indoors (wood piles, rocks, compost piles, old boards, and other debris). Add pea gravel to window wells. Remove debris from crawl spaces.
- **Chemical control outdoors** – Usually space treatments give best results. Aerosols (exterior residual sprays), or mist applications with fast knockdown-short residual compounds, are effective.
- A good method of treatment in a sub area for black widows is to use a ultra low volume (ULV) machine.
- If a customer wants to get rid of spiders without using pesticides the best recommendation for spider control is for the homeowner to remove any clutter and to regularly dust and vacuum.
- If a customer requests that a large infestation of spiders be treated using an extra dosage of pesticide the field representative should always follow the directions on the pesticide label.

3) CENTIPEDES AND MILLIPEDES

- Centipedes and millipedes are *not insects*. Both are **arthropods** with centipedes belonging to the class Chilopoda and millipedes belonging to the class Diplopoda.
- Centipedes and millipedes are similar in many ways. Both are many legged, long lived, "worm animals. Their bodies are divided into two distinct regions: head and abdomen. They have no wings. Like insects, centipedes and millipedes "breathe" through a complex series of tracheal tubes which end in spiracle-like openings to the atmosphere. Unlike insects however, the tracheal system of centipedes and millipedes lacks a closing mechanism to conserve body moisture in dry environments. Their integument (outside covering) also lacks a protective outer wax layer to help control water loss. For these reasons, centipedes and millipedes must remain in damp environments in order to survive. During the day, they are most often seen hiding under houses, boards, rocks, leaf litter, rotting wood, etc. At night they forage for food. Centipedes and millipedes usually have compound eyes but some species are eyeless altogether.

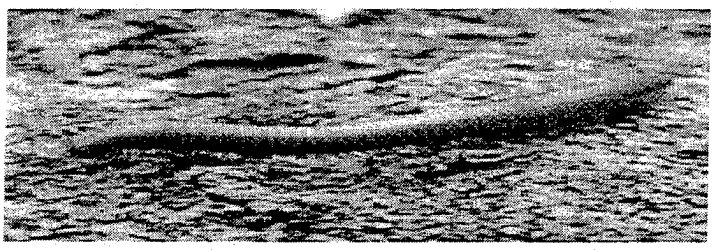


- Let us first consider the biology of centipedes in some detail. Fully grown centipedes have about fifteen to twenty pairs of legs and range in size from one-half inch to six inches in length. They can be identified from millipedes in any one of the following

ways:

1. Centipedes have *one pair of legs per body segment*; millipedes have two pairs of legs per body segment.
2. Centipedes *appear flattened in shape*; millipedes are almost cylindrical.
3. Centipedes have *long antennae*; millipedes have short antennae.
4. Centipedes *can crawl rapidly*; millipedes move slowly.
5. Centipedes *will not coil up when disturbed*; most millipedes will do so.

- One other unique feature of centipedes is that they have venom-bearing claws on the first segment behind the head. These are used to paralyze small living prey (other arthropods, snails, slugs and earthworms). A few tropical species can inflict a painful bee-like sting. However, the common species in the United States rarely bite humans.
- Centipedes have an incomplete life cycle (simple metamorphosis) consisting of egg, several larval stages and several so-called "adolescent" stages. The female deposits fifteen to thirty-five eggs in loose soil. The first larval stage has only four pairs of legs but the number increases with each molt. Following the larval stages, there are four adolescent stages in which the young centipede grows in size with each molt, but the number of legs remains the same.
- In addition to feeding on animal matter, centipedes will some times eat plant tissues and may occasionally injure garden plants and lawns.
- One species, the house centipede (Scutigera coleoptrata) is common inside homes throughout the eastern and southern United States. It can mate and breed indoors all year long in dark, moist areas such as in basements, closets and bathrooms. House centipedes may also congregate around lights at night to catch small flying insects. They have three conspicuous stripes running the length of their back and black and white banded legs. In the female, the last pair of legs is more than twice the length of the body.



- Millipedes range from ¼" to 4" in length. They lack the poison fangs characteristic of centipedes, but do have other protective devices. When disturbed most millipedes will roll up into a ball and remain motionless. Some species also have glands which give off an ill-smelling fluid. This substance is toxic to some small insects and can be irritating to human skin. Millipedes cannot bite or harm man in any other way.
- Millipedes are primarily scavengers, feeding on decaying plant material or dead insects, snails and earthworms. However, they may also feed on the root systems of lawns and other garden plants or damage the tender leaves of young shoots. Millipedes have also been known to eat planted seed and to tunnel into root vegetables and tubers. Occasionally they enter buildings including homes in great numbers. Migrations appear to be triggered by heavy rains or periods of drought. Once inside, millipedes are considered a general nuisance although they do not damage man's food or fabric.
- Like centipedes, millipedes have an incomplete life cycle. Several dozen to a few hundred eggs are laid in nests in the soil. Newly hatched larvae have only three pairs of legs and seven body segments. At each successive molt (usually seven in all) new segments and legs are added. It may take several years for the sexually mature adult to be formed. Adults generally overwinter in the soil.

Control of Centipedes and Millipedes:

- As is true with other pests that live in moist situations, control of centipedes and millipedes can be maximized by combining careful sanitation and exclusion practices with chemical controls.

- Outdoors, compost piles, mulch piles, fallen leaves, rotting wood, boards and other organic debris should be removed well away from the foundation of the house. Loose fitting doors and windows should be repaired and cracks in foundation walls should be sealed. If there is an excessive moisture condition underneath the house, it should be corrected.
- Indoors, check for moisture conditions such as leaking plumbing in the kitchen, bathroom and laundry room. Consider sealing cracks and crevices with a caulking compound such as Polycell-100.

4) FLIES

- Flies belong to the insect order Diptera along with mosquitoes, gnats and midges. A common feature of all Diptera is that they have only two wings (one pair). The prefix "Di" in the Latin word "Diptera" means two and "ptera" means wing. Most other flying insects have four wings (two pairs). Over the course of evolution, the hind pair of wings in flies became greatly reduced in size and they now appear as very tiny knob-like projections known as halteres. Despite their size, the haiteres are important as flight balancing organs. Flies have compound eyes which are especially capable of detecting motion and sudden changes in light intensity such as that caused by an approaching predator or a human armed with a fly swatter.
- Of the many thousands of different species of flies, only a small number are routinely encountered by pest control service technicians. Among these are:

COMMON NAME	**SCIENTIFIC NAME**
1. House fly	*Musca domestica*
2. Little House fly	*Fannia cancularis*
3. Cluster fly	*Pollenia rudis*
4. Stable fly	*Stomoxys calcitrans*
5. Green and Blue Bottle flies	*Calliphora spp.*
6. Fruit flies	*Drosophila spp.*
7. Gnats	Various families, genera and species

- The **common housefly** *(Musca dometica)* is named so because it was one of the most common flies found in houses during the horse and buggy days when such a survey was made. It is still the most common fly found in houses across the United States throughout the year although other species may be dominant for short periods of time for various reasons.
- The common housefly is about one-third inch long and can be identified by locating the four dark stripes that occur lengthwise on the topside of the thorax. The fourth vein on the wings is also characteristically curved (angled) in shape rather than straight House flies lay their eggs in batches of seventy five to one hundred and fifty eggs per batch, directly upon the material that the larvae (known as maggots) will eat when they hatch. This material could be excrement, garbage and other decaying materials. Garbage and dog manure seem to be the main larval food source in residential neighborhoods although there can be a number of other contributing sources.
- In restaurants and other food handling establishments, build ups of spilled food, grease unwashed trash dumpsters and garbage are the primary larval food sources. Eggs laid by house flies hatch into cream-colored larvae (maggots) in approximately twenty-four hours. The larvae burrow into the food material on which they have hatched and begin to feed and grow. The larva is the stage of the house fly life cycle that does most of the eating and all of the growing. As the larva develops, it casts its exoskeleton to pass from one instar stage to another. This process takes a minimum of three days and can take as long as three weeks.
- The hotter the weather, the faster the life cycle proceeds. The larva spends its entire time in the media in which it finds itself when hatching from the egg. The larvae are not readily visible to anyone looking at piles of infested garbage or manure because they tend to stay beneath the surface of the media. Thus, one needs to stir into the garbage or turn over the dog manure to see the presence of the larvae. It is amazing to realize how little decaying organic material will play host to so many fly larvae.

As previously stated, the female fly will deposit 75 to 150 eggs in a batch, but may lay several batches in one media source (or another adult female may also lay her eggs in the same media source). Thus, the one-time deposit of an Irish Setter may serve as "home' for more than one thousand fly larvae or a small size garbage pail may serve as home for thousands of fly larvae or a box full of decomposing grass clippings one cubic foot in size may serve as home for a thousand or more larvae.

- House fly larvae are about one-half inch long and have a rounded, blunt end and a more pointed, opposite end. The head is located at the pointed end. House fly larvae breathe through spiracles located on their posterior (blunt) end. The sharp service technician can identify various species of larvae by the placement, size and shape of the spiracular plates.
- As the larva becomes fully developed and ready to pass on to the pupa stage, it is beset with an urge to wander. This is called a migrating tendency and is really an attempt on the part of the larva to find a safe place to pass its pupal stage away from the media on which it has developed. It leaves the dog dropping or climbs up over the edge of the garbage can or out from under a layer of sludge under the restaurant refrigerator and seeks out a crack or crevice or some other "protection" such as a board or other object under which it can crawl and be out of sight and fully safe as it passes its rather helpless pupal stage. This migrating tendency is a very strong one and is responsible for the fact that pupae can be found from several feet to several hundred yards from the original larval source.
- The last larval "skin" (exoskeleton) becomes darker in color and forms the pupal case. As the pupa becomes older, the color of the pupal case proceeds from orange-red to darker reddish-brown to dark brown and in some cases, brownish-black. Inside of this pupal case, the maggot turns into an adult fly (metamorphosis = change). This process occurs in a minimum of three days and may normally take as long as three weeks or the fly may overwinter in this pupa stage. The pupa requires no food and is stationary. When the adult fly is fully is fully formed within the pupa case, it is ready to burst forth into the world. It escapes from the pupa case in an ingenious manner. Located near the top of the head of the adult fly is an "expander organ" which resembles a balloon. The fly inflates this balloon which acts like a pneumatic hammer to pop the top of the pupa case after which the fly painstakingly maneuvers its way out of the case. Thus, the life cycle of the fly is fully completed - egg, larva, pupa and adult.
- Under warm conditions, the pupa stage may last only four to six days. In fact, during really hot weather when there is an optimum supply of food, the entire life cycle of the house fly may be completed in as little as eight days. Under more temper ate conditions, the house fly life cycle requires about three weeks. There may be as many as ten to twelve generations in one summer. Obviously, the statistics indicate the enormous breeding potential of house flies.
- In discussing the larval stage, it was mentioned that the larva was the primary eating-growing stage of the fly. When the fly hatches from the pupa, it therefore is as large as it is going to get. It does not grow at all once it has emerged from the pupa. However, the adult fly does take on nourishment in liquid form (in order to supply its energy requirements. House flies have lapping-sponging type mouthparts adapted for sucking up liquid foods. These mouthparts look like an elephant's trunk with a big flat sponge on the end. The sponge like organ is mopped around in liquid food which is then taken up through the trunk-like part of the mouthparts. If a house fly lands on a desirable food that is in a dry condition (such as a sugar cube), it first "vomits" up onto the dry surface, dissolving some of the sugar in this liquid regurgitation and then, "sucks" the resulting sweet liquid up into the mouthparts. The process of first frequenting then eating off the surface of "food" such as human or animal excrement or garbage and then, regurgitating some of this material onto food inside homes shortly afterward is one of the ways in which flies transmit such diseases as dysentery and "summer diarrhea".
- Another obvious way in which flies can contaminate human food is when bits of filth adhere to their feet and body "hairs" and are deposited on food as they walk across food surfaces. Thus, the common house fly is a very undesirable creature to have around - either inside of the home, in restaurants, in food processing establishments or else where.
- Houseflies are equipped with compound eyes with the eyes of the male being set significantly closer together (across the face of the fly) than the eyes of the female. Like other insects, house flies breathe through spiracles located on the midline of the thorax and abdomen. The thoracic spiracles of a house fly are surrounded by dense "hair" which sift out foreign airborne particles.

- Tests have been done to research the flight range of flies. Flies tagged with radioactive materials were released at a central point then collected in traps placed in concentric circles around the release point. Some species o flies trapped as far away as twenty five miles from the release point exhibited radioactivity. Research entomologists have found that house flies do not fly far from the areas where they breed. For example, one experiment was performed in which groups of marked house flies were rarely recovered farther than one mile away from the central release point. Thus, it is probably safe to say that most house flies do not move away from the larval source by more than one city block or two (if that far).

- The **little house fly** which is also called the **lesser house fly** (*Fannia canicularis*) is the fly that hovers in the air in the lee of a garage, porch, patio, etc., never seeming to land anywhere. It is a pest mainly because of its presence outside. However, when produced in great numbers, it can be a pest in residences, restaurants and home processing establishments. It is the number one fly produced in chicken manure and can reach untold numbers in the neighborhood of a chicken ranch. It is also produced in pigeon and dog manure as well as, in most decomposing organic material.

- The larvae of the **little house fly** does not look like the typical maggot of the house fly but rather, it is brownish, flat and boat shaped somewhat like a carpet beetle larva and has "spines" on its dorsal and lateral aspects. Anyone looking for a typical fly maggot would probably not recognize the lesser house fly larva. The biology of this fly is similar to the biology of the common house fly.

- The **cluster fly** basically looks very much like the house fly. However, its body structure is more robust (fatter) in appearance and also, the cluster fly has no stripes on its thorax and is a slower moving fly.

- **Cluster flies** get their name from their annoying habit of entering homes in the fall and gathering in clusters in secluded areas such as attics and wall voids. An offensive, sweetish odor may be given off from these gatherings. During the warm days of winter and in the spring, cluster flies become pests because they will become active and crawl about over walls and windowsills in the living space of the house. Although this fly is obviously a nuisance, cluster flies do not fly around inside the house in a noisy fashion as do some other related flies (e.g., green and blue bottle flies).

- **Cluster flies** mate in the spring and lay their eggs in cracks and crevices in the soil. These eggs hatch in about three days and the larvae burrow into the bodies of earthworms where they develop. The entire life cycle takes about twenty-seven to thirty-nine days. Because the larvae of cluster flies do not utilize excrement or other filth as food, they are thought to be less of a mechanical carrier of disease organisms than the house fly.

- The **stable fly** is another fly which is often casually mistaken for the house fly. Despite its name, the stable fly is actually much less common around stables than is the house fly. The upper surface of the stable fly's abdomen is marked with a number of dark, circular spots not found on the house fly. When at rest, the wings of the stable fly are held widely spaced apart whereas the house fly rests with its wings projected backward.

- **Green and blue bottle flies** get their name from the fact that they have a metallic blue or green sheen. This characteristic makes them easy to see and identify despite the fact that they look like house flies in most other respects.
- Green and blue bottle flies are also commonly referred to as "blow flies". There are several different species of these flies but their life cycles and habits are very similar. For this reason, we will discuss them as a group.
- Green and blue bottle flies are among the common domestic flies found in urban areas. When an infestation of adult blue or green bottle flies occurs, one of two larval sources may be suspected: 1) garbage and/or 2) dead animals (especially rodents). The sources, if they are on the customer's

property, can usually be pinpointed and eliminated. Thus, the PCO can usually attain success in supplying successful fly control services when this fly is involved if he is willing to participate in mechanical reduction of larval sites. Garbage cans that are in poor physical condition and are not washed out routinely can serve as a larval source for myriads of adult flies. Even what we call "good" garbage cans (cans in good physical condition) can harbor many fly larvae. You will notice a small vent hole in the lid of metal garbage cans just under the lid handle. This vent hold is large enough to admit adult flies to the interior of the can — one female loaded with eggs is all it takes.

- Female green and blue bottle flies lay up to 600 eggs during their short two or three weeks' lifetime. Although they "prefer" to lay their eggs on a dead animal or other meat source, they may alternatively deposit their eggs in manure or decaying vegetable matter (garbage). The larvae first feed on the surface of the material they are infesting, then burrow down deeper into less decayed areas. When fully grown, the larvae leave their food sources and burrow into the ground where they change into the pupa stage. If the food source has been a rat or other small animal trapped iii between the wails or a room, when the adults hatch from their pupa cases, the homeowner may notice them coming out from around the edges of plumbing pipes, heater ducts, light fixtures, light sockets and other areas where there are openings in finished wails. The adults have a heavy, almost laborious flight characteristic and produce an annoying "buzzing" sound when in flight.
- **Fruit flies** (also known as vinegar flies, pomac flies or drosophila and not to be confused with the Mediterranean fruit fly) are very small flies (about one-fourth inch long) found around decaying vegetation and fruit. This group of flies is a large one and many species are very common.
- Fruit flies are generally yellowish-brown in color and frequently have red eyes. They are small enough to pass through window and door screens and are therefore, common pests in homes, restaurants, fruit markets and canneries containing over ripe or processed fruits. They are also attracted to open bottles or spills of wine, beer and vinegar found in bars.
- Fruit flies typically lay their eggs on or near the surface of overripe or rotting fruits and vegetables. The larvae develop within these materials. However, when fully grown, the larvae move to drier environments to pupate.
- The female fruit fly lays 400 to 1,000 eggs which hatch in one day. Development from egg to adult takes eight to eleven days. These flies are abundant in and around garbage cans where they cause little or no trouble. However, they also occur around fruit stands in markets and especially over ripe bananas. Because of their very short life cycle and therefore, the large number of generations of adults produced each year, these flies are sometimes used in high school biology classes in experiments on genetics.
- **Gnats** are very tiny flies of which there are many different families and species. Some, like midges, have aquatic larvae that are found in the bottom of fresh water lakes and ponds. Others have larvae found in the bottom of ponds containing water heavily polluted with organic debris (sewage ponds) and others have larvae that found in leaf mulch of flower beds.
- Outdoors, gnats may swarm by the thousands in the late afternoon and evening, thus creating a nuisance. They are small enough to get through most window screens and once indoors, gnats tend to swarm around lights and windows. Most gnats do not have mouthparts capable of biting. However, one group of gnats known as the "biting midges" can inflict a painful and vicious bite. These gnats are also sometimes called "punkies", "sand flies" or "no-see-ums". Like mosquitoes, biting gnats are blood-suckers. They are usually very tiny and difficult to see even when feeding on one's own skin.

Fly Control:

- A well conceived fly control program can serve as a classical example of the application of the principles of Integrated Urban Pest Management. The important steps in an Integrated Urban Pest Management (I.U.P.M.) program are: 1) Cultural Control; 2) Physical Control; 3) Mechanical Control; 4) Biological Control; 5) Legal Control; and 6) Chemical Control
- All **Integrated Urban Pest Management** is based upon an accurate identification of the pest involved and knowledge of its life cycle, habits and habitats. Assuming we have this knowledge, how then can we apply cultural control to a fly control program? A simple example would be the

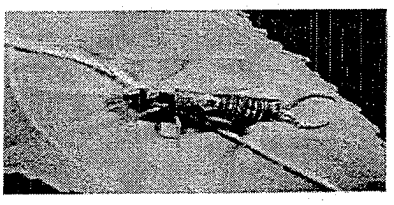
modification of the pattern of shrubs in a landscaping. We have all observed that certain shrubs when in bloom, attract house flies as well as green and blue bottle flies. Shake the shrub on a warm, summer day and watch a cloud of flies take off! If such a shrub is adjacent to the back door of a house or food processing establishment so that when the door is opened, flies enter from the shrub, then relocation of that shrub to another area of the premises or elimination of said shrub altogether, is an example of cultural control.

- Examples of **physical control** would include proper screening on all doors and windows and self-closing devices on doors.
- **Mechanical control** might consist of the use of electric units that attract the flies with an ultra violet light, then elec trocute them as they land on the grid in front of the light.
- **Biological control** might consist of elimination of fly larval sources wherever they exist (for example, elimination of dog manure and/or garbage in the background of a residence or on the premises of a food processing establishment for house fly and green bottle fly control). Removal of that layer of urine and manure saturated straw for biting stable fly larvae is another example of biological control.
- **Chemical control** should be used as the last line of defense. For indoors fly control where all sanitation and exclusion measures have been performed and there is still a need for control, several non-residual space sprays and residual surface sprays are available. These only control adult flies and repeat treatments are usually needed. Space sprays are fine mists or fogs intended to fill the air space within buildings and kill all insects flying about or at rest. Residual sprays are applied to surfaces upon which flies generally rest.

Summary of Flies:

- Flies are *insects*.
- Flies have a *complete life cycle* consisting of egg, larva, pupa and adult.
- House flies, lesser house flies, blue and green bottle flies have *lapping-sponging mouthparts* while biting stable flies have *piercing-sucking mouthparts*.
- Flies lay their eggs in batches on the material which the *larvae consumes* upon hatching.
- Rotting, decaying organic material of all kinds serve as larval sources.
- *Dog manure and garbage cans are the most frequent* **larval sources** found in residential neighborhoods.
- *Dead animals and garbage produce* **green bottle flies**.
- *Dog manure and garbage produce house flies.*
- The **fruit fly** is *produced by rotting fruits.*
- The P.C.O. can provide fly control under certain circumstances, but before he offers a contract, he had better know which species of fly he is dealing with and where the larval sources are located.

5) EARWIGS

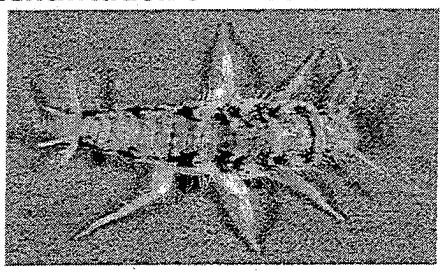


- The name originates from the superstition that earwigs crawl into the ears of sleeping persons and bore into the brain. Although earwigs appear somewhat dangerous due to their forceps, they are practically harmless to man.
- Earwigs vary in size from 1/2-1" in length, they are brown to black in color. Species may be winged or wingless. Only a few species are good fliers. The body terminates in a pair of forceps. These forceps or pincers are the earwig's most distinctive characteristic. The forceps are used in capturing prey and mating.

- Earwigs are *omnivorous*, feeding on a wide variety of food. They will eat live or dead insects as well as live or decaying vegetation.
- Earwigs can *cause damage to cultivated plants*. They can be a nuisance when they migrate indoors. Migrations of earwigs numbering in the 100's have been reported. They seldom become established indoors. Some species will emit a foul odor. Earwigs can be of value as predators of certain insect pests.
- Earwigs are *nocturnal*. During the day they will be found in moist shady places, under wood piles, stones, boards, compost piles, flower beds, and other secluded locations. When earwigs migrate indoors, they hide in cracks and crevices around baseboards and other locations. They may be found in potted plants and cut flowers.
- Earwigs have *biting-chewing mouthparts* which they use to eat their way into fruit such as apricots or to mar plant leaves and stems. They also use these mouthparts to clear away cavities for egg laying and to handle their eggs, once laid. Wood boring beetle larvae and adults have biting, chewing mouthparts. The larvae use their mouthparts to extend their workings in the wood.
- Earwigs have two pairs of wings – the first pair being formed into a thickened sheath and the second pair very cleverly folded in three directional fold beneath.
- The abdomen of an insect generally has ten segments. Located at the end of the abdomen of some insects is a pair of appendages known as cerci (singular – circus). In the case of earwigs, these are "pinchers" which the earwig uses as a pair of forceps to move its eggs around in the nest – like cavity in the leaves or to capture food such as tender young termites and to hold them while chewing off their heads.

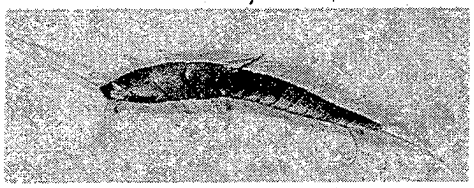
6) SILVERFISH & FIREBRATS

- Silverfish and body lice have an *incomplete (simple) metamorphosis.*
- Silverfish and firebrats belong to a very primitive group of soft wingless insects, evolving on earth even *before the cockroach*. They have a distinctive carrot-like form, long and slender, broader at the front end and gradually tapering to the rear. Their name is derived from the Greek: *thysan*, a fringe, and *ura*, tail. The fringe comes from the silver, flattened, hair-like scales scattered over the body and the "tail" is made up of three long posterior filaments. The young look very similar to the adults only they are smaller.
- All silverfish and firebrats are vegetable eaters, some are subterranean or live in caves, and others are found in ant and termite nests. Most species remain hidden under bark or in leaf litter and require relatively high humidity. Of the 320 species of silverfish and firebrats found throughout the world, 18 species occur in North America. Of these 18, two species are major cosmopolitan pests, the common silverfish (*Lepisma saccharina*) and the firebrat (*Thermobia domestica*). Both of these species occur in domestic situations, feed on starchy materials and may be able to withstand considerable drying. They can also survive long periods without food.
- **Identification of Firebrats**: Mottled gray to tan in color, with tufts of brown setae, ½ inch in length.



This species prefers to feed on paper and paper products, such as books with a glazed finish. This insect prefers the warmer situations around furnaces, boilers, and steam pipes. Temperatures of 90 degrees to 106 degrees F are in the optimum range. This insect lives from one to two years and can molt more than 50 times during this period. Injured appendages are regenerated throughout life.

- **Identification of Silverfish:** Uniformly silver to slate or pearl gray, ½ inch in length. These silverfish are a common pest in homes, libraries and museums where they eat paper, fabrics, and get into cereals. They have mandibles that can remove the sizing of paper in books, and magazines, damaging etchings and prints. They nibble on book bindings and feed on the glue and paste in the binding. This insect prefers cool, damp situations;



their preferred temperature range is 72 to 80 degrees F with 72 to 95% relative humidity. The common silverfish can live for as long as two years and may molt up to 50 times during this period. There are other species of silverfish that may also be present and their identification, biology and control are similar.

- If you see silverfish or firebrats running over the floor, you can be sure there are *more specimens lurking behind the walls, in voids of shelving and under baseboards.* Their eggs are very small, often laid in cracks and crevices and are carried into buildings along with cardboard boxes and other shipping containers. A single female may lay less than 100 eggs during her lifetime of 2 to 3 years. These insects are primarily nocturnal and will quickly retreat into hiding when lights are turned on. In general, silverfish are found at the floor level and on shelving. Moist, dark areas make the most attractive habitats. Firebrats are found around furnaces, boilers, and hot water pipes.

Evidence of Damage:

- Book bindings show minute scrapings. The sizing of paper is removed in an irregular fashion and the edge of the paper presents a notched appearance. Where the damage is severe, irregular holes are eaten directly through the paper.
- The small dark feces of silverfish and firebrats are visible to the eye, and their scales can be identified with a hand lens.
- Sticky survey traps can be set out to capture specimens for verification of species. These traps will also help to locate how pests are entering an area. Firebrats are often trapped as they enter a room from radiator pipe openings. Traps can also be used to measure the success of control measures.
- There is normally considerable difficulty in eliminating silverfish or firebrats, most infestations are chronic and are seldom resolved completely. However, in many situations it may be possible to tolerate a low level of these pests. If chemicals are the basis of a control program, the accumulation of dead carcasses and their scales over time may create other problems including allergies. Dead insects are a food source for carpet beetles, so the area should be thoroughly vacuumed. Under ideal circumstances, it is best to change the environmental conditions that allowed the population to exist in the first place.

Steps in reducing populations of Silverfish or Firebrats over time:

- Eliminating moisture in the immediate vicinity of an infestation. Dry out an area and keep it dry. Using desiccants such as silica gel in the microhabitat may accelerate this drying process. Frequently the installation of moist wallboards in new construction projects will introduce silverfish into an area.
- Prevent access to food, especially starch containing materials such as paper. Enclose in tightly sealed containers if possible. Another method is to use sticky tape or chalk barrier to prevent silverfish or firebrats from climbing up the legs of equipment.
- The use of heat, especially for the common silverfish, and cold for the firebrat will reduce populations significantly. By maintaining a room at a temperature consistently below 60 degrees F, both species will be discouraged from breeding.
- If environmental conditions cannot be altered, and they are ideal for firebrat development (warm temperature and high moisture with lots of cracks and crevices) then a combination of traps and baits may help reduce populations to acceptable levels.
- It is always a good idea to improve sanitation by picking up accumulated debris, drying out the area and removing any potential sources of food.

7) SOWBUGS & PILLBUGS

- Sowbugs and pillbugs are *not insects.* They are **arthropods** belonging to the class Crustacea (along with crabs, shrimp, lobsters and crayfish). Within the class Crustacea, the specific order to which the sowbugs and pillbugs belong is known as Isopoda. Although most crustaceans live in the water, sowbugs and pillbugs live on land in moist environments.

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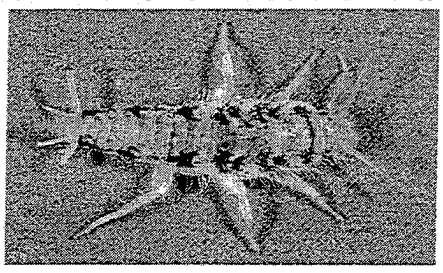

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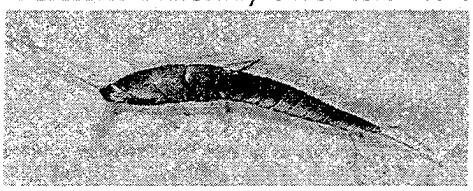

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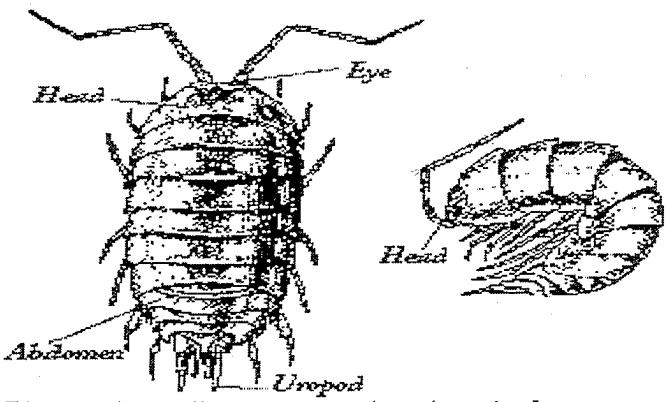
- Sowbugs and pillbugs are fairly small (one-half to two-thirds inch long), oval, flattened animals with fourteen legs. They do not have wings. The adults are dark grey to blue grey in color and have well developed eyes and two pairs of antennae. Sowbugs and pillbugs resemble one another not only in general size and appearance, but also in general biology and habits. However, one can easily distinguish a sowbug from a pillbug by observing how the two behave when disturbed. Pillbugs will roll themselves up into a tight ball if alarmed while on the other hand, sowbugs are able to roll themselves up only about half way into a U-shaped form. Additionally, sowbugs have prominent cerci (appendages that stick out of the end of their body) whereas pillbugs do not have prominent cerci.



This sow bug rolls up as pictured on the right. In contrast, pill bugs roll up into tight balls where the legs and head are not visible and loks like a solid ball(with small ridges)

- Sowbugs and pillbugs are primarily outdoor pests that live in dark, moist locations such as under leaf litter, boxes, boards, flower pots and in well-watered lawns, ivy and dense low growing shrubbery. These pests have biting-chewing mouthparts and feed on both decaying vegetation and animal matter. Sowbugs and pillbugs may also attack the roots, tender leaves and stems of young plants.
- The life cycle of sowbugs and pillbugs has three stages: egg, young and adult. Eggs are actually deposited inside the bodies of females in a pouch-like structure known as a marsupium. Following one or two months of development within the marsupium, the young sowbugs emerge alive from the females. Several more months must pass before the young mature into adults. The young molts for the first time within a day after leaving the marsupium. The second molt is one week later and the third molt takes place one week after that. Then it molts once every two weeks until it is twenty weeks old. Then, the molting periods are irregular until it reaches maturity as an adult. Breeding can occur throughout the year but is most frequent in the spring. There are one to three generations per year and adults live about two years depending upon temperature and moisture conditions.
- **Insects** breathe through openings in their body wall called *spiracles*. Pillbugs and sowbugs breathe by means of gills and so must live in a very damp, moist environment such as in areas of considerable leaf mulch under plants or in the damper, cooler parts of compost piles, under boards, bricks, turf and loose plaster and in general, anywhere around the outside of the house where sufficient moisture is present. They do not like the hot sun or a clear summer day. Everyone is familiar with the upward movement of pillbugs and sowbugs on the outside of stucco walls when the lawn sprinklers are turned on or when this strategic area of turf adjacent to the house is sprayed with a liquid pesticide. Occasionally, sowbugs and pillbugs will invade homes and other buildings either accidentally or because outside sources of moisture have dried up. They can be especially abundant in damp basements or in garages with leaky water heaters or laundry appliances. Kitchens and bath rooms are other areas frequented by sowbugs and pillbugs.

Sowbug and Pillbug Control:

- Both sanitation practices and chemical controls can be used effectively to control sowbugs and pillbugs.
- Outdoors, one should try to reduce the number of moist hiding places where sowbugs and pillbugs find harborage. Such measures can include removing piles of grass clippings and fallen leaves off the ground. Also, boxes, boards, trash cans, flower pots, etc. should be stored off damp ground. Chronic moisture problems in the crawl spaces (if any) underneath the house should be corrected.
- To control sowbugs and pillbugs which find their way indoors, one may simply vacuum or sweep them up or apply a pesticide to infested areas and points where they may enter the structure.

Summary of Pillbugs and Sowbugs

- Pillbugs and sowbugs are not insects.
- Pillbugs and sowbugs are closely related to shrimp, crab, lobster and crayfish.
- Pillbugs and sowbugs breathe by means of "gills".
- The female pillbug and sowbug carry their young in a marsupium.
- Sowbugs have prominent cerci; pillbugs do not have prominent cerci.
- Sowbugs and pillbugs feed on decaying vegetable matter.
- Young sowbugs and pillbugs molt many times.
- Pillbugs and sowbugs do not damage ornamentals, do not spread disease and do not cause harm to humans.
- Control measures for pillbugs and sowbugs are similar to control measures for earwigs.
- Non-pesticidal control consists of drying up areas of infestation whenever possible or feasible.

8) BEETLES

- Beetles might be the most successful creatures on earth! Their incredible ability to adapt to any environment makes sure that they will exist, probably long after humans have disappeared from earth. One of the most important features of the beetles that makes them distinctly beetles is their **elytra**, the *hard exoskeletal covering over their wings*. Elytra have many functions, but the most important is protection for the beetle.
- Some species are able to trap moisture on their wings and keep it because the elytra protects it from the heat and wind. This has allowed some species to travel to deserts, where moisture is scarce, because they can carry their own water with them. Other species can live under water because they are able to trap air in their wings and keep it under the elytra.
- The order name **Coleoptera** is pronounced "co-le-OP-ter-a." This name was first used by Aristotle in the fourth century B.C., more than 5,000 years ago! It comes from the Greek words "*koleos*," which means sheath (or shield), and "*ptera*," which means wings. The name refers to the fact that most beetles have hardened front wings, termed elytra, which cover the folded hind wings like a sheath. Insects in the order Coleoptera are commonly called beetles. The common name "beetle" comes from older English words for a "little biter". Larvae of some species are called grubs, wireworms, and rootworms.
- **Coleoptera** is the *largest order in the entire animal kingdom*. There are more species of beetles than species of plants! There are about 350,000 named species of beetles in the world and many more unnamed species. In the United States and Canada, there are almost 24,000 species. That's about 30% of all insect species in North America.
- Beetles can be found in many land and fresh-water habitats. In addition to being associated with all kinds of plants, they can be found in logs or under bark, in fungi, in mud, in decaying plant and animal matter, in water, in stored food, in bird and mammal nests, and in termite nests. Species in the genus Cremastocheilas (family Scarabaeidae) live in ant nests and feed on ant larvae. Many beetles live deep in the soil or in decaying leaf litter on the ground. Other beetles live under rocks or in caves.
- Adult beetles range in size from 0.01 to almost 8 inches in body length, but antennae of some are much longer than their bodies. Beetles usually have hard bodies, but sometimes they are leathery or even have soft bodies. These bodies may be very smooth or very hairy. Most beetles are dark brown or black, but many are red, blue, green, purple or a combination of colors.
- Beetles have many types of antennae. Some of them are threadlike, sawtoothed, comblike, feather-like, or clubbed. Some beetles have "lamellate" antennae with segments at the end of the antennae

that have long, plate-like projections on one side. Weevils have "elbowed" antennae, with an elbow-shaped joint between the long first segment and remaining shorter segments.

- Beetle mouthparts are usually the biting and chewing type with well-developed mandibles, or jaws being present. The mandibles may be very large and resemble the antlers of deer in males of stag beetles. Mandibles of some beetles are used in defense or mating instead of in eating. Mandibles of some predaceous (bug eating) larvae are grooved or have a tube inside for injecting digestive enzymes into the prey.
- Beetles usually have **two sets of wings**, the hard front wings, or elytra (elytron is singular), and the soft hind wings for flying. The hind wings are folded under the elytra when not in use. The elytra usually extend to the tip, or near the tip, of the abdomen. A special feature of Coleoptera is that the elytra meet in a straight line on the back. Some beetles, such as rove beetles, have short elytra, and most of the abdomen is exposed.
- The **three pairs of legs** in beetle species may be modified for swimming, digging, running, grasping, or other activities. Flea beetles (family Chrysomelidae) have hind legs modified for jumping. Males of some water beetles have wide segments for holding the female during mating. Many scarab beetles have sharp spines on their legs that are used for defense against vertebrate predators (animals with backbones).
- Beetle **larvae** can be of different shapes and sizes. Some are wormlike and legless, and others are more like caterpillars, with thoracic legs and abdominal prolegs (fake legs). Wireworms, such as larvae of click beetles, have short legs and are long, hard, and wirelike. Many larvae have C-shaped bodies and are usually soft. This form of larva, which is present in scarabs and other beetles, often is called a **grub**. Many predaceous larvae have long legs for running along the ground.
- **Pupae** are like pale, mummified versions of the adult beetle. The legs and wings project from the pupa, instead of being fused with the body as in Lepidoptera. In some species the pupa is surrounded by a silk cocoon or a round chamber made of hardened earth.
- Beetles have **complete metamorphosis** with egg, larva, pupa, and adult. Females of some beetles keep the eggs inside their bodies and give birth to live larvae. Blister beetles (family Meloidae) have a unique type of metamorphosis, termed hypermetamorphosis, in which the larva changes into different forms of larvae during its development. A blister beetle egg hatches into an active, long-legged larva. As the larva molts and becomes larger, it changes into a C-shaped larva with shorter legs. This form of larva molts into a legless instar that does not feed. Eventually, the legless instar molts into the pupa with legs and wings projecting from its body.
- In some beetles, the adults help take care of the young larvae, which is a simple form of social behavior. Females of rove beetles in the genus Bledius (family Staphylinidae) build, maintain, and defend larval tunnels and also provide algae for the larvae to eat. Males and females of some Scarabaeidae cooperate in digging nests and providing their larvae with food. Bess beetles (family Passalidae) and species in other families of insects also care for their young.
- Most beetle larvae pass through 3-5 instars, or stages. Some beetles may have as many as 30 instars, while one species of cave beetle is known to have only one instar. At the end of the final larval instar, the larva molts into the pupal stage. After the pupal stage, the adult beetle will emerge to feed, mate, and produce eggs for another generation. A few weevils, leaf beetles, and other beetles can reproduce without mating (parthenogenesis).
- Most beetles have one generation per year, although some may have two or more in warm regions. Many scarab beetles require two to three years to complete one generation. Some long-horned beetles (family Cerambycidae) have been known to take thirty years to complete their life cycle!
- Most beetles are either *plant feeding or predaceous* (hunters). Some species have different feeding habits in different stages, such as those with predaceous larvae and plant-feeding adults. Many species feed as scavengers on dead plants and animals. Other species feed on fungi or mold, and a few are parasitic on other insects or vertebrate animals (animals with backbones).
- Among the insects, beetles are the most important group of ground-dwelling predators. Beetles will prey on both active and inactive stages, such as eggs and pupae, of a wide range of insects and other prey. However, adults of some **ground beetles** (family Carabidae) and many **lightning beetles** (family Lampyridae) prey mainly on snails. Many beetles that live in decaying leaves on the ground, or

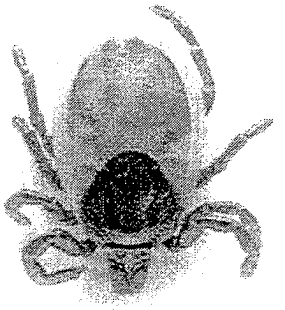
leaf litter, prey on mites (class Arachnida). Some predators can be omnivorous, with the larva or adult feeding on both plants and animals. **Soldier beetles** (family Cantharidae) and others have predaceous larvae and plant-feeding adults.

- A unique form of predation among beetles is present with larvae of **tiger beetles**. Most beetles are active hunters of prey, but tiger beetle larvae, also known as "chicken chokers," wait in burrows in the ground. These larvae have a large bump on their backs that help them hold their bodies in the burrow. When an insect walks over their camouflaged heads, they grab the prey with long mandibles.
- Most kinds of plants are eaten by some kind of beetle. Many beetles have certain parts of the plant that they eat. Adults and larvae of many beetles chew off parts of leaves. Larvae of some beetles are leaf miners, eating trails inside the leaves. Other beetles bore in stems or fruit. Some kinds of beetle larvae, including white grubs and rootworms, feed on roots. Many adult beetles can be found in flowers where they may feed on the petals, nectar, or pollen. Some beetles feed on sap that flows from a tree wound.
- Larvae of **long-horned beetles** (family Cerambycidae) and metallic **wood-boring beetles** (family Buprestidae) bore in the wood of shrubs and trees, especially those that are dying or dead. The female twig-girdler, a kind of long-horned beetle, lays an egg at the end of a branch on a living tree. Then, the female chews, or girdles, the stem to cut off the water supply. The tip of the branch dies and usually falls to the ground. The larva of the twig-girdler then feeds inside the dead branch. Metallic wood-borers are known also as jewel beetles.
- **Bark beetles** (family Scolytidae) feed under the bark of trees. Some bark beetles are known as engraver beetles because when they eat they make distinctive patterns on the wood. Other bark beetles are called **ambrosia beetles** because they feed on a kind of fungus, known as ambrosia, that they grow in their tunnels.
- Beetles in several families of Coleoptera eat many kinds of fungi. Some eat bracket fungi that grow on trees, and others prefer mushrooms or puffballs on the ground. Some beetles in fungi are actually predators that are eating larvae of beetles, flies, and other insects eating the fungi. Many beetles can be found in leaf litter that has fungi and bacteria aiding decay of the leaves. Sometimes it is not known if the beetle is eating fungi or is eating the decaying leaves and other organic materials.
- Several groups of beetles feed on animal droppings, or dung. Some **dung beetles** (family Scarabaeidae) feed on the dung where it falls on the ground, sometimes burrowing into the ground under the dung pile. Tumblebugs are dung beetles that form a round ball of dung and roll it away to another location where it won't be disturbed by other insects that eat the same food. Different species of dung beetles prefer different kinds of animal droppings. Some cave beetles feed on bat droppings.
- Certain species in the families Scarabaeidae, Dermestidae, and Silphidae feed on decaying animal flesh, or carrion. Some **carrion beetles** (Silphidae) bury small animals several inches below the surface of the soil. After finding a suitable spot for burial, a mating pair of these beetles work together to move the carcass and bury it. The beetles will feed on the buried carrion and lay eggs on it as well. The developing larvae may feed on the carrion for three or four weeks. Information on an endangered species of carrion beetle can be found at the **American burying beetle**.
- **Drugstore beetles and cigarette beetles** can be distinguished as well via knowledge of their distinct antennae features. The long horned beetle derives its name from the antennae which extend back beyond the end of its abdomen and look like a pair of long horns.
- Beetles have *four wings*. The first or outer pair is usually thickened into a protective sheath and the second pair, folded under the outer sheath, is membraneous and used for flight.
- Cigarette and drugstore beetles have hard outer wings and membraneous under wings. The parallel lines (striations) on the outer wings enable one to tell the difference between these two look-alikes.
- Adult carpet beetles have wings and frequently fly from bush to bush outside of the house and from cut flower to egg-laying site inside of the house.

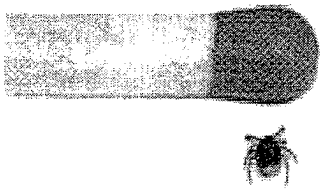
9) TICKS

- Ticks ARE NOT INSECTS because they have *Two main body parts* (not three); and *eight legs* (not six)

- Ticks have a hook on the end of their feet which helps them to cling to the host.
- Ticks are leathery-bodied, eight legged arthropods with mouthparts that are suited for holding tightly in the skin and sucking blood. Ticks feed exclusively on the blood of warm blooded animals; and they can transmit diseases. All ticks, as well as mites, spiders and scorpions belong to Class Arachnida with the Phylum Arthropoda.
- There are two general types of ticks: The **hard ticks** belonging to the *Family Ixodidae*, and the **soft ticks** belonging to the *Family Argasidae*. The ticks of primary concern in structural pest control are a few species of **hard ticks**.

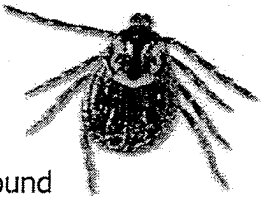


- The **soft ticks** are different from the hard ticks in that their entire skin cover (integument) is of the same bumpy or granular texture throughout; their mouthparts are on the underside of the body and do not protrude out in front; and they invariably are associated with the nest or dwelling place of their host animal. The hard ticks, however, do no wait passively in the host's nest or dwelling place for their food to come to them. Most of them stand perched on a wall or blade of grass or shrub ready to pounce of their host when it comes near.
- The **hard ticks** that are primary concern to the PCO are the brown dog tick, and couple of "wood ticks". Their biologies are similar, but the indoor habitat of the brown dog ticks makes it different from the other hard ticks. The brown dog tick feeds mainly on dogs, and not on man. The other hard ticks feed on man as well as other animals. Because of this, the control methods for the brown tick differ somewhat. And this makes identification very important.
- The hard ticks are so named because they have a hard shield (scutum) on their dorsal side. This shield covers the front one-third of the dorsal side of the unengorged female, and the entire dorsal side of the male. When the male feeds, it does not become dramatically enlarged as does the female.



General Life Cycle of the Main Species of Hard Ticks

- There are four stages in the life cycle of these ticks: egg, larva, nymph and adult. These hard ticks are called "3-host-ticks", as can be understood from the following abbreviated life cycle description: "Female lays many eggs. Eggs develop into --legged larvae (called "seed ticks"). These larvae attack the 1st host, thereby receiving their 1st blood meal. Larvae then drop from 1st host to late emerge from the larval skin into 8-legged nymph. These nymphs attack 2nd host, receiving 2nd blood meal, and then drop from 2nd host. Next, adults emerge from the nymphal skin. These unfed adults attack the 3rd host getting a third blood meal and becoming engorged – and then they mate. The engorged, fertilized female drops from the 3rd host, lays her several hundred or a few thousand eggs, and then dies." Each of the three hosts could be the same animal or a different animal. A 3-host tick requires a blood meal fro each of the 3 hosts. Ticks are said to have a very good sense of smell, so that they can detect when the proper host animal draws near and then move toward it.
- An unusual thing about these particular ticks is the change in the appearance of the adult females that comes from feeding. The adult males do not change very much. But as the females become engorged, they become much larger (about ½") and turn gray. At this point they are relatively immobile because of their unwieldy size. The smaller 8-legged nymphs of both sexes also turn gray when they become engorged.



Biology of the American Dog Tick

- This tick is commonly found on dogs, but it also freely attacks horses, coyotes, raccoons, cattle and other animals including man. It is seldom found in homes and buildings other than when it is carried there by infested dogs or

humans.
  - The immature stages (larvae and nymphs) feed almost exclusively on small rodents such as mice, rabbits, moles, shrews and certain small birds. They lie in wait in the springtime on grass and low vegetation for a host passing by.
  - After the adult female mates, and engorges herself on blood from the last host for about 10 days, she drops to the group where she later lays several thousand eggs, usually in masses of 800 or more. After this she dies.
  - The American dog tick complete life cycle takes anywhere from about 4 months to more than a year. Both the larvae and nymphs can live for more than a year without feeding, and the adults can live for more than a year without feeding.

- **Brown Dog Tick:** Occurs primarily around urban and suburban areas where dogs are numerous. Feeds almost exclusively on dogs. Each of the 3 hosts is a dog. Man is seldom attacked. The red-brown color of the brown dog tick is distinctive and no other tick you will encounter inside homes will be uniformly red-brown.
- A residence may become infested with brown dog ticks even though a dog is not kept there. And infested dog might visit the residence. Remember that the larva and the nymph both drop off the dog after a blood meal, and they can drop off wherever they dog might be at the time.
- The number of eggs laid varies from a few hundred to 5,000. The average is about 1,600. They usually are laid in batches between boards, under plaster or carpeting, or in cracks and crevices. When the eggs hatch in about 3 weeks (several month if it's cool and/or dry), the larvae move to the lower parts of walls where they wait for a dog to come by. They can live 8 months while doing so. When a dog brushes against them, or lies down near them (remember their sense of smell referred to earlier), they crawl on and begin to feed. They attach anywhere on the dog, but most often on the ears and neck. The larvae feed for about 3 days and then drop off.
- The tick prefers a warm, dry indoor environment. It seldom develops heavy infestations outdoors and does not live in the woods. Instead, it has its habitat wherever dogs occur.

Diseases Transmitted by **Brown Dog Ticks** and **Wood Ticks**

- Ticks are very efficient transmitters of diseases for a number of reasons. Among these reasons: 1) They attach firmly to the host and suck blood; 2) they feed slowly and can transmit pathogens (germs) from one generation to the next by their eggs; and 3) also from one life stage to the next (egg to larva to nymph to adult). Among the diseases transmitted are Rocky Mountain spotted fever and tularemia; and they also can cause tick paralysis.

Tick Control:

- American dog ticks occur primarily outdoors, so control should be done outdoors in addition to indoors (although the tick cannot complete its life cycle in a dwelling unit).
- If unchecked, successive generations of brown dog ticks can develop in dwelling units.
- **Crack and crevice treatment** using a long-lasting residual insecticide is the *best way to control a tick infestation inside a residence.*
- For effective tick control the infested areas should be treated with a residual acaricide, and, if a dog lives there, the dog should be treated at the same time. Treatment of the dog alone or the premises alone, will not provide control.
- Space sprays of pyrethrins or DDVP are not effective indoors except when used in conjunction with a residual application. After applying the residual, a fog or mist can drive many ticks out of hiding and over the residual application.
- For entrenched infestations, its best to plan on one retreatment. Some ticks may remain hidden for several days or a few weeks and not emerge until after the pesticide has lost its effectiveness.
- The **Western blacklegged Tick** is known to spread *Lyme disease* in California.

- The best **preventative measures** to take for tick control in and around a residence is to *keep the grass and weeds cut short, remove bird and rodent nests around structures and seal entrance points of hosts.*

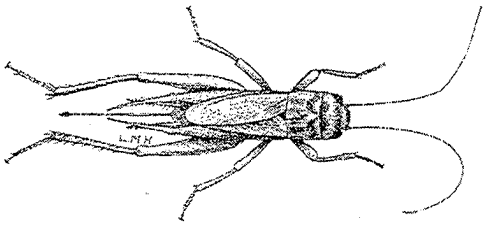
10) CRICKETS

- Crickets are well known for their pleasant chirping sounds. They are common insects occurring across the entire United States. Normally, crickets live outside where their diet consists primarily of wild grasses, small weeds and leaf litter. However, when these natural food sources dry up (usually in the late summer or fall), crickets may begin migrating in large numbers, randomly invading homes and other buildings in their path. Summer rains after a period of drought may also trigger migrations.
- Crickets easily enter homes and other buildings through the gap under the bottom edges of doors which have no weather stripping or are not aligned properly to fit snuggly against the door frame or floor covering. Once crickets get inside, they may chew damaging holes in carpets, linens, draperies, clothing and other valuable furnishings. Both natural and synthetic fibers are chewed or eaten, especially articles soiled with food, perspiration or grease.
- The chirping "songs" of crickets are produced by the rubbing of two unique organs located on the front wings of male crickets. These are called the "file" and the "scraper". Sexually mature males "sing" to attract females which can "hear" the males through an ear-like pit that is located on each front leg. Different species of crickets can be recognized by their different "calling" sounds. Although they make no noise, the females crawl around actively in order to locate singing males.
- Crickets have an *incomplete life cycle consisting of egg, nymph and adult.* They have biting-chewing mouthparts. Some species have well developed wings and can fly while others are wingless. Crickets stay primarily on the ground, hiding during the daytime and actively seeking food or mates at night. Crickets which wander into buildings will also tend to hide during the day. They can be found in areas such as under furniture, appliances, cardboard boxes (including rodent bait boxes), in the dark corners of closets, etc. They may also climb up walls and hide behind light fixtures and picture frames. Although out doors the songs of crickets are pleasant to hear, indoors, singing crickets are usually considered to be distracting and annoying.
- There are three main species of crickets that pest control service technicians routinely encounter and are listed below:

COMMON NAME	**SCIENTIFIC NAME**
Field Crickets	*Gryllus assimilis* and other species
House Cricket	*Acheta domestica*
Jerusalem Cricket	*Stenopelmatus fuscus*

- **Field crickets** are found throughout the United States. They range from one-half to one inch in length and their color varies between black and dark brown. The antennae of field crickets are much longer than the body. Males are easily distinguished from females by the fact that the males have only two spear-like appendages protruding from the tip of the abdomen whereas females have three such appendages. The middle rear appendages of the female are actually a stiff, tubular ovipositor through which the eggs are laid. Field crickets have well developed wings and can fly and jump well.
- Field crickets overwinter in the egg stage or as nymphs. Those that overwinter as nymphs become adults in May or June than die in July. Those that overwinter in the egg stage develop into adults by mid-summer and die in the fall. The females which reach adulthood in mid-summer start to lay eggs in damp areas in the ground after a few weeks have passed, starting the life cycle all over again. From 150 to 400 eggs are laid singly in shallow depths. In the warmer areas of the country (the Gulf states and desert Southwest), field crickets may actively breed all year around and produce up to three generations in a single year.

- Field crickets can cause considerable chewing type damage to vegetables and ornamental plants in the yard. Indoors, they have been known to chew holes in a wide range of fabrics including cotton, wool, silk and furs. Clothing and paper soiled with perspiration, food or grease are more prone to attack. Field crickets are more likely to invade homes in large numbers than any other species. Massive outbreaks occasionally occur in the Midwest, the desert Southwest and in the interior valleys of California. At such times, they may impede city traffic and wreak havoc inside of homes, restaurants, motels and office buildings. However, field crickets which wander into buildings are not able to survive for very long and usually die off by late fall or early winter.
- Like field crickets, the **house cricket** usually lives outdoors. However, it differs in that it is also capable of living out its entire life cycle indoors.
- House crickets are about the same size as field crickets and also have well developed wings. They can be distinguished from field crickets by observing that the head is light colored with three dark crossbars (bands).



- Outdoors, the house cricket produces only one generation per year. Eggs are laid in late summer and do not hatch until late spring. Nymphs do not reach maturity until mid-to-late summer. Indoors, eggs are usually laid in dark cracks and crevices such as underneath refrigerators or other appliances. Left uncontrolled, house crickets will breed throughout the year indoors. Adults may be seen or heard chirping even during the winter months.
- Persistent indoor or outdoor problems with house crickets tend to be associated with homes where standing trash is left unattended in the yard for extended periods of time. This provides an ideal breeding habitat for house crickets and serves as a source of continuing re-infestation problems.
- Like field crickets, house cricket populations are subject to massive periodic outbreaks which can disrupt normal home life and community business activities. House crickets are also capable of eating out large holes in many types of fabrics. The holes are usually larger than the small ones associated with clothes moth infestation.
- The **Jerusalem cricket** is much larger and fatter than either the field or house cricket. It has a massive head (sometimes termed baby faced), enlarged mouthparts and is very plump in appearance. Jerusalem crickets are wingless and have an abdomen that is striped with dark brown bands on top and is creamy-yellow colored below. They have strong spiny legs. These crickets look frightening and dangerous to most homeowners but are actually quite harmless. At worst, the Jerusalem cricket may inflict a small puncture wound in very tender skin with its strong jaws (mandibles). Like all crickets, they have biting chewing mouthparts.
- Jerusalem crickets mate in the spring and the female lays small masses of eggs in a hole in the soil. Adults are found during the summer under stones, logs, bricks, boards, etc. , around the yard - i.e., under anything that will allow them to hide during the day. They move around at night looking for food such as dead animal matter. Jerusalem crickets feed on and damage a number of root crops such as potatoes and radishes. For this reason, they are often called potato bugs". Occasionally, Jerusalem crickets will wander indoors where they may cause an annoyance merely by being present. However, they will not eat or chew holes in fabrics as do the field and house crickets.

CRICKET CONTROL:

- As we have seen, crickets can be damaging pests both indoors and in the yard. Complete control is often difficult during periods of cricket migration. However, by combining sanitation and exclusion practices with selective chemical controls one can usually achieve good control of crickets.
- If the cricket problem is indoors, check all floor level door and window openings to make sure they close tightly. Garage doors rarely seal tight enough at the bottom to keep crickets out. Advise the

owner or occupants of the structure that re-infestation will probably be an ongoing problem if floor level openings to the outside are not adequately sealed.

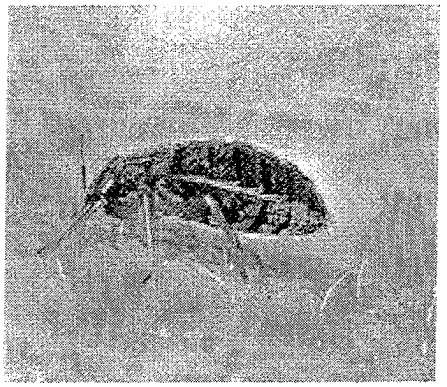
- When treating indoors for crickets, pay particular attention to floor level hiding places such as under upholstered furniture, boxes, mats, trash cans, edges of carpeting and inside sink cabinets and closets. Be sure to also check under and inside any rodent bait stations that may be present. Following application of a residual spray or dust, it may be desirable to drive out any remaining crickets hiding in hard to reach places with a contact-type aerosol containing pyrethrins or one of the synthetic pyrethroids.

Cricket Summary:

- Crickets are *insects*.
- Crickets have an incomplete life cycle (gradual metamorphosis).
- Crickets lay their eggs in the soil.
- Field and house crickets can fly; Jerusalem crickets do not have wings.
- Field and house crickets can jump like grasshoppers.
- Only the male cricket "chirps".
- Field and house crickets eat ornamental plants and crops outside of homes.
- Field and house crickets eat cotton, wool, silk, etc. with fabrics that are stained with perspiration, food or grease especially being vulnerable to attack.
- Jerusalem crickets attack tubers such as potatoes and bulbs such as gladiolus, tulips, iris, etc.
- Field and house crickets overwinter in the egg stage; Jerusalem crickets overwinter in the adult stage.

11) GENERAL PESTS

Bedbugs



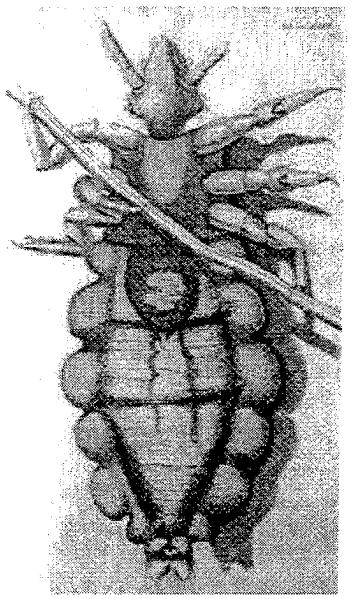
- Fifty to 100 years ago bedbugs were a common thing in hotels and inns, and in tenement housing in larger cities. Nowadays, since the advent of DDT, they are less often encountered. They feed mostly on humans, bats, and birds.
- Like the conenoses, bedbugs are true bugs belonging to Order Hemiptera; but the wings are vestigial (lost or almost lost through evolution). The adults are rusty brown in color, flat oval in shape, and ¼" to 3/8" long. They become larger, longer and redder (with blood) after feeding. The eggs are relatively large, about1/16" for this small and insect. They are laid in bedding or in cracks and crevices, and are covered with a transparent cement.
- Both the nymphs and adults can survive for prolonged periods without food. But the nymphs must have a blood meal between molts, and the adults must have a blood meal before each laying.
- Almost certain signs of their presence are blood marks on bedding and the characteristic spots of fecal excretion (yellowish brown or black); and in the case of a sizeable infestation, a characteristic unpleasant odor.
- **Where to find them:** Along the seams and around the buttons of mattresses, and in upholstered furniture, coils of bed springs, in cracks and hollow posts in bedsteads, and in upholstery of chair and sofas; but sometimes also in the backing of pictures of walls; behind baseboards and in other cracks and crevices near sleeping quarters. The visible signs of bedbugs are indicated by small blood stains on sheets.

Human Lice: The control of human lice is primarily a problem for the medical profession and the individual who is infested with the lice. This is because all lice are parasitic and spend almost all of their lives on their host. In practically every case, successful louse control involves personal treatment of the individual, a situation in which the PCO is not directly involved.

- The lice that attack humans are all sucking lice (not chewing lice). They have no metamorphosis and belong to the Order Anoplura. The nymphs and adults suck blood only from human hosts. Many other lice (e.g., chicken lice, hog lice, etc.) belong to the Order Mallophaga and have chewing mouthparts, but they do not attack people.

The Three Kinds of Human Lice: Head Lice/ Body Lice/ Pubic Lice

- The human lice are named according to the locations on the human body that they usually infest, i.e., the head, the body, and the pubic region. The head and body louse look almost exactly alike, except that the adult body louse is slightly larger, being 1/8" or larger and the adult head louse being 1/8" or smaller. The pubic louse, measuring only about 1/16", is also called the "crab louse" because it is shaped like a crab. All three lice are flat like a pancake.



- The head louse is found in the body hair about the neck; the body louse, in hairy areas below the neck; and the "crab louse" in the hair of the pubic area.
- The life cycle (no metamorphosis) is essentially the same for all three lice. The eggs are cemented to the hair of each part of the body and are called "nits", with one important exception: The eggs of the body louse sometimes are cemented to hair on the body, but more often are laid and cemented in the seams of the clothing of the individual.
- Nevertheless, the body louse attempts to stay in close proximity to its human host in order to have frequent blood meals. These three kinds of lice can live only short period away from their human hosts – – Eight to 10 days for head and body lice, and 12-48 hours for crab lice.

Transmission of Lice from Person to Person

- The most frequent means by which a person becomes infest with human lice is personal contact with an infested individual. Head and body lice can be transmitted by sharing personal clothing or hair combs. Crab lice most often are spread by sexual contact, although in some instances by toilet seats. In crowded conditions human lice move easily from one individual to another and infestations may increase rapidly. This is why human lice are such a problem in crowded slums, prisons, and in wartime.

Diseases Spread by Human Lice:

The medical term for an infestation of human lice, together with the associated itching and scratching, is "pediculosis". When this condition gets worse and the skin becomes scarred, hardened, and pigmented, it is sometimes called "Vagabond's disease". Body lice, but not head lice or crab lice, historically have transmitted the serious disease, typhus fever and relapsing fever. But these diseases have not been reported in the U.S. in decades. Neither head lice nor crab lice are known to be vectors of disease.

Lice Control:

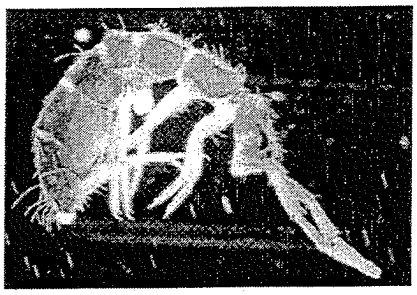
- Human lice can survive only short periods away from their human host. Eggs can survive for longer periods but need moderate temperatures for survival. For body lice, the clothing should be laundered.

All three lice require local applications of insecticide to the body. For this, the necessary advice normally should come from a medical doctor.

- For limited insecticide applications to "inanimate objects", a registered insecticide available through drug stores is "R&C Spray". It is packaged in small aerosol cans and contains pyrethrins, piperonyl butoxide, and a low percentage of lindane. It can be used on bedding, furniture, rugs, sheets and mattresses.

Springtails:

- Springtails are very tiny (one-sixteenth inch long), primitive wingless insects belonging to the order Collembola. Their bodies are normally long and narrow in shape and their antennae are usually composed of four segments. Some species have eyes while others are eyeless altogether. Different species vary widely in coloration.



  - Springtails jump like fleas by means of a forked, tail-like appendage which when released, enables these insects to leap several inches into the air — hence, the name "springtails."
  - Most species of springtails do not "breathe" through a complex system of tracheal tubes as do nearly all other insects. Rather, they obtain what little oxygen they require from the simple diffusion of air across the outer layer of their exoskeleton (epicuticle). The epicuticle of most springtails also lack a protective layer of wax to help prevent evaporation of internal body moisture and for these reasons, springtails must remain in damp environments in order to survive.
- Although springtails are very common insects, they are not often observed by the layman. One reason is that in addition to being very small, springtails tend to remain in concealed locations such as in the soil or in leaf mulch. And unlike fleas or mites, springtails cannot bite or do damage to food, clothing or health.
- Springtails normally become pests only when they enter homes, either by accident or because the outside environment becomes too hot or dry. Once inside, springtails tend to frequent areas where there is both high humidity and an excess of organic debris. These conditions can occur in poorly cleaned kitchens, bathrooms and around drain pipes where there is a build-up of mold and mildew. In these areas, springtails are most likely to be noticed by the homeowner, particularly if they happen to fall into sinks and bathtubs and become trapped there. Over watered potted plants may also support an infestation of springtails. Again, although springtails do no damage indoors, it is their mere physical presence that is objectionable to many people.
- Outdoors, some species of springtails will chew holes in the leaves and stems of young lawn seedlings or other garden plants.
- Springtails have a simple life cycle. Outdoors, infestations increase during hot, humid weather. Indoors, springtails may breed all year as long as there is a continuous supply of heat, moisture and organic debris.

Springtail Control:

- Indoors, control of springtails can be achieved by cleaning up deposits of mold, mildew, grease and food particles around pipes, drains, floor edges and in cracks and crevices. Damp linen, bedding and furniture should be cleaned and dried. House plants should be watered only when necessary. Currently (as of this printing), there are no popular insecticides labeled for control of springtails indoors or on the outside surfaces of buildings.
- Outdoors, removal of leaf litter, piles of mulch, compost and other decaying organic matter will aid control.

12) ANTS

- The two most numerous terrestrial animals on the planet are **ants** in the order *Hymenoptera* (including bees and wasps) and **aphids** (*plant lice*). Ants are extremely successful animals and range from the tropics into the arctic regions and from the dry desert areas down to sea level and moist regions.
- Part of the **success of the ant** is its *social and communal nature* and the fact that ant nests are usually terrestrial and are adapted to a great variety of climatic and soil conditions.
- One of the most **outstanding survival characteristics** of the ant is its *ability to adapt itself to a varying environment.*
- Another important factor in the survival of ants is their *division of labor among the division of labor among colony members.*
- Ants (as well as all insects in the order Hymenoptera) have a *complete life cycle* (metamorphosis).

The Anatomy of Ants

- Ants come in a variety of sizes and colors. Ants are typically either, blackish, brownish, yellowish, or reddish in coloration, or any combinational mixes of the aforementioned. The largest ant is the female of *Dorylus wilverthi* and attains a length of up to 4 cm. The smallest ant is 0.8 mm long.

- **Antennae:** One of the distinguishing elements of the ant from other insects is primarily by the **narrow pedicel**, consisting of one or two joints, situated between the thorax and the abdomen. Ants also manifest a noticeable **elbowed antennae**. The discernible pest control operator will notice that the narrow pedicel of the ant is distinguishable from that of the broad connection of the thorax and abdomen in termites.
- The antennae harbors the many sensory cells of the ant and enable the ant in the primary areas of touch and smell. It is made up of a **scape** and **funiculus** (whip), the latter being much more mobile than the former. The funiculus has a tendency to rapidly vibrate and this vibration is associated with the high development of the olfactory sense in ants. An ant losing its antennae would be the equivalent to a man losing his hearing, speech, and eye sight, due to the fact that it is primarily through the antennae that they are aware of their environment and adjust themselves accordingly.
- The sense of smell in ants is radically different to that of humans. Ants can smell with their antennae and even recall smells that are elongated, hard, soft, round, square, and even in a certain direction.
- Ants use their antennae to follow the trails laid down earlier by a lead ant that has dropped a drop of perfume-like chemical (pheromone along the trail at certain intervals. The ants follow the trail left behind through "smelling" the perfume left behind by the lead ants. If one were to cut off the insects antennae, it would be the equivalent of cutting off a human's nose and plucking out his eyes. It would lead to great confusion and handicap the insect severely.
- There eye sight on the other hand is much poorer than that of humans. They have lateral compound eyes; the queen, male and workers of some species have three simple eyes (oscelli). **Oscelli** are adapted only for seeing light or dark. Ants are not believed to be able to see things clearly and distinctly.

- **Head:** Ant heads come in a variety of forms: long, short, wide, thin, protruding, etc. One of the chief components of the ant head consists of the mandibles. The mandibles are used for a variety of endeavors: biting, building, carrying, cutting, gnawing, leaping, and sawing, but strangely enough, never for eating.

- **Legs:** Spurs are usually present on the legs of ants and those on the forelegs are especially large and comb-like. The ant removes dust from the antennae and legs by drawing these through the comb of the tarsus and the spur of the tibia. Moreover, the tarsal hairs are lubricated by the tarsal glands. In this regard, the comb and brush are never absent from the fore-legs. The secretion of the glands of

the tarsus causes the grains of dust and other impurities to stick to each other, and this makes it easier for the ant to dispose of them with its comb and brush.

Ant Biology and Habits:

- The ant egg is virtually microscopic in size. It hatches, producing a soft legless larva. After several molts, the larva pupates. In some ants, the pupa is inside a silk, smooth-surfaced, light colored cocoon, while in others the pupa is "naked" (not in a cocoon). The cocoon resembles a large capsule-shaped egg, about the size of the ant itself (a good example of this is the common *Argentine ant*). Sometimes these pupae are mistakenly thought to be ant eggs. Indeed, the pupae of some of the larger species of ants are sold in pet stores as "ant eggs". A good method in which to see this more clearly is by moving a board under where the ants are living and you will see the adults ants carrying off the pupae (or "ant eggs") and larvae. By looking more closely, you can see that they also are carrying away the actual very tiny eggs.
- The adult ant may require a few days to become completely mature after emergence from the pupa. During this period, the body hardens and darkens. From egg to adult takes 6 weeks to 2 months or more, depending on the season, temperature, and species.
- As with bees and termites, the ant colony is composed of individuals called **castes**. The ants have three distinct castes: (1) the *workers*; (2) the *males*; and (3) the *females*. All three of these castes go through the same process of egg, larva, and pupa stages of development.

The Establishing of the Ant Colony: The vast majority of ant colonies are formed when the newly mated queen rids herself of her wings, digs a nest or seeks a cavity under a stone or piece of bark. She then closes the opening of the cell and remains a volunteer prisoner for weeks or even months while the eggs are growing in her ovaries. The loss of her wings has a strange effect on the voluminous wing muscles in her thorax, causing them to break down and dissolve in the blood plasma. Their substance is carried by the circulation to the ovaries and utilized in building up the yolk of the eggs. As soon as the eggs mature, they are laid and the queen nurses the hatching larvae and feeds them with her saliva till they pupate.

- Since the queen never leaves the cell during all this time and has access to no food, except the fat stored in her abdomen during her larval life and her dissolved wing muscles, the workers that emerge from the pupae are all abnormally small. They are in fact, always minimae in species which have a polymorphic workers' caste. They dig their way out through the soil, thus establishing a communication between the cell and the outside world, collect food for themselves and their mother, and thus enable her to lay more eggs. They take charge of the second brood of eggs and larvae, which, being more abundantly fed, develop into larger workers.
- The population of the colony now increases rapidly, new chambers and galleries are added to the nest and the queen devotes herself to digesting the food received from the workers and to laying more eggs. In the course of a few years, numerous males and queens are reared and on some meteorologically favorable day, the fertile forms from all the nests of the same species over a wide expanse of country escape simultaneously into the air and celebrate their marriage flight. This flight provides not only for the mating of the sexes but also for the dissemination of the species, since the daughter queens, on descending to the ground usually establish their nests some distance from where the parental colony is located.
- The higher the rate of egg disposition of ants the more proportion of eggs escaping fertilization and therefore the higher proportion of males. It therefore follows that if differences in the rate of egg deposition by the queen ant determine the occurrences of the various castes, the males and queens will be produced when the rate is high, that is, when the ripe eggs are retained in the ovary for a relatively short time, while the sterile female castes and associated anomalies will be produced when the rate is low, that it, when the ripe eggs are retained in the ovary for a relatively long time.

The Worker: The workers are sterile and wingless females and may vary in size and forms almost as large as the queen to very small ants. The larger ants may defend the nest or use their large jaws to crush seeds. When there are not intermediate forms, but only two classes of workers, small and large, the large workers are called "soldiers." In many species of ants, there may be only one size for all the workers. For example, Argentine ants are known as *monomorphic* ants (same size), whereas Carpenter ants are *polymorphic* (many sized). The workers perform all the labor in the ant colony such as nest building, nursing of the young, procuring the food and duties of similar nature. At times the worker may take over the egg-laying duties of the queen. Workers may live up to seven years, but usually exist under natural conditions for a much shorter period of time.

The Male: The male is winged and keeps his wings until death. He is somewhat larger than the worker but smaller than the female. He dies one to two days after his mating flight with the female. Of the three ants in the caste system he has the largest eyes (perhaps with which to spot the queen) and a huge thorax which harbors powerful wing muscles.

The Queen: usually the largest ant in the colony. The queen mates only once, but may produce offspring until she dies. In species where the queen is winged, virgin queens found in the nest still retain their wings, unlike the mated queen, who removes hers. Once the queen has reared her first brood, she usually becomes an egg laying machine and is cleaned and fed by the workers.

- Many colonies have more than one queen in the nest. Should all the queens in a nest die or be killed, specially fed workers may undertake the egg-laying function. Some ant colonies have been known to exist for up to 40 years. Queens have been known to live as long as 15 years. The original colony queen is often replaced several times before a colony is disbanded or destroyed.

The Eating Habits of Ants:

- Ants are primarily **omnivorous** (meaning they eat practically everything). They mainly feed on those foods which are greasy, starchy, and sweet. Sense of smell is the most developed of the ant's senses and thus helps them find food by searching randomly and following their odor receptors (located on the last few segments of their antennae). Upon finding food, the ants find their way back to the nest and help direct the others to the newly found source of food.
- Ants have good memories and can recognize surroundings and landmarks in order to remember where the food source is located. Oftentimes ants will even use sunlight as a means of orientation. Another method of helping the ants find food is known as **pheromones**. Pheromones are substances secreted by the ant that influence the behavior of other ants in the colony. When a food source is located, the worker lays down a scent trail (pheromones) for others to follow. The other workers pick up the scent and help in gathering food for the colony.
- Ants are liquid-sugar imbibers and obtain much of their nourishment either from the sweet exudations of plants or insects. These sugar-eating ants attend the nectarines on leaves and in flowers, as well as collect the "honey dew" deposits of aphids, whiteflies, scale insects, mealy-bugs and other insects. This honey dew is the excess juice left over after the insects have assimilated the nutrients which they can use. These honey dew producers have changed the cane sugar to invert sugars which is similar to honey.
- Ants enjoy liquids and hefty solid particles do not enter the digestive tract. When found feeding on solid material, they are merely squeezing the liquid juices from this food. Although the larvae of most ants feed on liquids, the larvae of a few different species may swallow solid food.

Common Ants

- There are approximately *217 species of ants in California.* We will examine a few of the most common ants likely to be encountered by the pest control worker in California.

- **The Argentine Ant** (*Iridomymex humilis*) – most likely made its entry into the United States into New Orleans by way of the coffee ships from Brazil in the late 1800's. The worker or sterile female is 2.2 to 2.8 mm long, but it may appear larger when the abdomen is distended with food. In color it varies from a light to a dark brown, with the thorax, scapes, and legs somewhat lighter. The queen is brownish and from 4 to 6 mm in length and is by far the largest ant in the colony. There is usually more than one queen in the colony and a way of finding this out is to pour a 20 oz. bottle of water over a nesting site and observe within a short time, the workers carrying their young with their mandibles and very often a number of queens will emerge.
- Though small and easy to kill, the workers are quite aggressive and will eliminate other ants in their path. They seldom swarm; but will move their colonies with great frequency – for example: if the ground becomes too dry, hot, wet, or too cold. They may move indoors in the winter or when it is too dry or too wet outdoors. They prefer sweets over all other foods. They also enjoy fruit, honeydew, insects, meats, and seeds.

The **Argentine Ant** has successfully survived and thrived in the United States for the following reasons:

- They are friendly to one another (even the queens), unlike ants of most other species.
- The ants are very adaptable and nest in a variety of conditions.
- In an area where there is an infestation, the widely separated galleries of the ants eventually come together (interconnect). In addition, there are a great number of queens in an infested area, having a high reproductive potential, and therefore the ability to build large colonies.
- They feed on the secretions produced by aphids and scale insects which are in abundance at the bases and trunks of trees.

Controlling the Argentine Ant: Sweet syrup baits work well due to the ants "sweet tooth". Surfaces should be treated with a residual insecticide around the perimeter of the area outside the nest. The theory behind poisoned baits is that when the queens are killed or made ill, the reproductive capacity of the colony is diminished and therefore there will eventually be a curtailment in the number of workers.

California Fire Ant – It is the same species as the "*Southern fire ant,*" but not as vicious. It will *both bite and sting* at the slightest provocation. It is very competitive and will displace other ants. In turn, it is often driven away by the Argentine ant and is rarely found in close proximity to the Argentine ant. Sometimes they nest indoors. The workers are polymorphic (2 sizes: ¼" and 1/8"). The head and thorax are yellowish red to dark yellowish brown, and the back end of the abdomen is darker brown to blackish. The nest *of the fire ant consists of a mound in the soil that resembles a mini volcano.*

Control of the Fire Ant: Dusts, granules and sprays around the entrance holes of the mound are the easiest to apply. Dusts should be used with caution since they may be blown where not desired.

- Fumigation of the areas where the nests are located is possible if permitted by the label, but would require care for the surrounding vegetation, as well as the workers.

Carpenter Ant – Are the *largest* of the ants. The reproductives can reach ¾"; but most of the workers are ¼" and larger. Are primarily considered a **Branch 3** (wood destroying organism) pest because it *nests in wood,* often the wood of a human dwelling unit. It does not eat the wood, but with its mandibles it hollows out its smooth large galleries in the wood, leaving little piles of wood fragments that look almost exactly like sawdust. The workers are polymorphic.

- Carpenter ants are commonly found outdoors in fallen trees, rotten logs, tree stumps and other wooden structures—from which they come into buildings. They forage at night and, if outside, readily enter a home in search of food. Carpenter ants are nocturnal and enjoy sweets more than fats. They don't sting, but have a *painful bite* and have been known to attack people. One of the most common ways they enter a home is either via an open window or on a tree limb that is touching the household. They will travel up to 100 yards to search for food from their nest.

Treatment for Carpenter Ants: *Should include both outdoor and indoor inspections.*

- If the nest is found, treatment is usually easy with either a dust or a spray.
- Extreme infestations should be treated by fumigation by covering the house and introducing a gas like methyl bromide.
- Once treatment for carpenter ants is completed, it should be highly recommended that any overhanging tree limbs close to the residence be treated to prevent a reeinfestation.

Harvester Ant – Red to dark brown or black color. They have long hairs forming a "brush" under their chins. They nest in dry, exposed soil, never in houses. They clear vegetation from around their nest opening, and create a bare area. They typically eat small seeds and insects.

- **Control for Harvester Ants:** Typically not a problem for homes, but may cause problems in or around the lawn.
- Currently available insecticides should be applied around the entrance hole and out to the edge of the mound area so foraging ants will carry the pesticide into the nest.
- Since most foraging is within 50 feet/ 15 m of the nest, a treatment of a residual chemical within this area should prove effective.
- Burrow fumigants such as the liquid fumigants if labeled should be effective.

Odorous House Ant – Similar in size and habits to the Argentine ant, but is somewhat darker in color. And it has the odor of rancid butter when it is crushed. Smashing with the finger and smelling is the usual way to assure the identification of the odorous ant. They enjoy sweet foods (like the Argentine ant) and are thus commonly found in the kitchen of a residence.

- **Control of the Odorous House Ant:** Locating the nest is well worth the effort by first searching outside for a nest, if the nest is found then a simple residual pesticide will work well.
- These ants have food habits similar to that of the Argentine ant. However, the odorous ant has a much more localized colony than that of the Argentine ant. It is therefore imperative for the control of this ant to find and treat the nesting site.

Pavement Ant – Light brown to blackish in color. Workers are about 1/8". The head and thorax have fine distinct parallel lines. Nests in soil beneath stones, pavements, and slab-on-grade foundations; occasionally in walls, under floors, and elsewhere. An extremely slow moving ant which is a great nuisance because of slab-on-grade construction. Works through cracks in slabs to enter houses. They forage as individuals and do not travel in trails.

- **Control of the Pavement Ant:** Whenever possible, residual sprays should be forced into the entry point with drilling if necessary.
- Where heating ducts are the entry point, it may be necessary to use baits which will be more effective in the ducts than they will be in other parts of the structure.
- Sticky traps such as glue boards may be helpful, but they will soon get a coating of dirt and become ineffective.
- Regular treatments of the mounds as seen along the sidewalk and pavement outside can reduce the likelihood of an interior infestation.

Pharaoh Ant – It is yellowish to light brown. The workers are only 1/16". It sometimes occurs outdoors in the South; but otherwise it nests in inaccessible places in buildings such as wall voids, above ceilings, beneath floors, and in foundations. Colonies are very large, sometimes 300,000 individuals. It nests in warm places—frequently near furnaces, heating ducts, and hot water pipes. They travel considerable distances over well-established trails. Eats practically anything; but prefers grease and vegetable oils.

- **Control of the Pharaoh Ant:** The hardest to control of all the ants. Because they quickly disseminate into satellite colonies when treated.
- Identification must be established before treatment can begin.

- Saturation treatments of all kinds must be used. Thorough treatment of baits, sprays, dusts, etc. must be used for up to two years in order to eliminate this pest.

Thief Ant – This ant gets its name from the fact that it steals food, as well as the young from other ants. The thief ant is the smallest of our commonly encountered household ants – only 1/16". Its small size enables it to get into food containers where other ants cannot; also other ants are unable to follow the thief ant into its tunnels. The thief ant will not eat sugar, but prefers fats.

- **Control of the Thief Ant:** Thief ants are more likely to have an outside nest than Pharaoh ants so an outside barrier strip should be a part of a control program for the homeowner.
- Pesticides are useful in controlling this ant.
- Although this ant may nest inside all year long, it is thought by some to nest inside more frequently in hot weather. Following the trails to the nest is reportedly difficult, but should be attempted.
- Control should be centered around the pantry and other food sources, as well as around sinks and other moisture sources. Natural voids such as the area under kitchen cabinets or nearby wall voids should be dusted with a residual dust.

Velvety Tree Ant – Light brown to brown in color – sometimes contains a reddish thorax. Body covered with velvety hairs. Relatively large being from 1/8" to ¾". They are very fast runners. Can be found throughout California, but more commonly found in Southern California. Has a similar odor to the odorous house ant when crushed. Will often form large colonies under bark and in cavities of trees, in stumps, and under piles of rocks. They are commonly found traveling rapidly in trails up and down tree trunks in search of aphids. They eat honeydew, and live and dead insects. Sometimes they can be found in homes but are in search of insects to eat, not human food. They have a tendency to be pugnacious; when they are disturbed they will bite and inject a poison into the wound (they do not sting).

- **Control of the Velvety Tree Ant:** These ants will come into homes looking for insects to feed on. If the trees they are using for nesting are nearby, then tree spraying can be effective. The columns in the house can be sprayed with residual or contact sprays by the homeowner.

SINGLE NODE ANTS	COLOR	SIZE	CHARACTERISTICS	SWARMS
Argentine	Light brown to brown	1/16-1/8"	Travels in columns. Greasy or musty odor when crushed.	Rare. Usually mate in nest in early summer.
Carpenter	All black or black and red, black and brown	¼-1/2"	Usually nests in wood. Formic acid odor when crushed.	May-July
Cornfield	Brown to dark brown	1/16	Builds crater-like nests in Formic acid odor when crushed.	Late summer or early autumn
Crazy	Dark brown to black	1/16-1/8"	Very long legs & antennae Runs with quick jerky motion.	Spring
Field	Reddish to dark brown or black	1/8-3/8"	Builds mounts or craters in soil, under rocks.	Late summer to early fall
Honey	Reddish brown to blackish, Shiny in appearance	1/16-1/8"	Mid-thorax constricted giving "sway-backed" appearance. Node is well developed.	Early spring

SINGLE NODE ANTS	COLOR	SIZE	CHARACTERISTICS	SWARMS
Larger Yellow	Pale yellowish to yellowish red	1/8-3/16"	Citronella or lemon odor when crushed.	Early spring
Odorous	Brown to black	1/8"	Node very small; rancid-butter Odor when crushed. Well-established trails.	Rare. Mating Usually in nest. May to mid-July.
Pyramid	Brown to black, orange and black, red and black	1/8"	Workers forage in conspicuous files. No sting or circle hairs.	Early to mid-Summer
Velvety Tree	Brownish-black head, red Thorax, black abdomen	1/8-1/4"	Forage in files. Spray secretion with disagreeable odor on intruders.	Not known.

DOUBLE NODE ANTS	COLOR	SIZE	CHARACTERISTICS	SWARMS
Acrobat	Dark brown to blackish	1/8-1/4"	Holds heart-shaped gaster over rest of body when disturbed	Mid-June to late September
Big-Headed	Yellowish to light brown to brown	1/16-1/8"	Head very large in relation to the rest of the body (soldier)	Not known.
Fire Ant	Yellowish to reddish to blackish	1/8-1/4"	Build large mounts. May produce painful stings.	Late spring to September.
Harvester	Red to dark brown or black	3/16-3/8"	Hairs under chin. Bare area around nest entrance. Can sting.	June & July
Little Black	Dark brown to black	1/16"	Antenna with 3-segmented club. Stinger present.	Late spring to early fall
Little Fire	Light brown to golden brown	1/16" or smaller	Last segment of antennal club is very long. Can sting.	Not known
Pavement	Light brown to blackish	1/8"	Head and thorax with fine	Late spring
Pharaoh	Yellowish or light brown to reddish	1/16"	Antenna with 3-segmented club	Rare. Usually mate in nest
Thief	Yellowish or light brown to dark brown, shiny	1/16"	Last two segments of antennae enlarged. Eyes small	Late July to early fall

13) Bees

- Bees are similar to wasps except that bees have denser and more featherlike body hair than wasps; and, also, bees feed their young pollen and nectar, while wasps feed their young meat (mostly captured insects or spiders). Honeybees and bumblebees both live in colonies and are called social insects. Carpenter bees and sweat bees do not live in colonies and are called solitary insects. Solitary bees sometimes sting people but the sting is mild, unlike the more painful sting of the social bees. All bees, wasps, yellow jackets, mud daubers, and ants belong to a rather sophisticated (= more specialized) order of insects: Order Hymenoptera. All the Hymenoptera have a complete metamorphosis. The honeybee is the bee most frequently encountered by the PCO. Therefore, most of this lesson will be on that bee. Most honeybees live in the hives of commercial or amateur beekeepers, but some live in tree hollows, attics and wall voids of vacant buildings, etc.

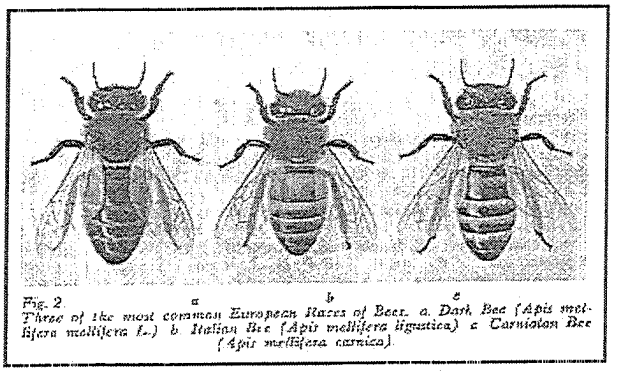


Fig. 2 a b c
Three of the most common European Races of Bees. a. Dark Bee (Apis mellifera mellifera L.) b Italian Bee (Apis mellifera ligustica) c Carniolan Bee (Apis mellifera carnica).

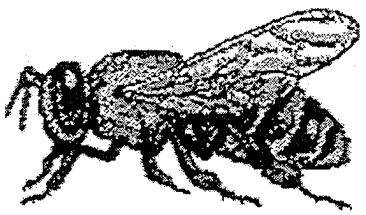
- Honeybees in the U.S. are not overly aggressive. However, a strain of African bee, brought to South America to increase honey production, escaped and mated with South American wild bees. This resulted in a very aggressive wild bee, called the "killer bee" (or the "Africanized bee"). It attacks people and other animals in swarms. Hundreds at one time have been seen vigorously pursuing and attacking their victim. This bee is now making its way slowly up through Central America to the U.S. Researchers disagree on whether or not the Africanized bee will mate with other bees and become less aggressive by the time it arrives in the U.S.

The Honeybee – Description and Habits

- There are **three castes of honeybees** in the colony: (1) *the one-per-colony long slender queen (2) the few stout robust male drones, and (3) the thousands of workers.*
- The queen is responsible for reproduction. The drone's only purpose is to mate with one virgin queen one time, while flying outside the hive, after which he immediately falls to the ground and dies. The drones which do not die this way are killed or forced out of the hive as the nectar supply gets smaller in the fall of the year.
- The workers, which may number 20,000 to 60,000 per hive do all the other work: feeding the queen; keeping the hive clean; fighting off ants or robber bees from other hives; making the beeswax comb in which the young are developed and in which the pollen and nectar are stored; caring for the young larvae in the comb; and going out and finding and collecting the pollen and nectar.
- Honey is essentially evaporated and aged nectar. Pollen, or "bee bread", is the main food of the young bees. Workers live about three months (less in the heavy honey flow season when their wings and bodies wear out from all the work). Those that emerge from the pupal stage in the fall overwinter in the adult stage. They remain relatively dormant in the colder parts of the country, or sometimes the whole colony freezes to death. Stored honey is their food during the winter.
- When the bee stings, she inserts a stinger that has barbs on two sides. This prevents her from removing the stinger once it is inserted into the victim. In her frenzied attempt to pull away, the shaft of the stinger, a poison sac, and a self acting muscle are ripped from her body, and she dies within a few minutes. But the self acting muscle continues to work, forcing the stinger and poison deeper into the victim even after the bee is gone. When a person is stung, they should never grasp the stinger (What are most visible are the muscle and the poison sac.) and pull it out. This squeezes the poison from the poison sac into the flesh, increasing the pain. The stinger should be scraped out with the fingernail. It's better to leave the shaft of the stinger in the flesh than to squeeze the poison sac.
- *Only the worker bee stings people.* The drones have no stinger and cannot sting. The queens have a very proficient stinger that can be used many times killing other queens. But they will not sting humans.

The Honeybee – Biology and Life Cycle:

- The queen honeybee is a remarkable egg-laying machine. At her peak production she may lay more than her own weight in eggs in one day on a continuous basis. As in most complete metamorphoses, the stages of development are: egg, larva, pupa, and adult. The young adult workers care for the eggs and larvae, which are located in the cells in the comb in an area called the "brood chamber".
- The older adults go out in search of nectar. When they return, they communicate where the nectar is located, and how far away it is. This is done by a "wag tail dance" that they perform on the comb for the other bees to see.
- When the colony becomes large enough for a new colony to be formed, the workers begin feeding a few very young larvae a substance called "royal jelly". This substance causes the young larvae to develop into queen bees in a greatly enlarged cell, instead of merely becoming workers. The old queen attempts to destroy these new larger cells, but they are protected by the workers.
- The old queen then leaves the hive with a few thousand workers in the form of a "swarm" and seeks a new location (and the owner of the new location then becomes a customer of a PCO).
- Meanwhile, back in the hive, the first new virgin queen to emerge from the pupa stage attempts to destroy all the other queen cells. Usually she is not completely successful and two or more virgin queens are loose in the hive at the same time. But not for long! They fight to the death until only one remains. After about five days this virgin queen goes on her mating flight.



- Mating takes place only in the air. This process results in fatal injury to the successful drone. He falls to the ground dead.
- The swarm accompanying the old queen flies until she tires, coming to rest on a tree limb, fence post, bush, or similar place. But if this location is not suitable for establishing a new colony, scout bees will seek out a more suitable site. Upon their return, the swarm will follow the scout bee that performs the most enthusiastic "dance". Openings in sidings, and entrances into attics or wall voids, or chimneys, are some favorite locations.

Control of the Honeybee:

- A swarm on a tree or shrub probably will leave of its own accord within a day or two. The local State extension service entomologist usually can furnish the name and phone number of a local beekeeper interested in this easy to capture type of swarm. Or, an insecticidal treatment with a power sprayer will probably eliminate the swarm.
- New swarms are easier to control than swarms that have built comb and established a brood chamber with both adult bees and sealed brood between the combs.
- After applying a pesticide, the dead bees sometimes leave an undesirable odor. Removing dead bees, the wax combs, and the honey reduces the likelihood of reinfestation by other bees, dermestids, and wax moths. If this is impossible, which usually is the case, at lease all entrance holes should be plugged.
- If an entrenched infestation is in a wall on the hot sun side of a structure, and the bees are killed, sometimes the comb will be melted and honey will run out. A colony of (live) bees creates its own ventilation system which often keeps this from happening.
- Bees can be trapped out of wall voids by the use of a wire cone about 18" long and a bee hive, but this requires several weeks.
- Insecticide dust usually can be blown into the nest inside a wall by drilling a hole if the colony can be precisely located in the wall. Treating at night reduces the likelihood of being stung.
- Voids in exterior walls are a good spot to check when suspecting a colony of bees.

Carpenter bees are large, resembling bumblebees. They are usually black and yellow in color. Carpenter bees are solitary bees and do minor damage to wood. The nest opening in the wood is ½" in diameter, extending directly into the wood 1". It then turns 90 degrees and extends 4-6" with the grain of the wood. After the female carves out this nest, she puts a combination of pollen and honey deep into the bottom of it, lays one egg on top of this food mass, and seals it off, forming a cell. She continues doing this until about 6 or 8 such brood cells are formed, each containing an egg and the food mass for the hatching larva. From egg to flying adult takes about 1-3 months. Observing the bee usually leads you to the entrance hole. Look for round holes the size of a dime. Males cannot sting; but females will sting if molested. In California, the Valley Carpenter Bee male is tan in color, and the female is black. If a homeowner has complained of large, black flying insects hovering around the outside and above the windows and has discovered large holes in ceiling rafters, this is a sure sign of an infestation of Carpenter bees. To treat for a carpenter bee infestation you should spray the wood and plug the hole.

Bumblebees are social insects which nest in the ground. They are sometimes a nuisance near houses and schools and they will sting if provoked. However, bumblebees are not a major PCO problem.

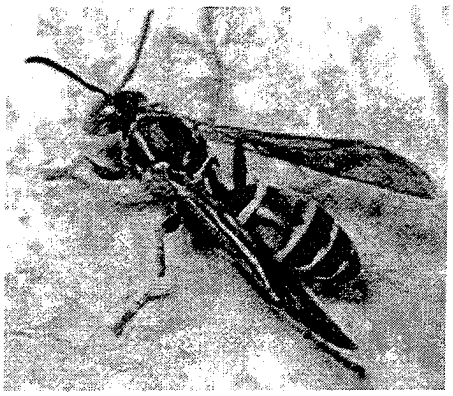
Sweat bees are much smaller than honeybees. In fact, they might easily be confused with flies. They are attracted to human perspiration. Sweat bees may sting when brushed away, but very little pain ensues.

Wasps:

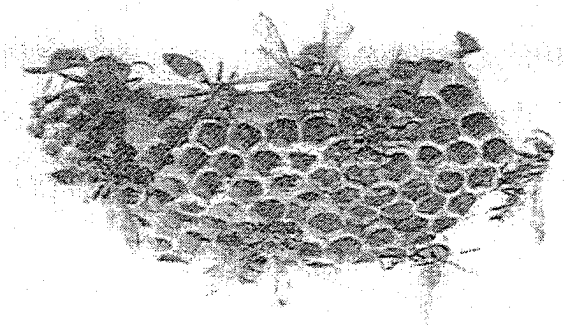
- Wasps differ from bees in two definable ways: *(1) Bees usually have broader bodies covered by more hairs than wasps; and (2) Bees feed their young pollen and honey while wasps feed their young meat* (mostly captured insects and spiders).
- Wasp stings are quite painful to most people, but without serious consequences. However, to some individuals a wasp sting can produce a severe allergic reaction, and sometimes almost immediate death. Many highway accidents are believed to be caused by wasp or bee stings.
- Some wasps are "social wasps". (Man individuals work together in building the nest and caring for the young.) And some are "*solitary wasps*" (A single female constructs and maintains a nest for her young only and does so without help from other wasps).

Social Wasps:

(The umbrella wasp, the yellow jacket, and the hornet)



- The umbrella wasp, the wasp most commonly seen in small nests under the eaves of houses, has been erroneously named "the paper wasp". This is confusing because yellow jackets and hornets construct even larger paper nests. A better name is the "umbrella wasp" because the nest looks like an upside down umbrella. This same wasp is also known as the "Polistes wasp".

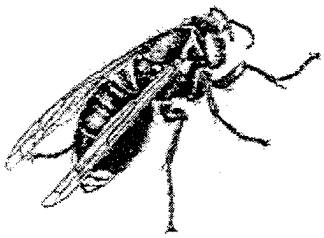


Identification and Nests

The umbrella wasp: (= paper wasp or Polistes wasp) has a spindle shaped abdomen (distinctly tapered at both ends.) The nest is a fairly common sight on the eaves and in the upper corners of buildings. It is 2-5" in diameter and hangs down

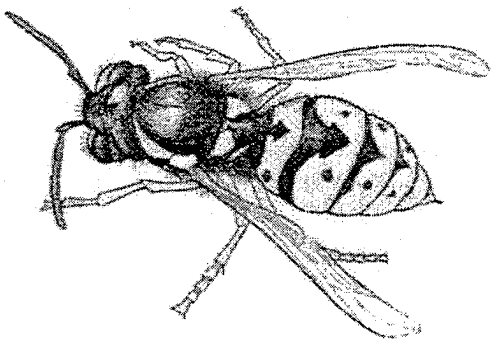
from the building (or tree) on a short pedicel, like an upside down umbrella. The bottom side has the hexagonal shaped cells in it, and it looks like a honeybee's honeycomb. And, indeed, it is called a "comb". The wasp makes this "paper" nest out of weather beaten wood and dead plants chewed in its jaws with saliva. The nest rarely accommodates more than 100-200 individuals. A warm temperature is the environmental factor which most effects wasp activity. The best time to treat the paper wasp is when the temperature cools down (dusk or dawn) by treating the nest and then removing it when the wasps are dead.

Yellow jackets: are colored similar to the umbrella wasp. To tell the difference, look for the umbrella wasp's spindle shaped abdomen, and the nest. The nest of the yellow jacket, as it is built larger, consists of several "combs" placed side by side (not just one comb as in the case of the umbrella wasp). The nest may contain as many as 10,000 individuals. And the entire yellow jacket nest is covered with layers of paper, giving it roughly the shape of a gray football with a hole in one end for entry and exit. In California the yellow jacket usually is located underground in the vacated burrow of a rodent; but it can be located in a tree hollow, under a house eave, or similar place. Of course, if the nest is underground, there is less of a gray paper covering over the combs, so the combs are somewhat visible when the soil is removed.



Hornets: The biology, nest and appearance are very similar to the yellow jacket. But in California the hornet usually makes its nest above ground, such as in trees, shrubs, and on the eaves of structures.

Life History – Yellow Jackets and Hornets



The queen and males mate in the fall. The males then die and the queen overwinters in a protected place such as a crack, under loose bark, or occasionally in an attic or similar sheltered location.

In the spring the queen emerges from this protected place and selects a site for a new nest. She lays eggs, then collects insects or other meat and feeds it to the young larvae. She continues this until her first brood becomes young adult workers, and then she becomes a full time egg layer while the adult workers continue to expand the nest and collect food.

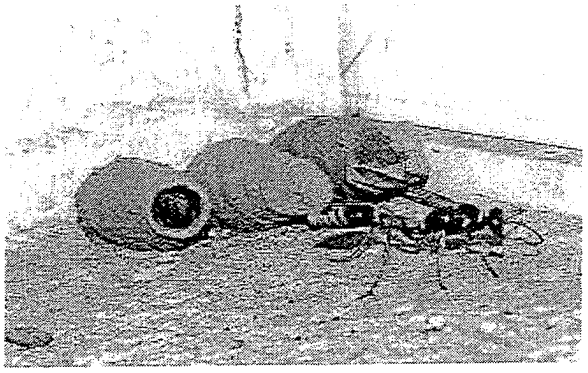
The ground nesting yellow jackets enlarge their hole in the ground to accommodate their expanding nest. Similarly, the above-ground-nesting hornets expand their football-like nest on underside of the eaves of a building or whatever similar location has been chosen. During this time the workers make up almost the total adult population of the colony. They feed on nectar, honeydew, fruit juices or sap as they continue to feed the young larvae insect prey and bits of meat. In early to mid-August, males and "queens" (instead of the workers that were produced all summer) begin to be produced. They mate nearby.

And with the onset of winter, the males die and the females hibernate. They abandon the nest and it is not used again. Throughout the season the adult food includes liquids high in sugar, such as fruit juices and probably almost any kind of meat, including many kinds of insects.

Life History – Umbrella Wasps:

- Life history is essentially the same as yellow jackets and hornets.
- The key differences are that the **umbrella wasp** has many *fewer individuals in its colony*; and the umbrella wasp *nest is quite different* from the nests of the yellow jackets and hornets.

The Solitary Wasps:



- There is no socially organized life; no workers; only reproductive males and females. The females are "hunters". They take prey for putting into the nest for their young larvae. They first kill the prey, then place it in the cell and lay an egg on top of it, and then seal the cell.
- The adults generally do not eat prey, but feed on honeydew, nectar, ripe fruits, and other plant liquids. In general, solitary wasps overwinter as larvae in their cells in the nest. The males and females die as winter approaches. The **mud-daubers** are 1 to 1-1/2" long and had thread-like waists ending in an expanded abdomen. Mud-daubers *build the smallest nest of the bee family.*

Control of Bees & Wasps:

- Control of social wasps is not difficult. *The trick is to do it without getting stung.* If possible it is best to do this at dusk or night to avoid the possibility of getting stung, but also to be certain that most of the wasps have returned to the nest. Wear gloves, a hat, and bee veil, if the situation necessitates it.
- A *flashlight at night can excite the wasps to sting.*

14) COCKROACHES

- The Romans called the cockroach *blatta* and *lucifuga* for its habit of fleeing from the light. Our English term "cockroach" comes from the Spanish word "cucaracha." There is little agreement as to the country or origin where cockroaches originated. There is close to unanimous agreement that they have come from the tropics. They have come over to America as stowaways on ships from various parts of the earth and their ability to reinfest areas despite advances in the pest control industry leave little doubt that they will ever go extinct anytime soon.
- Cockroaches are unwanted by humans due to the fact that they devour food, which it is believed they discover primarily through their sense of smell. They are of extreme importance in bakeries, butcher shops, hotels, private homes, ships, and various localities where humans live and work. They live in or near drains, cracks or wooden store fixtures, hot water pipes, moist kitchen sinks, behind stoves and refrigerators, and under meat chopping blocks.
- All cockroaches are *omnivorous.* They mainly feed on starchy foods such as cereals, meat products, and sweetened or sugary substances. Some of the common substances upon which they feed include beer, cheese, leather (such as that found in upholstered furniture), hair, wallpaper, and dead animals. They eat books; especially those soiled with perspiration, and may feed on the binding of books in order to get to the paste behind the binding. Interestingly enough, they may even be found in greenhouses where they will feed on various plants.

COCKROACH BIOLOGY:

- Humans have what is known as an *endo-skeleton,* or simply a skeleton on the inside of the body. Humans are equipped with arm bones, head bones, leg bones, and backbones that are covered with a layer of muscles, a layer of fat, and a layer of skin. Insects, on the other hand, have what's called an *exo-skeleton,* or simply a skeleton on the outside of its body. The skeleton of an insect resembles a suit of armor which covers the entire insect. The exo-skeleton is made of a substance known as chitin. Chitin is a hard material covered with a wax-like layer which helps conserve the water inside the insects' body.

An insect's body is divided into the following body parts:

1) Head – consists of one pair of jointed antennae.
2) Thorax – has three pairs of jointed legs.
3) Abdomen

Pests That Are NOT Insects:	**Why They Are Not Insects:**
• Mice & Rats	Has an endo-skeleton instead of an exo-skeleton
• Snails	No legs; and has no division of body parts
• Sow Bugs & Pill Bugs	Two pair of antennae (not one); seven pairs of legs
• Spiders	Two main body parts (not three)
• Ticks	Two main body parts (not three); eight legs (not six)

A pest may only be classified as an Insect when it contains the following characteristics:

1) An exo-skeleton (outside the body),
2) Three divisions of the body (head, thorax, and abdomen)
3) A pair of jointed antennae on the head &
4) Three pairs of jointed legs.

THE HEAD OF THE COCKROACH

There are three structures on the head of an insect to which we should pay particular attention:

1) Antennae
2) Eyes
3) Mouthparts

1) ANTENNAE

- Knowledge of what the antennae of various insects look like can help us in the identification of that insect and can separate quickly some types of insects that look alike to the untrained eye. For instance, a homeowner may experience a flight of insects within her home and she may want to know right away if these creatures are carpenter ants or termites. A trained service technician knows right away that a carpenter ant has elbowed antennae and that a termite has antennae that are *moniliform* (like beads strung on a wire) in shape and extend straight out from the base to the tip. The segments of an ant's antennae are elongated and not bead-like as in the case of the termite.
- The confused flour beetle is difficult to distinguish from the red flour beetle unless one looks at the distinguishing characteristics of their antennae. Drugstore beetles and cigarette beetles can be distinguished as well via knowledge of their distinct antennae features. The long horned beetle derives its name from the antennae which extend back beyond the end of its abdomen and look like a pair of long horns.
- Antennae are a very important aspect of insect anatomy. They are typically covered with very tiny fine hairs and help the insect to feel their way around the environment in which they live. Its sense of hearing and smell are also in the antennae (an exception to this rule is the cricket which contains its "eardrums" on the front of its legs). Ants use their antennae to follow the trails laid down earlier by a lead ant that has dropped a drop of perfume-like chemical (pheromone along the trail at certain intervals. The ants follow the trail left behind through "smelling" the perfume left behind by the lead ants. If one were to cut off the insects antennae, it would be the equivalent of cutting off a human's nose and plucking out his eyes. It would lead to great confusion and handicap the insect severely.

Antennae are important in that they help the cockroach:

1) Communicate with other cockroaches.
2) Taste food materials (recognition by taste).
3) Follow pheromone trails (via scent).
4) Recognize previously used cockroach harborages by smelling the previously deposited fecal matter.

2) EYES

- There are two distinct types of eyes to be found among the many kinds of insects: a) Ocelli or simple eyes and b) Compound eyes.
- **Simple eyes** are little more than simple light receptors that are able to differentiate between different light intensities. They can detect a shadow that has been cast over them by a predator and thus be alerted to danger. Spiders are not insects – but they are a good example of pests with simple eyes. Some spiders have six eyes and others have eight. The black widow has eight simple eyes arranged in two rows of four in each row.
- **Compound eyes** consist of the surface of the eye that is broken up into hundreds of tiny sis-sided lenses, each of which is viewed by such an eye is similar to a tile mosaic. This type of eye does not permit crystal clear vision, but it definitely recognizes the movement and changes of light intensity. The male housefly has compound eyes that are close together and can be distinguished from the female fly which has its eyes spread wide apart.
- The *cockroach has compound eyes*. They extend over the top front of the head (high forehead and top of the head) and down both sides of the head halfway to the mouthparts. They look sort of like a marine with a crew cut and long side burns. The compound eyes allow the cockroach to see backward, frontward, sideward, and upward, however, not with much clarity.

3) MOUTHPARTS

- There are three commonly occurring types of mouthparts among insects:

1. Piercing, sucking (biting stable fly, fleas, mosquitoes)
2. Lapping, sponging (common housefly)
3. Biting, chewing (yellow jackets, earwigs, carpenter ants, termites)

- Some insects are equipped with piercing, sucking mouthparts that pierce plant stems and leaves and suck plant juices (e.g. Aphids and scale insects). The biting stable fly, fleas, and mosquitoes pierce animal skin and suck blood. As they drive their needle-like mouthparts into the skin they inject saliva which contains an anticoagulant (incidentally, the antidote for all anticoagulants is Vitamin K) – to keep the blood from clotting during the feeding period. The saliva has a protein in it to which humans are allergic. As the allergic reaction sets in, the tissue around the "site" begins to swell. The swelling is simply designated as a flea bite or mosquito bite. A person receiving such a bite will scratch the area due to the sensation of itching caused by the swelling of the tissue.
- When a **flea feeds**, it engorges itself with the blood of its host until the blood drops out of the posterior of the flea. These droplets have passed through the alimentary canal and intestines of the flea and contain any disease organisms the flea may have been carrying in its intestines. The human then scratches these blood droplets right into the open wound caused by the flea mouthparts. Typhus fever and the plague are transmitted by fleas in this manner. Mosquitoes transmit diseases such as yellow fever, encephalitis, and malaria through the use of their piercing and sucking mouthparts.
- An example of an insect that has lapping, sponging mouthparts is the common housefly. These mouthparts look like a retractable "elephant's trunk." When landing on a dry surface (such as a sugar cube) to feed, the housefly first vomits a liquid down its trunk and uses the sponge to wet the surface and dissolve some of it. The dissolved material is then taken up through the same procedure. This tendency for the fly to bring up liquid material is the clue to the method by which it transmits disease.

The fly has a wide range of food from which to obtain its liquid nourishment – all the way from exposed fecal material to the contents of your dinner plate. Enteric diseases like summer diarrhea are transmitted by the lapping, sponging mouthparts of the common housefly.

- **Biting, chewing mouthparts** are very commonplace in the insect world. Yellow jackets use their biting, chewing mouthparts to excavate ground nest cavities and to chew cellulose debris to form a pulp for building nests or to gather meat to feed to their larvae – (the adults feed only on the liquid sweets).
- Carpenter ants eat only liquid sweets but have biting, chewing mouthparts which they use for defense and offense, for transporting their eggs, larvae and pupae, for extending their exactions in the wood, etc. Termite nymphs and workers have biting, chewing mouthparts used in much the same way as carpenter ants' mouthparts. They are elongated and scissor like and adapted for defense of the colony to such a degree that the soldier termite cannot feed itself but must be fed by the nymphs of the colony.
- The mouthparts of termite nymphs and of those of cockroaches are very similar in composition. Both the termite and the cockroach have unique "teeth" used to rip up the food from the surface on which they are standing and both have surfaces to grind up the food before "swallowing" it.

THE THORAX

- The thorax consists of all the muscles that give the insect the strength to move. All adult insects have six jointed legs and many adult insects have four wings – all legs and wings are attached to the thorax. The legs of different species vary in shape and size and include distinctive features. Ticks have a hook on the end of their feet which helps them to cling to the host. The hind pair of legs on the flea are significantly distended and are responsible for the fact that the flea can leap twenty times his own length. Flies' feet are adapted by being equipped with a sticky pad which enables them to walk on the ceiling upside down, and a pair of hooks that allows them to cling to rough surfaces.
- Upon close scrutiny the foot of a cockroach reveals a pair of hooked claws which enable it to scurry upwards across a fabric surface or maintain a steady footing on various rough surfaces. The same close-up look will divulge a sequence of five sticky pads on the foot of the cockroach which allows it to climb up over the polished metal flashing in back of the stove in a restaurant kitchen, or up over glass, or up the walls and across ceilings. There are few places that the cockroach cannot go. It is these same sticky pads that collect and spread various diseases.
- Numerous insects have four wings (two pairs). The wings are always attached to the second and third segments of the thorax. The termite swarmer, for example, has four wings of equal length which gives rise to the name of the order of insects to which it belongs – "*Isoptera*" ('*Iso*' meaning equal & '*ptera*' meaning wing in Greek).
- The majority of butterflies and moths have four wings and on these wings are scales arranged into patterns that enable one to identify the butterfly or moth. Beetles have four wings. The first or outer pair is usually thickened into a protective sheath and the second pair, folded under the outer sheath, is membraneous and used for flight.
- The external pair of wings of rice weevils have a sequence of light colored spots on them which distinguish them from granary weevils. Rice weevils can fly – granary weevils cannot. Cigarette and drugstore beetles have hard outer wings and membraneous under wings. The parallel lines (striations) on the outer wings enable one to tell the difference between these two look-alikes.
- Adult carpet beetles have wings and frequently fly from bush to bush outside of the house and from cut flower to egg-laying site inside of the house. Fleas do not have wings and are therefore, known as "*apterous*" – '*a*' meaning without and '*ptera*' meaning wing.
- Flies belong to the order "*diptera*" – '*di*' meaning two and '*ptera*' meaning wing. Thus, flies have two wings. The second set of wings called "*halteres*" help the fly to balance his flight. The reproductive castes of ants have four wings but unlike termites, the second set of wings is only half to three quarters as long as the first set.
- Cockroaches have wings. American and brown banded cockroaches are both capable of flight. German and Oriental cockroaches do not fly. A look at an adult Oriental cockroach will tell you why. The wings

on an adult male Oriental roach extend only two thirds of the way down the length of the abdomen. The wings on the adult female Oriental cockroach are merely stubs – the wings of both the male and the female Oriental cockroach are incapable of supporting the heavy bodied cockroach in flight.

- The third major feature of the thorax of an insect is thoracic spiracles or entrances to the breathing system of the insect. These spiracles look like portholes in the sides of the insect and extend from the second segment of the thorax backwards through most of the segments of the abdomen – two spiracles on each segment – one on each side. The port holes are connected to tubes which extend throughout the body of the insect, becoming smaller and smaller as they branch away from the spiracular opening. The larger tubes are known as trachea and the smaller tubes are known as tracheoles. The whole system looks like a series of tree trunks and all of their branches. Air enters the spiracles and travels by diffusion through the tubes to all parts of the insect's body. The spiracles have muscles surrounding the openings so that they can be closed off at will to help prevent dehydration. This type of breathing system is quite different from man's blood system. The series of portholes, or spiracles, along the side of an insect can also serve as entrance ports for insecticides whether in a gaseous form or in the form of fine spray droplets, particularly when they are only a few microns in diameter.
- The *thorax of the cockroach serves as a key for the purpose of identification.* The light areas on the side of the prothorax of the American cockroach distinguish it from other roaches. The parallel dark streaks ("hash marks") on the prothorax of the German cockroach differentiate it from the brown banded cockroach. The thorax of the cockroach also contains a nerve ganglion which sends impulses to the leg muscles.

THE ABDOMEN

- The abdomen of an insect generally has ten segments. Located at the end of the abdomen of some insects is a pair of appendages known as cerci (singular – circus). In the case of earwigs, these are "pinchers" which the earwig uses as a pair of forceps to move its eggs around in the nest – like cavity in the leaves or to capture food such as tender young termites and to hold them while chewing off their heads.
- The cerci of cockroaches perform an entirely different function. The bottom side of the cerci is covered with fine hair. When held in an upright position, these cerci serve as early warning "radar scopes". Any change in the air movement in the room, such as would be caused by opening a door, is detected by the fine hairs on the cerci. A sensory nerve impulse moves from the hairs to the thoracic nerve ganglion which sends out a motor nerve impulse to the legs telling them to run like blazes. Thus, the cockroach escapes the potential danger indicated by a change in the air motion without the brain being involved at all.
- This then, completes a review of some of the external structures on the body of an insect – a knowledge of which will aid in control measures: 1) Antennae; 2) Eyes; 3) Mouthparts; 4) Legs; 5) Wings; 6) Spiracles & 7) Cerci.
- Insects go through distinct changes as they develop into adults and this process is known as metamorphosis. The process of growing from egg to adult is known as the life cycle of the insect. There are several distinct variations in the life cycles of insects. In reference to pest control there are two primary types of life cycles to be considered here: 1) The Complete Life Cycle, and 2) The Incomplete Life Cycle (sometimes called "gradual" metamorphosis, or "no"metamorphosis).
- The common fly is a good example of an insect that has a complete life cycle. The larva (called a "maggot") does not resemble the adult fly in any way. The change from larva to adult takes place in the pupa stage. Fleas also have a complete life cycle. The larva looks like a caterpillar without legs. They have biting, chewing mouthparts and eat decaying organic debris (pieces of skin, dried blood, etc). The adult flea, on the other hand has piercing, sucking mouthparts and eats only liquid blood.
- All ants have a complete life cycle. The ant larva is a white grub-like immobile creature that must be tended and fed by the adult. All beetles have complete life cycles. The grub-like larva of the cigarette beetle, for example, is responsible for major damage to stored foods while the adult eats little or

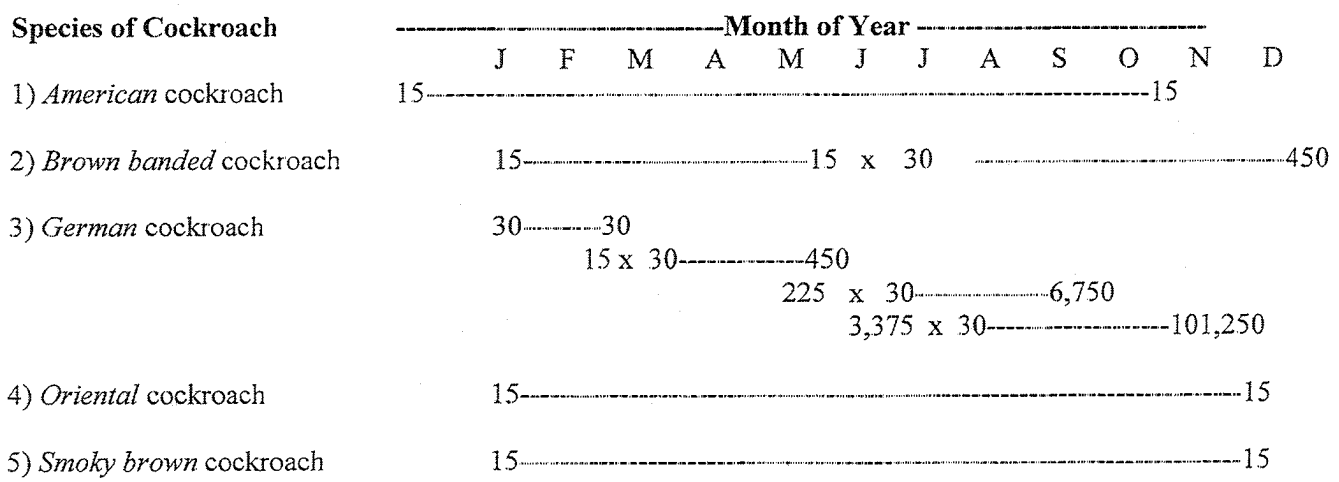
nothing at all. All moths have a complete life cycle. The larva of the naval orange worm moth is one of the most destructive of all of the stored food product pests while the adult moth doesn't eat at all.

- The **simple or incomplete life cycle** consists of *three stages*: 1) Egg, 2) Nymph, and 3) Adult.
- One of the pertinent facts about insects that have an incomplete life cycle is that the nymph that hatches from the egg has the general appearance of the adult and develops the same habits, habitats, food preferences, etc. Thus, all stages after the egg resemble the adult except that they are not fully developed.
- An example of insect with an incomplete life cycle is an earwig. There are four nymphal stages (also known as "instars") between the egg and the adult. Each stage looks like an earwig, acts like an earwig, eats like an earwig and in fact, is very similar except in size and sexual maturity to an adult earwig. Silverfish and body lice have an incomplete (simple) metamorphosis. Termites have an incomplete or gradual metamorphosis. The nymphal stage has seven instars, each a size larger and more mature than the previous instars.
- **Cockroaches have an incomplete life cycle** – *egg, nymph and adult*. Young cockroaches closely resemble older cockroaches of the same species. The young cockroaches are found in the same habitats as the older cockroaches, eat the same food and contaminate man's food just as efficiently.
- It is interesting to notice the different ways that pest take care of their eggs. Termite queens lay their eggs one by one in a chamber of the termite colony. The eggs are cared for by the nymphs or workers of the colony. Black widow spiders lay their eggs into egg sacs which they construct from the same material they use for webbing. An egg sac may contain as many as 1,000 eggs. The spider lings hatch within the egg sac and bore their way to the outside world. Carpenter ant queens lay their eggs within a chamber of the ant colony and the eggs are carefully cared for by the workers of the colony.
- Clothes moths and carpet beetles lay their eggs on the fabric that the young larva will eat upon emerging from the egg. Head lice, crab lice and body lice stick their eggs to the hairs or clothes of the host. Houseflies, lesser houseflies, green bottle flies and flesh flies lay their eggs in batches on the garbage, manure or dead animal that the larva will eat upon emerging from the egg.
- Cockroaches produce "egg capsules" and the embryos develop within these capsules. Cockroach species can be distinguished by the size and shape of their capsules and the number of embryos which they contain. Of the five species of cockroaches that we'll be discussing, the brown banded cockroach produces the smallest capsule and the Oriental cockroach, the largest. The German cockroach is long and slender and contains twice as many embryos as the other four species.

Species of Cockroach	**Number of Eggs in Capsule**	**Hatching Time**
1) *American* cockroach	10 to 20	5 weeks
2) *Brown banded* cockroach	10 to 20	4 weeks
3) *German* cockroach	30 to 40	3 weeks
4) *Oriental* cockroach	10 to 20	8 weeks
5) *Smoky brown* cockroach	20 to 30	5 weeks

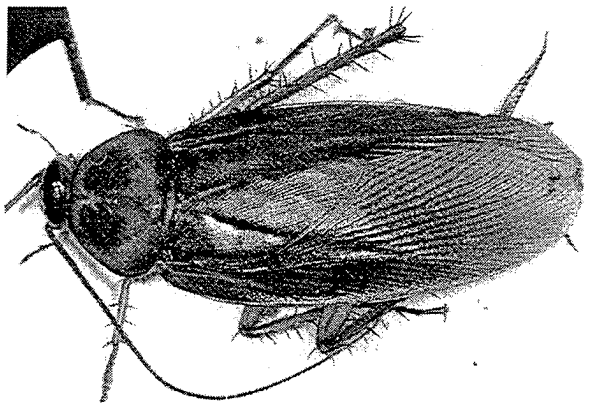
- It is important to remembers that the German cockroach deposits its egg capsules on a flat surface just before the young cockroaches are ready to emerge while the brown banded cockroach "sticks" its egg capsule to the underside of a surface (under the seat of a chair, under the table top, under the bottom of a drawer, on the back side of a picture frame, etc.)
- As the embryos inside of the cockroach egg capsule mature and they are ready to emerge to the outside world, they exert an internal pressure on the capsule which bursts open along the top seam and releases them. Some cockroach egg capsules look like fly pupae to the untrained observer.

- Place American or Oriental cockroach egg capsules side by side with the pupal cases of green bottle flies and note the difference. This is important to observe on a first hand basis because fly pupae can occur in a restaurant in some of the same places that cockroach egg capsules can be found.
- The tiny little cockroach (first instar nymph) that emerges from the egg capsule has an exo-skeleton (a skeleton on the outside of the body) similar to a suit of armor. It cannot grow larger without shedding this exoskeleton and emerging from the cast skeleton with a new skeleton which is a size larger.
- It is then known as second instar nymph. After a period of time, this exoskeleton is shed and the nymph goes into its third instar stage. This shedding of the exoskeleton takes place at intervals until the cockroach finally reaches sexual maturity. The time span for this process varies from species to species. As the nymph molts its skeleton and the next stage emerges, it is white in color. In a relatively short period of time, the exoskeleton dries and hardens and takes on the typical coloration of the species.
- Almost every new service technician has excitedly proclaimed that he has found an albino cockroach -- when in fact, he has merely discovered a cockroach nymph which has recently molted its exoskeleton.
- The subject of biological potential plays a role in cockroach control. Biological potential is merely the potential number of cockroaches that can be produced over a given period of time starting with one female and one male.
- We know that an American cockroach can produce ninety egg capsules in a lifetime and that German cockroaches may produce four to eight capsules in a lifetime, Oriental cockroaches – eight to fifteen capsules and brown banded -- an average of fourteen capsules in her lifetime.
- For the purpose of illustration of variability of biological potential between cockroaches however, let us assume that each pregnant female produces only one egg capsule. It takes one year for **American** and **Oriental** cockroaches to proceed from egg stage to mature adult. Thus, one could expect fifteen mature American or Oriental cockroaches per year starting from one egg capsule. A **brown banded** cockroach matures in six months. Thus, in six months, there could be fifteen mature adults, (eight females and seven males for the sake of illustration). Each female in our example could produce an egg capsule and by the end of the year, there could be 8 x 15 = 120 mature brown banded cockroaches -- eight times as many as with either American or Oriental cockroaches.
- The significance of this process becomes evident when we consider **German** cockroaches. The developmental period takes only three months for the German cockroach. Thus, beginning in January with an egg capsule, one could expect thirty mature German cockroaches by March. If fifteen of these were female, one could expect 450 mature cockroaches by June. If half of these were female (225 x 30), one could expect 6,750 mature cockroaches by September. If half of these were female (3,375 x 30), one could expect 101, 250 by the end of the year! And that could take place if each female cockroach produced only one egg capsule. One can readily see that the great biological potential of the German cockroach is one reason it is our number one cockroach pest.



- **Cockroaches are nocturnal in habit.** This means that they hide in a dark place (crack, crevice, void) during the daytime and come out at night to forage for food. Therefore, control measures applied directly to their daytime hiding places are most effective. Most cockroaches prefer a moist environment and none can afford to dry out by staying in a hot, dry environment for very long. Of the five species, the Oriental cockroach is most likely to inhabit very damp areas (in the basement, under the house, in the ground cover around the house, in the water meter box). All cockroaches are scavengers with a wide choice of food. All five species thrive on food that humans eat. All five species pollute human food in the process of feeding. We will focus on the five species commonly found in structures such as food processing plants, homes, restaurants, and warehouses.

Order: Orthoptera	Genus: Species:	Size:	Markings:	Flight:
1) American cockroach	Periplaneta Americana	1 ½ inches	Reddish Brown	Yes
2) Brown banded cockroach	Supella longipalpa	½ inch	Light stripes	Yes
3) German cockroach	Blattela germanica	½ inch	Black Hashmarks	No
4) Oriental cockroach	Blatta orientalis	1 inch	Black	No
5) Smoky brown cockroach	Periplaneta fuliginosa	1 ½ inch	Smoky Brown	Yes

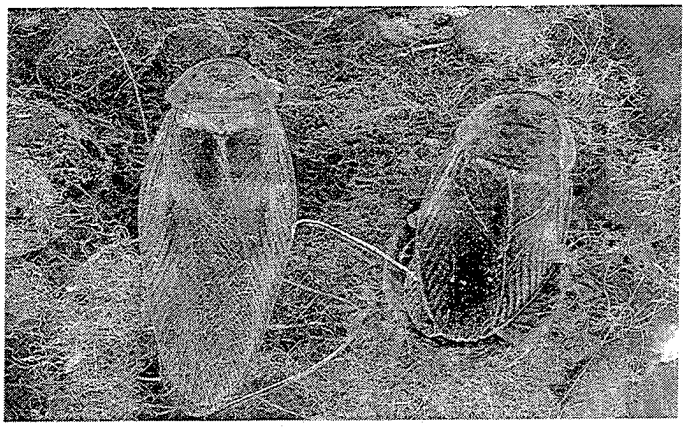


American Cockroach (Periplaneta americana)

- Known also as a "waterbug" or "Bombay canary" due to its habitat of living on docks, ships, sewers and various places around water.
- It is the largest of the five species listed above at 11/2 inches or longer.
- It has reddish brown coloring.
- Develops into an adult from 1 to 2 years.
- Adults have a lifespan of 1 to 3 years.
- Male & Female adults have wings and fly.
- The female drops her egg capsule within days after formation—usually glues it to a protected surface. Each capsule contains approximately 10-20 eggs which hatch in 60 days. She may have one egg per week and up to 90 in her lifetime.
- Commonly found in bakeries, basements, breweries, and in and around heating ducts running under hospitals, sewers, and septic tanks.
- Insecticide treatment should be placed along plumbing pipes entering the sub area and under door jams.
- To help track down pockets of these insects in basements, a careful search of spider webs will often lead to the source of infestation.

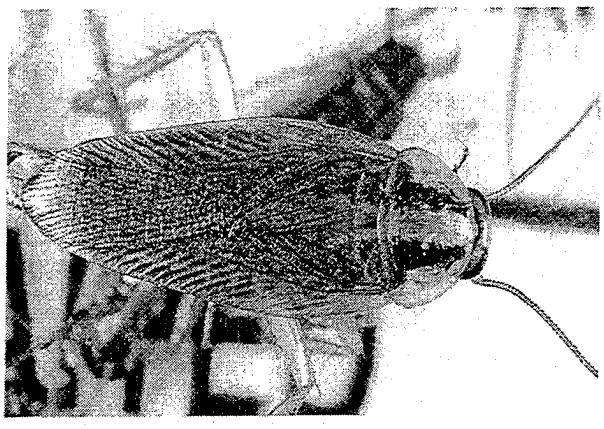
Brown Banded Cockroach (Supella longipalpa)

- Known as the "spotted" or "tropical" roach, originated in Africa and was introduced to Miami via Cuba
- One of the smallest species at ½ inch long or less.
- Coloring is light brown.
- The female is broad and flat with shorter wings than the male.
- The male is long & narrow with wings covering the abdomen.



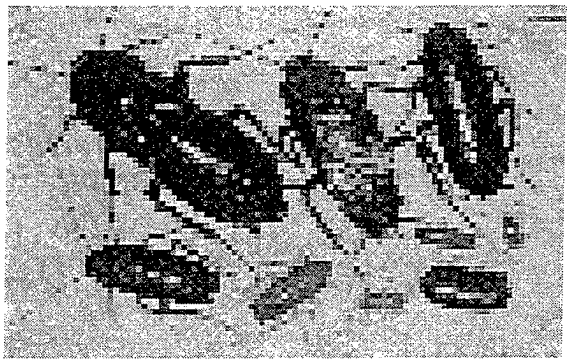
- The male flies away when disturbed
- Both the male and female have two light brown bands running across the body –side to side.
- Development varies from 90-270 days
- Adults live 150-200 days.
- The female carries the egg capsule (ootheca) for 1-2 days after formation & attaches it to a protected surface.
- Has the smallest eggs of the aforementioned species & have between 10-20 eggs.
- The female will produce 14 capsules during her lifetime which will hatch in 50-75 days.
- Have been known to attach their egg capsules on the back of picture frames.
- Live in warm climates.
- They do not need as much water as other cockroaches and can be found anywhere inside a structure. The female may hide her egg capsules in furniture which helps account fro their occasional presence in apartments, homes, and hospitals.

German Cockroach (Blattela germanica)



- Known as the "Steam Fly."
- This world-wide species is about ½ - inch in length.
- Coloring is brown with two dark streaks on the thorax.
- The male is light brown & somewhat boat-shaped.
- The female is typically darker in color with a broad & rounded posterior.
- The female carries her egg capsule (ootheca) until the eggs are ready to hatch (unique to only the German cockroach).
- The female produces 4-8 egg capsules in a lifetime containing 30-40 eggs each.
- Eggs hatch in 3-4 weeks.
- Nymphs develop in 40-125 days (up to 4 generations per year).
- Adults may live up to one year.
- They are commonly found in association with all kinds of food products (egg & soft drink cartons, beer cases, sacks of onions & potatoes). Prevalent in food warehouses, food delivery trucks, and storage areas of restaurants.
- If found in a restaurant the best way to control is crack and crevice treatment.
- Methods of control in a home for a large population should include sanitation, residual insecticides, and insect growth regulators.
- Methods of control in a chemically sensitive area (rest home/hospital) should include baits and pheromone traps.
- Very difficult to control due to their ability to get into cracks and crevices of food storage areas and their habit of re-infestation.
- Glue boards are a good way to monitor the reduction of the population and the effectiveness of a particular treatment.

Oriental Cockroach (Blatta orientalis)



- Known as the "Shad roach" & "Black Beetle."
- The adult is 1 inch in length.
- Coloring is dark brown to black.
- Female has short wing pads.
- Male wings cover ¾ of abdomen.
- Adults live for 4-5 months.
- The female carries the ootheca for 30 hours & then drops it or attaches it to a protected surface.
- She produces 8-15 capsules with 10-20 eggs each over her lifetime.
- The Oriental female has the largest capsule of the four most common species of cockroach.
- Most closely associated with moisture of all the species. Found in basements, ground cover (red-apple or ivy), and in and around areas of dampness under buildings.
- The best way to treat in and around a residence is to treat damp areas around the outside of the house, in the garage, and under the house.
- Will attach their eggs to the back of picture frames.

Smokey Brown Cockroach (Periplaneta fulignosa)

- Known as the "Wood roach."
- Same size as the American cockroach – 11/2 inches or longer.
- Coloring is reddish brown to dark brown (smoky).
- When bothered the male or female will run away, however, both are fully winged and capable of flying.
- Takes one year to develop into an adult and then another year of life as an adult.
- The female drops her egg capsule within days after formation & glues it to a protected surface (oftentimes will cover the egg capsules with protective debris).
- They enter homes through cracks and crevices around doors and find protection in weep holes and irregularities in foundations. They also enter homes through attic vents and do well in attics, especially in those homes with cedar shake roofs. In wooded areas, are common inhabitants of the woods surrounding semi-rural dwellings. Ground covers like ivy or vines give them protection and attract them closer to the home and provide them with conditions conducive to build up large infestations.

Transmitters of Diseases:

- It has been known for a long time that cockroaches hide in and browse around in *filth* – sewers – garbage – dirty areas.
- It has also been known for a long time that cockroaches also *crawl over food preparing surfaces* and browse around on our food itself.
- It has been known that a cockroach can transmit *salmonella*.
- It is also well known that cockroaches *defecate on the food* upon which they are eating. Cockroaches have been proven to transmit the E. coli bacteria, staphylococcus, and streptococcus, and are thus responsible for food poisoning.

Cockroach Control:

- It has been postulated by some individuals outside of the structural pest control industry that they concept of Integrated Urban Pest Management is a brand new concept to our industry and one which is resisted by our industry. On the other hand, it has been authoritatively asserted by respected members of our industry that Integrated Urban Pest Management has been practiced by the industry since day one and as a matter of fact, is an integral part of the everyday practice of structural pest control.
- Unfortunately, there are those both inside and outside of our industry who, through ignorance or prejudice, confuse the concept of Integrated Urban Pest Management with the concept of biological control. Certainly, biological control can be under certain circumstances, an effective segment of an Integrated Urban Pest Management program, but it should hardly be the only segment to be considered. And many times under practical circumstances, has no place at all in a specific Integrated Urban Pest Management program primarily because of the nature of such a specific pest problem.
- Because of the confusion, apprehension, frustration, charges and countercharges that sometimes creep into a discussion of Integrated Urban Pest Management by groups, both within and outside of the industry, it is important to define the term Integrated Urban Pest Management (I.U.P.M.) as it applies to the structural pest control industry. Since the words, Integrated Urban Pest Management are well chosen and since each individual word has a particular significance, let's take a brief look at them one at a time.
- The word "Integrated" means to us that all of the applicable parts of the program are meshed together. If the word "homogenized" had been used instead, we would expect that all of the ingredients of this concept would be forcibly mixed together in one homogenous mass. Consider a homogenized bottle of milk. Every ingredient is forcibly mixed with every other ingredient until the individual ingredients have lost their identity and a new product has resulted. Not so with Integrated Urban Pest Management. The term "**integrated**" suggests that the applicable facets are brought together to produce the desired result. Perhaps cultural and biological control concepts just don't fit. On the other hand, in another situation, the pest problem may be solved by integrating only cultural and biological controls and perhaps mechanical, physical, regulatory and chemical concepts would just not fit the situation. In another instance, perhaps all six facets of the program could be applied. So, Integrated Urban Pest Management means bringing together the applicable facets of this concept to arrive at a satisfactory control level.
- The next word in the title is "**urban**". This word is derived from the Latin word, "Urbus" which means 'city'. The word city, in most people's minds conjures up a vision of masses of people, houses, crowded streets, commercial buildings, and other man-made structures. Structural Pest Control operators control pests in and around man-made structures of all sorts whether they are fish canneries, food processing establishments, granaries, restaurants, hospitals, individual family dwellings, apartments, movie theatres and the like. These structures tend to clump together into cities. Therefore, the word "urban" is a neat word – it identifies our industry and differentiates it from agricultural pest control, crop spraying and the like.
- The third word is "**management**" and this is an interesting and perhaps, even scary word. Management does not necessarily mean annihilation or 100% kill. It means just what it says — management of the pest population to achieve a level of infestation that is acceptable to your customer and even perhaps, to your customer's customer. On one hand, you may be confronted with the wild-eyed environmentalist type who might say that we have to learn to live with a few cockroaches – that eradication is not even desirable. On the other hand, you may be confronted with the irate hotel or restaurant owner who, despite your best efforts, has spotted a lone cockroach in his establishment and demands immediate action bent upon eradication. So the term, management, means bringing the pest population to a tolerable level -- and you, as a structural pest control operator, had better be aware of what is tolerable and to whom -- and especially hold in mind the tolerance level of the person who is paying the bill.
- So, put it all together and you have **Integrated Urban Pest Management**. It is important to remember that the foundation upon which all Integrated Urban Pest Management rests is proper

identification of the pest involved and a basic knowledge of its biology and in all of his dedication to Integrated Urban Pest Management, the structural pest control operator must constantly hold in mind that the uppermost thought in his customer's mind is SAFETY and this means safety with whatever facet of the system is employed.

- If a structural pest control operator wants to measure his efforts in Integrated Urban Pest Management, he may measure them against the yardstick of being profitable, energy conserving, environmentally sound, ecologically based, sociologically acceptable and technologically correct. Let's investigate the aspects of I.U.P.M., cultural, mechanical, physical, biological, regulatory and chemical control and some of the examples of the use of each of these aspects for the purpose of gaining a more sound and professional approach to cockroach control.
- The **cultural control** of the home should involve the replacement of low growing ground covers (ivy and the like) with a different type of landscaping that does not offer a harborage and favorable breeding conditions to Oriental cockroaches and Smokey Brown cockroaches.
- **Cultural control** inside of a food processing establishment could involve the overall level of sanitation inside the plant. It could specifically involve the cleanup of the organic crud that forms layers under the refrigerator and/or stove, etc. and which renders the application of other aspects of I.U.P.M. difficult to worthless at best. It could involve the cleaning up of food that has been carelessly slopped anywhere in a restaurant kitchen or in the serving or dining area.
- **Physical control** as it pertains to cockroach control outside of the home, could involve building out cockroach infestations to whatever degree that could be accomplished. Obvious habitats can be eliminated or relocated. For example, the removal of the trash burning and garbage storage areas from immediately adjacent to the back door or loading dock of a restaurant to some other convenient part of the property is an effort to put as much distance as possible, between the potential breeding site and the point of entry to the food establishment.
- **Physical control** inside of food processing establishments can range all the way from sealing up cracks and crevices with Polycell-100 to denying access to hiding and breeding areas—to making the owner aware of certain changes he could make that would eliminate infestations of cockroaches. This could involve construction of cabinets and shelving in a manner to eliminate cockroach harborages or it might just mean installing the refrigerator on a concrete base rather than on a series of two by fours. Education of, and recommendations to, the food processing plant owners of items he could accomplish during his next renovation project could over the long haul, make cockroach control more feasible in a given plant.
- **Mechanical control** can play a very important part in monitoring levels of cockroaches present in food processing plants through the use of sticky traps. These traps which are inexpensive and easy to use may not only indicate the presence or absence of an infestation, but also may indicate which area of the food plant has "hot spots" of infestation that can be taken care of by physical or pesticidal control. The concept of mechanical monitoring boards such as sticky board with or without an attractant could be made use of in our industry to a far greater degree than is in effect at the present moment. It probably would not be very smart to try to eliminate infestations of German cockroaches with sticky boards because of their terrifically prolific biological potential. On the other hand, it would probably be very smart to use sticky boards to confirm, deny or pinpoint infestation sites within a structure.
- **Biological controls** for cockroaches in food processing establishments that are practical for Pest Control Operator are in short supply. There is a great need for further research in this area. Some I.U.P.M. proponents point to a project at the University of California at Berkeley in which the levels of populations of brown banded cockroaches in some of the labs and student housing buildings were decreased over a long period of time by the introduction of a parasitic wasp which was specific for Brown Banded cockroach egg capsules. In this euphoria, they tend to overlook the fact that restaurants and other food processing establishments are infested with German cockroaches not Brown Banded cockroaches and the owners of the establishment as well as, the Health Department representatives want some measure of relief now – not two years from now. They tend to overlook the measures applied must be socially acceptable and thus, fail to understand why a restaurant owner might not want 20,000 parasitic wasps released into his establishment periodically.

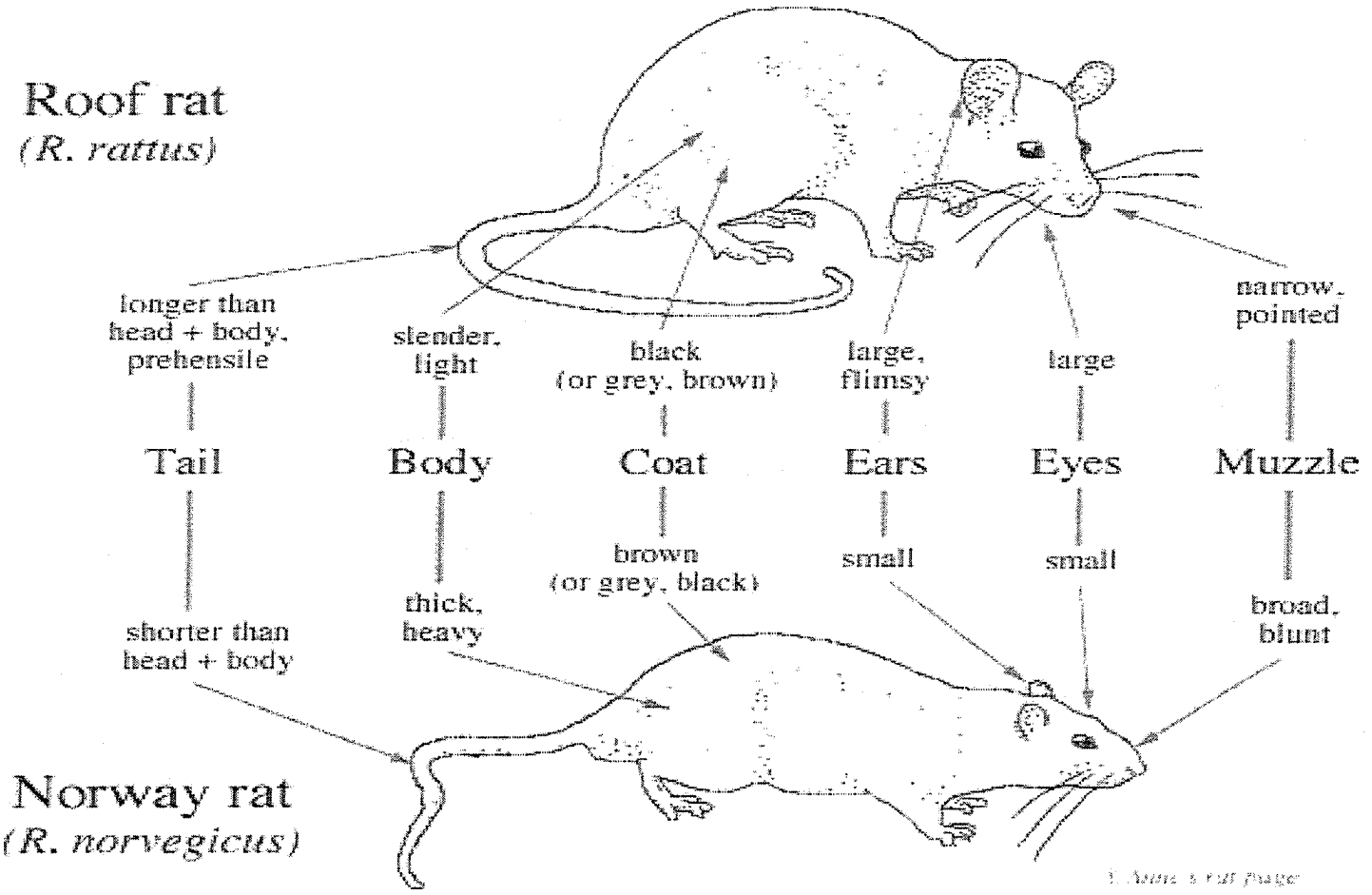
- There is on the books of every city, county and state Health Department Code, enough legal jargon to put teeth into laws against maintaining a public or private establishment replete with vermin. The structural Pest Control Operator has the law on his side in the battle to control cockroaches -- but how in the world does he use it? Sending a bureaucratic agent to a customer could result in a heavy fine for the customer, a closing of his establishment at least, until he has cleaned up and probably, the loss of an account -- and our industry tends to resist losing accounts whether or not they are profitable accounts to them. So how ca we as an industry take advantage of the fact that we have a legal weapon in our I.U.P.M arsenal?
- One obvious answer is an educational approach. Inspections of the premises based upon legal requirements as well as, cultural and physical improvements and mechanical monitoring and the issuance of "sanitation inspection reports" requiring action on the part of the owner of the food processing establishment are gaining wide attention in the structural pest control industry. Many companies print up an inspection check list which indicates sanitation improvements to be made and leave this list with the owner or manager of the food processing establishment. Copies of the applicable local, state or federal laws governing the presence (or absence) or vermin in such an account can be stapled to such a report. Certainly it is good sense, for a pest control serviceman to make acquaintance of the Public Health Sanitarian into our confidence, educate them regarding sanitation problems relating to professional cockroach control and enlist their aid in solving some of our most stubborn cockroach infestations. All of this can be done on the high level of cooperation that results in a more sanitary, cockroach-free food processing establishment without alienation of the customer.
- Perhaps the best way to treat cockroaches in technologically sensitive areas is via the use of a gel bait. When applying bait it is a good rule of thumb to thoroughly clean and remove items like food particles in order to get the best results.
- **Hydroprene** is the *active ingredient that should be used as an IGR for cockroaches.*

15) RODENTS

1) *Rattus norvegicus* (**Norway Rat**), commonly called barn, house, sewer, wharf, brown, or burrowing rat.
2) *Rattus rattus* (**Roof**) commonly known as tree, climbing, ship, black, or grey rat.
3) *Mus musculus*, commonly known as the **house mouse.**

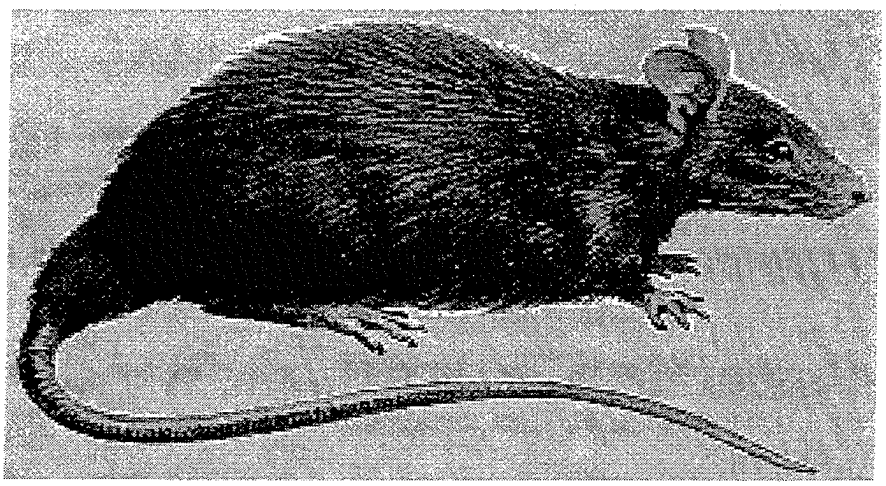
Physical Characteristics of the Norway Rat:

- Color usually brown on back and sides with gray to yellow-white belly.
- Tail shorter than combined length of head and body, lighter colored on the under side.
- Body broad and heavy with blunt muzzle.
- Ears small, close set, appearing half buried in fur, covered with short, fine hair.
- Feet, four toes on front paws and five on back toes, hind foot usually longer than 1 ½" from heel to longest toe.
- Mammary glands usually 12 per female.
- Teeth, no notch on inside of upper front (incisor) teeth.
- Weight 10 to 17 ounces
- Length (tip of nose to end of tail) 12-3/4" to 18"

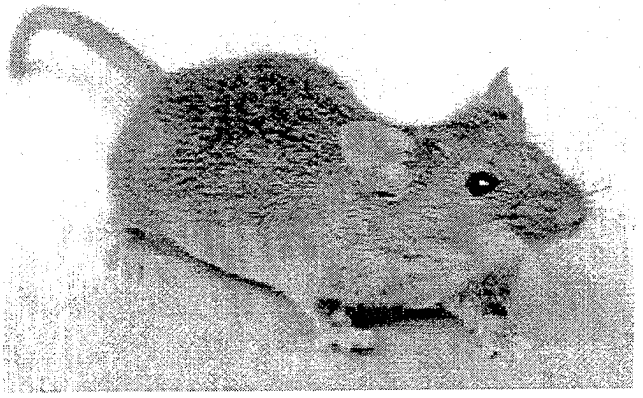


Physical Characteristics of the Roof Rat:

- Sub-species *rattus* black to slate colored on both back and belly.
- Sub-species *alexandrinus* reddish brown back with grayish-white belly, hairs on belly are always slate colored at their bases, never clear white or lemon colored.
- Sub-species *frugivorous* gray back with white or lemon colored belly, hairs on belly are white or lemon colored at their bases.
- Tail longer than combined length of head and body, uniform color on top and bottom.
- Body slender and light with pointed muzzle.
- Ears large and prominent, standing well out from fur, with no hairy covering.
- Feet, four toes on front paws and five on back toes, hind foot usually less than 1 ½" from heel to tip of longest toe.
- Mammary glands, ten per female.
- Teeth, no notch on inside of upper front teeth.
- Weight, 4 to 12 ounces.
- Length (tip of nose to end of tail) 13-3/4" to 17-3/4"



Characteristics of the House Mouse:



- Color mixed yellowish-brown and black on back with ash gray belly.
- Tail equal to or slightly longer than combined length of head and body, under side slightly lighter than the top.
- Body average, neither broad nor slender.
- Ears fairly large for body with bare appearance.
- Feet, four toes on front paws and five on back toes, generally less than ¾" from heel to longest toe.
- Mammary glands usually ten per female.
- Teeth, notch on inside of upper front teeth.
- Weight, ½ to ¾ ounce.
- Length (tip of nose to end of tail) 6 to 7 ½".

Life Cycles:

- **Norway Rat** – Females breed when about three months old. Gestation period is about 25 days and litters normally range from 6 to 14 young and average about 8. Litters are usually spaced at intervals of 60 to 65 days. In nature few rats live more than two years. The first two months are spent in the nest and in short forays with the mother rat. Rats are most active from the third month through the ninth month. Thereafter activity gradually declines until approximately 18 months of age. Rats older than 18 months are quite inactive.
- **Roof Rat** – Same as the Norway Rat except that litter size normally ranges from 4 to 10 and average about 6.
- **House Mouse** – Females breed at about the age of six weeks. Gestation period is about 17 days and litters average about 5 or 6 young. Individual captive females have produced as many as 100 young in a year. Activity phases are similar to those of the rat but accelerated.

Senses:

- *Sight* – Apparently motion is quickly detected, depth perception is good, and variations in light intensity are recognized. Other details of vision are probably relatively poor.
- *Smell* – Sense of smell is very well developed.
- *Taste* – Sense of taste is probably not as well defined as it is in man.
- *Hearing* – Hearing is well developed; sources of sounds are accurately located.
- *Touch* – Sense of touch is quite highly developed. Vibrassae (long stiff hairs extending from the nose) are sensitive feelers on which the rodent relies for contact with its surroundings. Tactive hairs distributed through-out the fur serve a similar purpose. The nose is very sensitive to touch and is carefully protected.
- *Balance* – Sense of balance is very well developed.

Physical Abilities:

- Gnawing – Rat incisor teeth are very efficient cutting tools. Rats must gnaw to keep the incisors, which grow about five inches per year, short enough to be useful. They can gnaw through lead pipes, fresh concrete, soft and semi-hardened aluminum and other relatively hard materials.
- Jumping – Norway Rats can jump vertically up to three feet from a standing start, and easily three feet with a running approach and supplemental push against the obstacle. Jumping out and down from a

standstill, a rat can cover a horizontal distance of 3 feet while dropping less than 15 feet; it can fall as much as 50 feet without being killed.

- Reaching -- or Swinging – Rats can reach from one vantage point to another horizontally along a smooth vertical wall over a distance almost as long as their bodies. Vertical reach is almost the same.
- Climbing – Rats can climb both vertical and horizontal wires, the inside of a vertical pipe with a diameter of from 1 ½ to 4 inches, the outside of a vertical pipe of any diameter if the pipe is within 3 inches of a wall or other continuous support.
- Burrowing -- Norway rats have been found to burry as much as five or six feet to reach food. Roof rats have been found to burrow 2 ½ feet.
- Swimming -- Rats are excellent swimmers and will readily enter water if it is necessary to obtain an objective.

Behavior Patterns:

- **Food Habits –** Rats develop regular habits in eating; food is transported to harborage for consumption when possible. Individual colonies often demonstrate a food preference. Rats require ¾ to 1 ounce of dry food per 24 hour period. Maximum drive to obtain food occurs after three or four days of starvation. Norway rats show more preference for meats than do roof rats; the latter respond more to fruits and vegetables.
- **Water Consumption** - Rats require about one ounce of water per 24 hour period. Maximum drive to obtain water occurs after 1 or 2 days of thirst.
- **Fear** - Rats are very cautious and will avoid strange objects as much as possible for several days. Familiar objects which have been moved will be avoided for a short period and then approached with great caution. Mice are much more curious than rats and hence are more easily trapped.
- **Nesting and Harborages** - Rats build nests wherever security, food, and water are available. Preferred harborages include enclosed spaces between walls and floors, under counters, machinery, shelving, stairways, etc., in trash piles and in burrows; for nesting and shelter purposes, burrows seldom exceed 18 inches in depth. Nests are well hidden and are rarely found in a routine inspection. They are made of soft, warm materials, such as paper, excelsior, etc.
- **Nocturnal Activity** - Rats are primarily nocturnal foragers, but will move about during the daylight under pressure of hunger, thirst, fear, or anger. They will also be active during the daylight hours if their fears of men and predatory animals have been allayed by previously undisturbed forays.
- **Home Range** - Home ranges of rats depend on a number of factors such as the nearness of food and water to places of harborage, quantity of food and water available, presence or absence of hazards, etc. Experiments conducted in Baltimore indicate that the normal home range is about 40 feet and rarely exceeds 100 feet. Mice range over a smaller distance from their homes than do rats, usually not more than 20 feet.
- **Travel Routes** - Rats are inclined to establish regular routes which are as well protected as possible. They will make every effort to maintain contact with a vertical surface through their vibassae on one side and preferable on both sides.
- **Migration** - Mass migrations sometimes occur, presumably caused by crop failures, floods, etc.
- **Swimming** - Rats are excellent swimmers. They have been known to swim rivers and have been observed in open water far from shore. Young rats placed in a tank of water will dive repeatedly in search of an exit. They will sometimes come through the water seats of toilets in floor drains.

Rat Signs:

- **Droppings** - are the most constant and earliest observed signs of infestation. Number, freshness, and size of droppings indicates the extent of the infestation. Droppings are found in secluded corners, harborages, and runways. *Fresh fecal droppings are glistening and soft.*
- **Tracks** - are distinctive and easily recognized; they resemble hand prints. The back feet have five toes and the front have four. Tail marks appear as wavy lines on dusty surfaces.

- **Runways** - Rat bodies are dirty and greasy and repeated contacts with surfaces along which they travel produces smudges. Semi-circular "swing" marks appear under beams and rafters which obstruct overhead runways.
- **Gnawings** - Rats gnaw to gain access to food and harborage, and to shorten their incisor teeth. Fresh gnawings on wood can be distinguished by the light color of the newly exposed wood. The extent of the damage from gnawing gives an indication of the degree of the infestation. Also, rubber shavings found during an inspection are the result of rat gnawings.
- **Burrows** - are easily observed along the walls of buildings, in dirt floors of buildings, embankments, fills, under bushes and brush, etc.
- **Other Signs** - of rat infestation less frequently observed include urine stains, the use of a black light will highlight the urine tracks to show rodent pathways. Observation of live rats in the daytime and the presence of a rat odor are indications of a large rat population. Dead rats usually indicate that poison has been used or an epizootic has occurred.

Rat Control:

- Rats have behavioral traits such as aversion to new objects and sometimes having many alternatives to multiple food source, that make baiting programs sometimes ineffective.
- One should consider pre-baiting traps at the beginning of a control program.
- The most common place to set traps in any type of structure is along the walls, especially behind storage bins.
- Always place traps with the trigger end towards the wall. Place traps at least 6-10 feet apart and always use a sufficient amount of bait in the traps, so that the rats will consume a lethal dose.
- Always use locked, tamper resistant bait stations in a residence. Monitor the consumption of rodent bait taken in bait stations at least weekly and relocating them after three weeks if there are no signs of acceptance.
- Sanitation and exclusion are non-chemical types of control measures. Sealing all small holes or entrances to a structure along with trimming back excess foliage is a good start to control by exclusion.
- After a rodent control program has been established, the elimination of harborages should done to maintain treatment effectiveness.

16) PESTICIDES & LABELS

- The name "*pesticide*" includes any material(s) or combinations thereof proposed for destroying, controlling, repelling, preventing or influencing the growth and activities of any form of life declared to be a pest.
- This definition includes *defoliants, herbicides, insecticides, insect growth regulators, rodenticides* and others. Because pesticides are so broadly defined, it is possible to classify them in several ways depending on one's particular interests. The simplest distinction we can make between pesticides is to divide them into two main chemical groups, depending on whether or not they contain *carbon* in their molecular structure. An effective but slow-acting, multiple feeding formulation in common use today is *Diphacinone*.
- The **inorganic pesticides** are those which contain any element found in nature *except carbon*. They are usually very stable, crystalline, salt-like materials that occur as deposits found in nature.
- **Organic pesticides** are those which contain the element carbon in any form. Some of these are found in nature, but most of those used today are synthetic (man-made).
- **Inorganic pesticides** commonly used are *Boric Acid, Silica Gel, Diatomaceous Earth*, and *Sodium Fluoride*.
- **Sodium Fluoride** is a crystalline, white powder which is tinted blue or green when used for insecticidal purposes. Used as a dust for roach, silverfish and ant control, acting as both a stomach and contact poison.

- **Boric Acid** is sold both over the counter and to pest control operators as a dust or in pellet form for cock-roach control. It is slow acting, unsightly (if applied improperly) and ineffective in wet areas. It is also hazardous (especially to infants) if accidentally swallowed. Silica Gel (*Silica Aerogel*) is a desiccant sold under the trade name *Whitmire PT 240*, "Tri-Die". It is long-lasting, not dangerous, and slow but sure material which can be used for cockroach control.

Classification by Target Pest:

Pesticides can also be classified according to the pests against which they are intended to be used:

Pesticide:	Target Pest:
Aracicide	Mites, Ticks
Avicide	Birds
Herbicide	Weeds
Insecticide	Insects
Rodenticide	Rodents

Classification by Formulation:

- As discussed earlier under cockroach control chemicals, pesticides are obtainable as emulsifiable concentrates, wettable powders, dusts, baits, microencapsulated products, and aerosols. Other formulations the pest control operator may encounter are the flowables, fumigants, granules, and soluble powders.
- **Flowables** (abbreviated F) are a thick (not easily poured) concentrated *liquid deferment* of microfine particles of insecticide.
- **Fumigants** are gasses, some of which have the *capability of penetrating thick wood or stored grain where many destructive insects live. Sulfuryl Fluoride* (Vikane), *Methyl Bromide, Hydrogen Phosphide* (Phostoxin), and *Chloropicrin* (Tear Gas), are just several of many.
- **Granules** (abbreviated G) are similar to dusts in that the toxicant is mixed with an inert (unreactive) carrier material. However, the carrier material used in a granulated formation is much larger; ie. in the size range of fine to coarse sand or even as large as pellets of *Vermiculite*. (Ground corn cobs, talc, chalk). *The primary advantage of granulated formations over dusts is that they are heavy enough to resist drifting to non-target pests.* Also, *they are ready to use immediately.*
- **Soluble powders** (abbreviated SP) are basically similar to the wettable powders. *An advantage to the use of water-soluble packets is that the chemicals are less hazardous in this form.* One major difference though, is that they will *completely dissolve in water* rather than just stay suspended in water. The soluble powders do not require periodic agitation as do the wettable powders. Because insecticides are so widely used in structural pest control, we will examine how they are classified into specific groups.

Classifying Insecticides:

- **Chemical Group** - The chlorinated hydrocarbons (*oganochlorines*) contain chlorine, hydrogen, and carbon. Those currently registered for use in structural pest control are: *Chlordane, Heptachlor, Aldrin, and Lindane*. Except for *Lindane*, all of these are registered for use only as soil poisons against subterranean termites.
- The **organophosphates** (organophosphorous) insecticides all contain the element *Phosphorous*. They are the *largest group of insecticides today.*
- As a group, the *Organophosphates* are less unrelenting in the environment than the chlorinated hydrocarbons.
- The **Carbamates** all include the element nitrogen. Three **Carbamates** commonly used for structural pest control work are: *Ficam* (Bendiocarb), *Baygon* (Propoxur) & *Sevin* (Carbaryl).

- The **Botanicals** are a group of pesticides all of which were initially extracted from plants. For instance, the common insecticide *pyrethrum* (active ingredient known as *pyrethrins*) is extracted from certain flower parts of a species of chrysanthemums. It is one of the less toxic to humans and least persistent insecticides known to man.
- **Rotenone** is an additional *botanical insecticide* and is used as one of the fast "knockdown" agents in a flea and tick fogger. The fact that botanical pesticides are "natural" and "organic", does not automatically mean they are safer to use than man-made (synthetic) insecticides.
- **Nicotine** is a botanical insecticide and up till now, is *one of the more highly toxic materials* used in pest control.
- In recent years, chemical compounds structurally related to **pyrethrum** have been prepared synthetically in the laboratory. These are known as the synthetic *pyrethroids*. These materials generally *mimic the functional characteristics* of natural *pyrethrins*; i.e., fast knockdown, short persistence and low toxicity to man.
- A readily available synthetic pyrethroid is *Resmethrin*, Whitmire PT110. **Microbial Pesticides** are those whose active ingredient is neither a natural or man-made chemical but rather, and *actual living bacteria or infective virus.* These agents literally cause insects to die of an infection. To date, the microbial pesticides are only available for ornamental and agricultural uses. Brands available include "*Dipel*" and "*Thuricide*". These products are especially effective on destructive moth larvae such as the *California Oak Moth Caterpillar.*

- Two unique advantages of **microbial pesticides** are that the active ingredients (bacteria and viruses) are: (1) Non-toxic to man and (2) Do not harm the natural enemies of insect pests.
- **Petroleum Oils** are refined from crude oil. They are used on some ornamental and fruit trees in the winter to control insects such as *Scale* and *Pear Psylla.*

Classification by Mode of Action:

- **Insecticides** are occasionally classified by the *way they go into and affect the bodies of insects.* Stomach poisons are acquired during feeding. They may be formulated as baits, dusts, granules or liquids. Dusts and liquids are frequently applied to a surface on which the insect will feed or walk through. Poisoned baits and granules may be formulated with a feeding attractant such as molasses, fish, peanut butter, etc.
- **Contact Insecticides** enter the insect's body as a result of either direct spraying onto the insect or contact by the insect with treated surfaces such as inside cracks and crevices or on wall or baseboard areas. These insecticides may penetrate the outer cuticle of the insect to get inside its body or they may penetrate the respiratory system via the spiracles and trachea.
- **Fumigants** are gases which penetrate the body of an insect primarily through the respiratory system. Systemic insecticides act as stomach poisons. They are applied to plant foliage or roots and are absorbed and trans-located throughout the plant. Insects become poisoned when they eat parts of treated plants or suck up plant juices.
- Common **systemic insecticides** for ornamental use are Metasystox R and Orthene.
- **Herbicides** include Roundup, Oust, Banvel, and Amitrolf.
- **Systemic Fungicides** include Benlate and Subdue.
- **Desiccant dusts** absorb and/or abrade off the outer waxy layer lining the cuticle (outer skeleton) of an insect's body. This results in death due to dehydration. Silica Gel & Diatomaceous Earth are used.
- **Insect Growth Regulators** are *synthetic organic substances* which mimic the action of certain key insect hormones which regulate insect growth and development. Insect Growth Regulators should be added to a tank mix of residual pesticide for a long-term control plan. Precor is an "IGR". When ingested by the flea larva, it prevents the flea pupa from developing into the adult stage. A common outstanding feature of "IGR's" is that the active ingredient (the synthetic insect hormone) is non-toxic to man. "Gencor" is an IGR for roaches.
- The toxicity of pesticides is generally broken down into two categories -- (1) **acute toxicity** and (2) **chronic toxicity**.

- Generally speaking, **acute toxicity** is the *immediate, short-term response to a sudden exposure to a pesticide*, while the **chronic toxicity** is the *long-term effect resulting from exposures to many small doses of a substance over a period of time.*
- Chronic exposure may also refer to an effect which does not manifest itself for a long time, even though the exposure may have been a one-time exposure. This can be exemplified by **asbestosis** – lung degradation resulting from the inhalation of asbestos fibers, perhaps years before. Chronic toxicity is the more frightening of the two, as far as the general public is concerned, as many substances, including some pesticides have been accused of causing cancer, birth defects, or miscarriages.
- The level of toxicity of a pesticide, or indeed, of any substance, is measured in some way. For toxicants which are airborne and may be inhaled, the measurement is expressed as LC-50 – that amount of toxicant in either parts per million (ppm) or milligrams of toxicant per a cubic volume of air which is a lethal dose to 50% of a test population of animals. These airborne toxicants may be droplets, dusts, gases, smokes, or vapors. For toxicants which may be ingested or which may be absorbed through the skin, the toxicity level is established as the LD-50 – that amount of the material lethal to 50% of a test population of animals, whereby the material is administered either orally or dermally.
- Generally, the LD-50 is lower (more toxic) when taken orally than when placed dermally, as the chemical is able to enter the body much more quickly through the digestive system and be carried into the blood more easily. LD-50's are established for all pesticides, both oral LD-50 and dermal LD-50, and new regulations for this method dictate that the LD-50 reflect the formulated product, or the toxicity for the material as it is packaged rather than for the 100% technical grade chemical as was previously done. Thus, an LD-50 for 100% technical diazinon is about 350 mg/kg, but for most formulated products at about 45% concentration it would be above 700 mg/kg.
- An important point to remember, with regard to this measuring of the toxicity, is that the **LD-50** is a value set to *indicate the concentration which actually kills the test animals.* The 50% which were not killed are also, probably, in pretty bad shape but just not dead. A much lower concentration of the chemical may be all that is necessary to bring on symptoms of poisoning, possibly severe.
- Also, different species of animals react different ways to a particular product, and thus, the **LD-50** *may vary considerably between species*, such as rats vs. mice vs. dogs vs. people. As a matter of fact, *brodifacoum* (Talon rodent bait) is more toxic, ounce for ounce, to dogs than to rats, and thus, the LD-50 for Talon would be a much lower value for dogs and a small amount may be lethal.
- The establishment of an LD-50 then allows placement of the chemical into one of four categories, with an appropriate "**Signal Word**" which identifies that level of toxicity:

  Category 1 – oral LD-50 = 1-50 mg/kg = "**Danger**"
  Category 2 – oral LD-50 = 50-500 mg/kg = "**Warning**"
  Category 3 – oral LD-50 = 500-5000 mg/kg = "**Caution**"
  Category 4 – oral LD-50 = 5000+ mg/kg = No signal word required.

- Thus, the lower the LD-50 valve, the greater the toxicity and the les chemical needed to achieve the lethal dose. The signal word on the pesticide label, then, is an indicator as to the relative toxicity of the pesticide. A few more **measurements referred to with regard to toxicity** of pesticides are:
  1) **TLV** (*Threshold Limit Value*),
  2) **TWA** (*Time Weighted Average),* and
  3) **PEL** (*Permissible Exposure Level*).
- The **TLV** is a level established by the American Conference of Governmental Industrial Hygienists as the recommended safe maximum exposure to a toxicant by a person during a normal eight hour day, five day a week work schedule. It is normally used with airborne toxicants.
- The **TWA** is essentially the same measurement but is more precise in that it implies the levels of toxicant to be found in the work environment are averaged over the eight hour period to take into account times when the levels may reach highs and lows, or when the person who may be exposed is absent from the area for various periods.

- The **PEL** may also be referred to as the **CEL** (*Ceiling Exposure Limit*) which is that level of toxicant which cannot be exceeded under any circumstance. In other words, it is the maximum level which can be found without some sort of action being taken. There is also a STEL (*Short-Term Exposure Limit*), a maximum concentration allowed for a continuous fifteen minute period, not to exceed four such exposures per day.
- The method of travel of a pesticide into the body can vary, but is usually placed into one or more of four categories – *oral, dermal, respiratory, or through the eyes*, which may actually be a dermal route but is placed into a separate category for the sake of this discussion. Oral exposure could be an obvious one, as a child might drink a pesticide improperly stored in food containers, or eat a rodenticide mistaken for a food-stuff.
- Many **rodenticides** are manufactured with human-food-grade materials, and one marketed product was even made from crumbled cookies as the filler. It was very acceptable to rodents but more of a hazard to non-target species as well. This is the reason that pesticides and their containers may not resemble common foods or food containers and *may never be stored in a food container.*
- **Oral ingestion** may also occur by eating food with hands that are contaminated with a pesticide, thus transferring the chemical onto the food, or by using utensils or dishes that by sprayers used at too high a pressure or with an unsuitable nozzle, thus producing many "fines".
- A technician working with pesticides must recognize the additional hazards his chemical tools create and work accordingly, taking extra precautions where needed. Some substances, such as *chloropicrin* (tear gas) in methyl bromide and Vikane fumigations, are eye irritants simply by their contact with the eyes as gas molecules. New EPA regulations for labeling require that tests for eye irritation by chemicals be performed by the manufacturers. The signal word on the pesticide label must read at least "Warning!!" if the formulation can irritate the eyes. It may not even be the active ingredient, but the solvent used that is the irritating factor, as in the case of the insect growth hormone methoprene (Precor, Altosid, Dianex) which in itself is virtually non-poisonous but has solvents that are eye irritants. Every pesticide label must contain the warning "Keep out of the reach of children" before the signal words.
- Generally speaking, minor symptoms or initial symptoms, would be very much like a good hangover (if there is such a thing as a good one), with headache, nausea, and blurred vision. This may progress to tightness in the chest, cramps, vomiting, and diarrhea. If a consumer reports flu-like symptoms after an initial pesticide treatment, you should refer him/her to the telephone numbers on the pesticide disclosure notice given prior to the pesticide application. *Advanced poisoning* exhibits difficulty in breathing, tremors, collapse, and possible coma or death. The progression to this most tragic stage may take a short time, and thus allow for effective medical treatment or it may be very sudden, as with an exposure to a very high concentration of a fumigant.
- **Fumigants** are by far, as a group, the *most toxic* of the chemical formulations commonly in use in pest control. The anti-coagulant rodenticides, in their 100% technical state, are essentially much more toxic, but all of them are offered for use at extremely low percent concentrations, such as 0.0025% active ingredient. The fumigants have a depressant action on the nervous system causing symptoms ranging from unconsciousness to seizures to muscle weakness. They may also damage body organs such as the liver and kidneys.
- Several fumigants may be eye irritants, as in *chloropicrin* (tear gas), and do require eye protection for any exposure to their gaseous state. *Pentachlorophenol* generally has a burning or irritating effect. It is poisonous if swallowed and can be absorbed through the skin, but normal exposure would be by skin contact where symptoms resembling either blisters, rash or a burn may appear. Body temperature may be elevated as with a sunstroke or even a fever, with sweating and flushed skin.
- The *botanicals*, primarily *pyrethrum*, are generally low in toxicity and the worst effect normally encountered in a "poisoning" would be an allergic response – possibly skin rash, irritated eyes, or sneezing. The same types of symptoms could be exhibited by any number of other natural substances that a person shows allergies to, such as pepper or poison oak, these being mentioned to point out that many common-place materials or activities can produce symptoms similar to those of pesticide poisoning.

- **Solvents** in which the technical pesticides are dissolved or carried, such as kerosene, petroleum oils, or xylene can be toxic or irritating. In some cases the solvent may be the eye or skin irritant or stomach poison while its associated active ingredient may be virtually harmless to animals other than the target pest. The best example of this is the insect growth hormone, *methoprene*, which carries a Category 2 label due to its solvent.
- First aid for acute pesticide poisoning takes several steps, and it is the immediate implementation of these steps which may determine the severity of the symptoms that the victim will go through, a true life or death situation.
- *First, if poisoning is suspected, a physician should be called immediately and help sent for.* Very few pest control technicians are also doctors and they should not plan to handle the whole incident themselves. First aid means just that, with any administering of drugs or antidotes left up to qualified physicians.
  a) If any pesticide is on the body it should be removed as quickly as possible to prevent further absorption.
  b) Clothing which is contaminated should be removed and any skin which has been contacted should immediately be washed with at least water, preferably soap and water.
  c) If breathing has stopped, mouth to mouth resuscitation should be administered.
  d) If a fumigant is involved, the victim should be removed to fresh air before taking any of the other steps, so that the rescuer does not himself become a victim.
  e) If the victim is conscious, and no corrosive agents have been swallowed (such as kerosene, which is in copper naphthenate and pentachlorophenol) then vomiting should be encouraged to remove as much poison as possible from the stomach before further entry into the blood occurs.
  f) If it is eye contamination, the eyes should be flushed thoroughly with fresh water for up to fifteen minutes.
- *When the victim is taken to a physician the information should be sent regarding the incident and the chemicals involved.* This will allow medical personnel to proceed with the proper drugs as antidotes or other continued treatment. Chronic poisoning by pesticides is another type of problem altogether. "Chronic" implies that the problem is one which has built up over a relatively long period of time.
- The anticoagulant rodenticides are classed as "chronic poisons" due to the fact that it may take anywhere from three to ten days for a rodent to succumb to the effects created by the poison. Rather than an "acute" poison, such as zinc phosphide, which kills quickly with one ingestion, many of the anticoagulants rely on multiple feedings to achieve the lethal effect.
- However, with chronic poisoning, one is normally speaking of other circumstances. Most common and most easily tested for is the potential chronic poisoning from exposure to *organophosphate* and *carbamate* pesticides. These two groups are considered to be "cholinesterase inhibitors" due to their ability to tie up an enzyme in the body called cholinesterase (the letters –as always indicate an enzyme). It might be comparable to the way in which carbon monoxide latches onto red blood cells in the body, prohibiting them from carrying oxygen to the cells of the body. *Cholinesterase* is an important chemical in the transmission of nerve impulses, being the entity that causes a nerve impulse to cease being transmitted from one nerve cell to the next.

Important Requirements for the Labeling and Handling of Pesticides:

- It's required by the applicator to place pesticide identification tags on all pesticide service containers in order to comply with the California Code of Regulations.
- The EPA registration number, chemical name, and the name and address of the firm responsible for the container must be posted on all service container pesticide labels.
- It's important to conduct a visual inspection before planning a pesticide application so that you can identify objects that could be damaged or contaminated by pesticides.
- Sometimes it may be necessary to use insecticides in or around a nursing home or elderly shut-in situation. The best type of low risk formulation to use in this situation would be baits because they have no odor.

- What do you do when you have to do space treatment in a room that contains a large fish tank? The best way to handle this scenario would be to shut off the fish tank pump and cover the tank.
- What should you do if it is so windy while applying a pesticide with a sprayer that the pesticide is drifting to a non target site? You should stop the application and return when the wind isn't a factor (sometimes this may mean returning another day). The same would apply for application during rain. Anything that causes drift to non-target pests should be done only when it is safe to do so.
- If there is ever a major pesticide spill that could jeopardize public safety it is required by law to notify the county agricultural commissioner.
- The best place to keep a pesticide canister is in a locked storage area away from the cab of the truck when the pesticide is not being applied.

Cockroach Control Chemicals and Equipment:

- **Aerosols -** These are very fine mists with a particle size ranging from 5-50 microns. They include everything from pressurized cans and total release "bombs" to large fifteen pound Whitmire aerosol generators. In general, those aerosols intended for use as space sprays for cockroaches usually contain fast knock-down agents such as Pyrethrins, Vapona or one or more of the Synthetic Pyrethroids. Cockroaches are very irritated by these materials and can be effectively "flushed out" from their hiding places. The flushing action of the Pyrethroid-based aerosols also helps the service technician monitor the effectiveness of his cockroach control work. One of the major advantages of using aerosol sprays is that they *cause the least amount of damage* to a surface of the chemical formulations that are used in terminating cockroaches. Other aerosol type formulations intended for use as crack and crevice treatments only, usually contain a residual material such as Dursban, Diazinon or Baygon.

- **Baits -** These are edible materials containing a lethal amount of insecticide. They work well as a supplement to residual sprays, especially where there is a lack of readily available food (for example, in void spaces under drawers or under built-in seats in restaurants or wall voids, etc.). One popular bait is 2% Baygon bait which is particularly effective on American cockroaches. All baits must be kept dry and applied thoroughly to as many locations as possible. In addition to the name of the active ingredient and registration number the tamper-resistant bait station must contain the signal word and the name and telephone number of the pest control company.

- **Dusts -** These formulations (abbreviated as D) consist of finely ground inert carrier materials (clay, talc or volcanic ash) mixed with the active ingredient of an insecticide. They have several advantages over sprays as residual materials for cockroach control. For example, when injected into a crack or wall void, they can drift deep into the void and float around corners. They are also formulated at higher concentrations than properly diluted liquid residual sprays and consequently, have a longer residual life. Two drawbacks of dusts, however, are that they can be messy to handle and take more time to properly apply than do sprays. A dust type chemical could be silica aerogel.

- **Micron Generators -** The microgen is one of several pieces of equipment capable of dispensing oil or water-based pesticides in micron-sized particles. It is sometimes incorrectly called a fogger. The correct term is an Ultra Low Dosage (ULD) or Ultra Low Volume (ULV) machine. If one were going to use space treatment in a warehouse it would be a good choice to use a ULV generator. The microgen breaks up liquid pesticides into droplets which are 5-15 microns in diameter (1 micron = 1/25,000 inch). This is the particle size range which has been found to be the best compromise between a particle too small to impinge (stick) on an insect and one which is so big that it will not float in the air very long.

- **Whitmire Crack & Crevice Units -** These are available in several sizes and with many injector guns. The insecticide formulations available include Diazinon, Dursban, Baygon, Pyrethrin and several Synthetic Pyrethroids. Whitmire crack and crevice units are unique in that they consist of pure, technical insecticides dissolved in an inert (chemically unreactive) gas. When the aerosol mist is

injected into a crack or crevice, the inert gases dissipate, leaving only undiluted technical insecticide on the treated surface. Whitmire residual deposits last longer because technical insecticide is more stable in the absence of oils, water or emulsifiers.

- Whitmire has developed a large number of very useful "roach location" charts illustrating where and how to treat the wide range of accounts that pest control operators service, including such sensitive areas as grocery stores, hospitals and nursing homes.
- Since Whitmire crack and crevice products contain no added oils or water, they are *probably the safest products on the market for treating electric motor housings and switch boxes.* The motor housings of refrigerators and freezers are important (and often overlooked) place where large numbers of German cockroaches find an ideal habitat offering darkness, warmth, moisture and easy access to food.

- **Residual Sprays -**The basic mechanical unit for applying residual sprays for cockroach control is still the B & G compressed air stainless steel sprayer. This unit is easy to use, efficient and gets the job done well. The sprayer has a four way adjustable nozzle which is capable of delivering two different "fan" sprays and two different "pin stream" sprays.
- In addition, plastic tubing can be adapted to the four way nozzle for crack and crevice treatment. The residual sprays registered for cockroach control are available in several different formulations. The most common formulation is the emulsifiable concentrate. An emulsifiable concentrate contains the toxicant dissolved in a petroleum based solvent such as kerosene or xylene, plus the addition of an emulsifying agent. The emulsifying agent causes the solvent (carrying the toxicant) to break up into very small droplets which will remain dispersed in emulsion, when water is added as the diluting material. In other words, emulsifiable concentrates allow chemicals which cannot be dissolved in water, to be suspended in water with the water serving as the diluting material.
- Some of the **emulsifiable concentrates** (abbreviated as EC) available for cockroach control are: Dursban 1E, 2E and 4E; Diazinon 4E; Baygon 1.5E; Namco Malathion 5E; Vaponite 2E; and Safrotin EC.
- Another residual formulation used in cockroach control is the wettable powder (abbreviated or WP). A wettable powder consists of pure, finely ground dry insecticide mixed with an inert (unreactive) powdery material such as talc. A surfactant (suspending agent) is also added to help keep the powder dispersed and mixed well in the water. Wettable powders do not dissolve in water; they are merely suspended in water. It should be kept in mind that wettable powders are very hazardous to mix under windy conditions. However, a distinct advantage of wettable powders is their long residual effect. Wettable powders also make an excellent choice as an effective barrier treatment for an exterior maintenance program for control service agreements (this should be applied quarterly).
- Since wettable powder formulations lack petroleum solvents, they have little, if any, odor. This feature can be a real advantage when spraying for cockroaches indoors when people are close by. Another advantage is that two of the commonly used wettable powders today (i.e., Ficam W and Baygon WP) are not repellent to cockroaches. However, a minor disadvantage of wettable powders is that they have less vapor action and thus, do not "flush" cockroaches very well out of their hidden habitats. This means the service technician must be extra thorough in his application to assure that he has not left any "pockets" of roaches untreated. Another point the service technician should try to remember, when using wettable powders, is to invert his sprayer occasionally to help prevent the suspended powder from settling out on the bottom of the tank.
- A relatively new concept in liquid residual formulations is micro encapsulation of the active ingredient. This involves a special process in which the technical insecticide is encased in tiny capsules of plastic. These capsules are easily suspended in water. As long as the capsules are wet, they do not release the insecticide. However, once a sprayed surface has dried, there is a slow and steady release of insecticide.
- There are **three distinct advantages of sprays**:

  1) *Greatly Reduced Odor* – The capsules release only a small amount of insecticide over a long period of time.

  2) *Safety* – Practically non-toxic even if accidentally swallowed, since the capsules do not release insecticide when wet.

  3) *Increased Residual Life* – of the insecticide deposit.

- Two currently popular **microencapsulated materials** are:
  1) *Knox-Out 2FM* (microencapsulated Diazinon)
  2) *Sectrol* (microencapsulated Pyrethrins)
- Indoors, Knox-Out can be applied with a conventional hand held compressed air sprayer. The sprayer must be equipped with a 50 mesh screen or coarser. Knox-Out is effective against cockroaches for up to sixty days.
- Sectrol is approved for use in food areas of food processing plants (except those inspected under the meat and poultry inspection program). It can be applied with either a Microgen fogging machine or an ordinary one-gallon compressed air sprayer such as the B & G. As with other microencapsulated formulations, the service technician must remember to invert his sprayer occasionally to prevent settling or clumping of the insecticide. One of the distinct advantages of the microencapsulated formulations is that the insecticide particles are enclosed within tiny polymer spheres.

17) APPLICATION EQUIPMENT

- The pesticide application equipment you use is important to the success of your pest control job. First, you must select the right kind of application equipment; then you must use it correctly and take good care of it.
- This unit provides an overview of some things you should know about choosing, using, and caring for equipment. To use your pesticide application equipment safely and effectively, **study the manufacturer's directions carefully**. Some pesticide applications -- such as airblast spraying, fumigation, aerial application, and chemigation -- are highly specialized. You will need special training to use the equipment these applications require.

Sprayers

Sprayers are the most common pesticide application equipment. They are standard equipment for nearly every pesticide applicator and are used in every type of pest control operation. Sprayers range in size and complexity from simple, hand-held models to intricate machines weighing several tons.

Hand sprayers are often used to apply small quantities of pesticides. They can be used in structures, and they can be used outside for spot treatments or in hard-to-reach areas. Most operate on compressed air supplied by a hand pump. The air in the tank is compressed by the pump. The compressed air forces liquid pesticide through the hose and nozzle whenever the control valve is opened. A few types of these sprayers use carbon dioxide cartridges instead of a hand pump for compression. Capacity is usually 1/2 to 3 gallons.

- **Advantages:** simple to operate & easy to clean and store.
- **Limitations:** pressure and output rate fluctuate, & often provide too little agitation to keep wettable powders in suspension; must be shaken frequently.
- **Safety:** If a compressed air sprayer hose develops a leak during an application, you should invert the canister.
- **Maintenance**: Application equipment be inspected for wear or damage before each use. The maximum period that should be allowed between regular maintenance and cleanings of a hand-held sprayer that is one week. The following *preventative maintenance* should be used for a **compressed air sprayer**: 1. Check hoses for deterioration, check for leaks, and release pressure at the end of the day; & 2. Rinse sprayer, hose, and nozzle at the end of each day's use.

Pressurized can (aerosol sprayer): This type of sprayer consists of a sealed container of compressed gas and pesticides. The pesticide is driven through an aerosol-producing nozzle when the valve is activated. Pressurized cans usually have a capacity of less than 1 quart and are not reusable. Larger reusable cylinders are available for some specialty agricultural uses.

Trigger pump sprayer: With trigger pump sprayers, the pesticide is not packaged under pressure. Instead, the pesticide and diluents are forced through the nozzle by pressure created when the trigger is squeezed. The capacity of trigger pump sprayers ranges from 1 pint to 1 gallon.

Hose-end sprayer: This device causes a fixed rate of pesticide to mix with the water flowing through the hose to which it is attached. The mixture is expelled through a high-volume nozzle. These sprayers usually hold no more than 1 quart of concentrated pesticide, but because the concentrate mixes with the water, they may deliver 20 gallons or more of finished spray solution per fill.

Push-pull hand pump sprayer: This type of sprayer depends on a hand-operated plunger that forces air out of a cylinder, creating a vacuum at the top of a siphon tube. The suction draws pesticide from a small tank and forces it out with the air flow. Capacity is usually 1 quart or less.

Bucket or trombone sprayer: These sprayers involve a double-action hydraulic pump, which is operated with a push-pull motion. The pesticide is sucked into the cylinder and pushed out through the hose and nozzle with the return stroke. Pressures up to 150 psi can be generated. The separate tank often consists of a bucket with a capacity of 5 gallons or less.

Backpack (knapsack) sprayer: One type of backpack sprayer is a compressed air sprayer with a harness that allows it to be carried on the operator's back.

- Another type of backpack sprayer has a hand-operated hydraulic pump that forces liquid pesticide through a hose and one or more nozzles. The pump is usually activated by moving a lever. A mechanical agitator plate may be attached to the pump plunger. Some of these sprayers can generate pressures of 100 pounds per square inch (psi) or more.

- Capacity of both these types of backpack sprayers is usually 5 gallons or less. Wheelbarrow sprayer: Wheelbarrow sprayers are similar to backpack sprayers, but have a larger tank and longer hose line. The tank is mounted on a wheeled cart for easy transport. The capacity of these sprayers is usually less than 25 gallons.

Small Motorized Sprayers: Some small sprayers have all the components of larger field sprayers but usually are not self-propelled. They may be mounted on wheels so they can be pulled manually; mounted on a small trailer for pulling behind a small tractor; or skid-mounted for carrying on a small truck. They may be low-pressure or high-pressure, according to the pump and other components with which they are equipped. Standard equipment includes a hose and an adjustable nozzle on a handgun. Some models have multi-nozzle booms. These sprayers are suitable for relatively small outdoor areas.

- **Advantages:** larger capacity than hand sprayers; low- and high-pressure capability; built-in hydraulic agitation; and small enough for limited spaces.
- **Limitations:** not suitable for general field use

Estate sprayers: These sprayers are mounted on a two-wheel cart with handles for pushing. Trailer hitches are available for towing the units. Spray material is hydraulically agitated. Some models have 15- to 30-gallon tanks. Pumps deliver 1-1/2 to 3 gallons per minute at pressures up to 250 psi. Larger models have 50-gallon tanks and pumps that deliver 3 to 4 gallons per minute at pressures up to 400 psi. Power is supplied by an air-cooled engine of up to 5 horsepower.

Power backpack sprayer: This backpack-type sprayer has a small gasoline-powered engine. The engine drives the pump, which forces the liquid pesticide from the tank through a hose and one or more nozzles. The engine also drives air blowers, which help propel the spray droplets. This model can generate high pressure and is best suited for low-volume applications of dilute or concentrated pesticide.

Power wheelbarrow sprayer: This sprayer, like the manually operated wheelbarrow sprayer, has a tank mounted on a wheel for easy transport. It may deliver up to 3 gallons per minute and can develop pressures

up to 250 psi. The 1-1/2-to 3- horsepower engine is usually air-cooled. The tank size ranges from 12 to 18 gallons. The spray mixture may be either mechanically or hydraulically agitated.

Large Power-Driven Sprayers (Low Pressure): These sprayers are designed to distribute dilute liquid pesticides over large areas. They deliver a low to moderate volume of spray -- usually 10 to 60 gallons per acre -- at working pressures ranging from 10 to 80 psi.

- These sprayers usually are mounted on tractors, trucks, or boats, but some are self-propelled. Roller pumps and centrifugal pumps are most often used and provide outputs from 5 to more than 20 gallons per acre. Tank sizes range from less than 50 gallons to 1,000 gallons. The spray material usually is hydraulically agitated, but mechanical agitation may be used. The spray rig tank must be equipped with an air gap/back flow prevention device to keep pesticides out of the main water supply. A sign that the pump seals could be worn is the vigorous pulsating of the spray hose during high pressure spraying.
- **Advantages:** medium to large tanks permit relatively large area to be covered per fill, and versatility.
- **Limitations:** low pressure limits pesticide penetration and reach.

Boom Sprayers: Low-pressure sprayers often are equipped with sprayer booms ranging from 10 to 60 feet in length. The most common booms are between 20 and 35 feet long and contain several nozzles. The height of the sprayer boom must be easily adjustable to meet the needs of the job. Boom supports should allow the boom to be set at any height from 12 to 72 inches above the surface being sprayed. Many nozzle arrangements are possible, and special-purpose booms are available.

Boomless Sprayers: Low-pressure sprayers that are not equipped with booms generally have a central nozzle cluster that produces a horizontal spray pattern. The resulting swath is similar to the pattern made by a boom sprayer. These sprayers are useful in irregularly shaped areas, because they can move through narrow places and avoid trees and other obstacles. Some low-pressure sprayers are equipped with a hose and handgun nozzle for applications in small or hard-to-reach areas.

Large Power-Driven Sprayers (High Pressure): These sprayers are used to spray through dense foliage, thick animal hair, to the tops of tall trees, and into other areas where high-pressure sprays are necessary for adequate penetration and reach. Often called "hydraulic" sprayers, they are equipped to deliver large volumes of spray -- usually 20 to 500 gallons per acre -- under pressures ranging from 150 to 400 psi or more.

- These sprayers usually are mounted on tractors, trailers, trucks, or boats, or are self-propelled. Piston pumps are used and provide outputs up to 60 gallons or more per minute. Large tanks (500 to 1,000 gallons) are required, because the application rate is usually 100 gallons per acre or more.
- **Mechanical agitators** are usually standard equipment, but hydraulic agitators may be used. When fitted with correct pressure unloaders, these sprayers can be used at low pressures. All hoses, valves, nozzles, and other components must be designed for high-pressure applications.
- **High-pressure sprayers** may be equipped with a hose and single handgun nozzle for use in spraying trees and animals. These sprayers also may be fitted with a boom for broadcast agricultural applications.
- **Advantages:** provide good penetration and coverage of plant surfaces, & usually well-built and long-lasting if properly cared for.
- **Limitations:** large amounts of water, power, and fuel needed, high pressure may produce fine droplets that drift easily.

Airblast sprayers use a *combination of air and liquid* to deliver the pesticide to the surface being treated.

- These sprayers usually include the same components as low-pressure or high-pressure sprayers, plus a high-speed fan. Nozzles operating under low pressure deliver spray droplets directly into the high-speed airstream. The air blast shatters the drops of pesticide into fine droplets and transports them to

the target. The air blast is directed to one or both sides as the sprayer moves forward, or it may be delivered through a movable nozzle.

- Most airblast sprayers are trailer-mounted, but tractor-mounted models are available. Tank capacity ranges from 100 to 1,000 gallons. Most of these sprayers can be adapted to apply either high or low volumes of spray material as well as concentrates. Mechanical agitation of the spray mixture is usual. An airblast sprayer may cover a swath up to 90 feet wide and reach trees up to 70 feet tall.
- **Advantages:** good coverage and penetration; mechanical agitation; high capacity; can spray high or low volumes; & low pump pressures.
- **Limitations:** drift hazards; use of concentrated pesticides may increase chance of dosage errors; not suitable for windy conditions; hard to confine discharge to limited target area; difficult to use in small areas; high power requirement and fuel use.

Ultra-low-volume (ULV) sprayers: These are sprayers that *use special pesticide concentrates.* ULV sprayers may be hand-held or mounted on either ground equipment or aircraft.

- **Advantage:** no water is needed, so less time and labor are involved.
- **Limitations:** drift hazards; coverage may not be thorough; high concentrates present safety hazards; use of concentrated pesticides may increase chance of dosage errors; few pesticides are labeled for ULV.

Controlled droplet applicators (CDA): These applicators use a spinning disk (or cup) that breaks the liquid into uniformly sized droplets by centrifugal force. The droplets may be carried to the target by gravity or by an air stream created by a fan. Power to spin the disk or cup is provided by a small electric or hydraulic motor. Most CDA's do not use a pump. CDA's range in size from a small hand-held type to large tractor-mounted and trailer-mounted units.

- **Advantages:** requires a low volume of water; produces narrower range of droplet sizes than conventional nozzles, thus reducing drift; droplet size can be adjusted by speed of rotation.
- **Limitations:** gravity type may not penetrate foliage well; not suitable for use in windy conditions.
- **Electrostatic sprayers:** give the pesticide *a positive electric charge as it leaves the nozzles.* Plants naturally have a negative charge, so the positively charged pesticide is attracted to the plants. The spray is directed horizontally through or above the crop (depending on the pesticide being applied).
- **Advantages:** pesticide adheres to foliage well, so less pesticide is needed per acre; coverage is more even than with other types of equipment; & minimizes the likelihood of drift.
- **Limitation:** useful only for application to foliage.

18) PERSONAL PROTECTION:

- **PPE (Personal protective equipment)** – *must be inspected daily.*
- **PPE (Personal protective equipment)** – *must be stored in clean, sealed plastic bags from pesticides.*
- All **Category 2 handlers** must have a *respirator, safety glasses, rubber gloves, and rubber boots.*
- **Unlined rubber gloves** should be worn for all types of chemical application. These type of gloves will most likely prevent dermal exposure. All rubber gloves should be washed/cleaned on a daily basis. The only time gloves may not be worn is when the label permits it.
- **Chemical gloves of a resistant material –** should be used if the label does not specify the type of glove to be used when applying the chemical.
- **All respiratory protection devices** *must be approved by* **NIOSH or MSHA**
- **Respirators** should be stored in an air tight sealed case when not in use. Respirators should be checked before each use. Always use your own respirator, even if you a borrowing someone else's vehicle for the day, do not use the respirator stored in the truck. If you should smell or taste a contaminant during the use of a respirator, leave the area and inspect the filter cartridge.

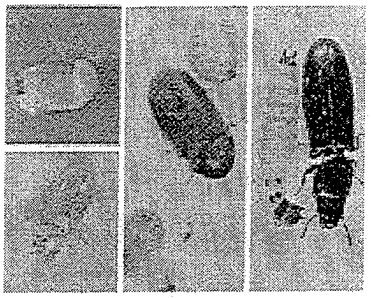
- **Respirators** must be worn whenever the label requires their usage.
- The **proper sealing of a cartridge respirator** may be prevented by a *beard or sideburns*, so it is recommended that an applicator keep his facial hair trimmed or be clean shaven.
- When deciding on **protective eye wear** it is important to consider *temple and eye protection as well as brow protection.*

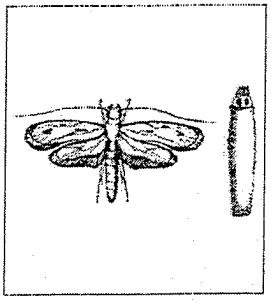
Glossary of Terms:

Abrasive -- Capable of wearing away or *grinding down another object.*

Agitation -- The process of *stirring or mixing.*

Calibrate -- Measure and adjust the amount of pesticide the application equipment will release per unit of area.





Casemaking Clothes Moth -- Often found in old woolen blankets spotted with individually spun pupae (*pictured at right*).

Carpet Beetle – infests woolens, dried flowers, and even bird nests. They cause major *damage to fabrics in their larval stage* (see "*Varied Carpet Beetle*" on next page).

Cigarette Beetle – A stored product pest that would likely be discovered during an inspection of dried peppers in a supermarket. *Often feeds on grain and milled cereals in a warehouse.* Sometimes found in bagged or boxed spices in kitchen cabinets (*pictured above on the left).*

Concentrate -- Pesticide having a *high percentage of active ingredient*; occasionally applied full-strength, but usually diluted before application.

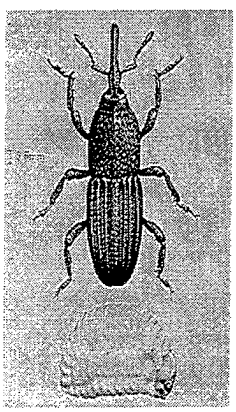
Corrosion -- Process of being *worn away gradually by chemical action.*

Diluent -- Anything used to *dilute a pesticide.*

Dilute pesticide -- A pesticide that is *not concentrated*; one that does not have a high percentage of active ingredient.

Drift -- Pesticide *being carried away from the release site by air movement.*

Emulsifiable concentrate -- A pesticide formulation that usually *contains a liquid active ingredient*, one or more petroleum-based solvents, and an agent that allows the formulation to be mixed with water to form an emulsion (droplets of one liquid dispersed in another liquid).

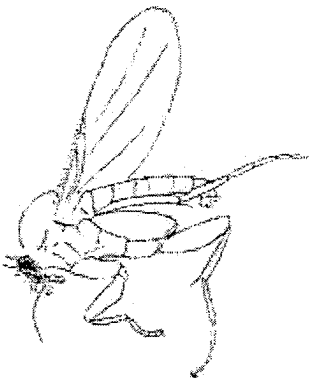


Formulation -- *Pesticide product as sold*, usually a mixture of active and inert ingredients.

Fumigant -- Pesticide that is a *vapor or gas* or that forms a vapor or gas when applied and whose pesticide action occurs in the gaseous state.

Granary weevil – A stored product pest that feeds inside kernels of corn. May be identified by its *long cylindrical snout* (*pictured at left*).

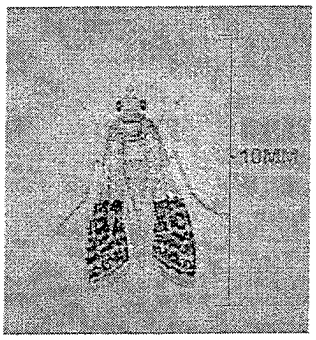
gpm -- *Gallons per minute.*



Humpback fly -- Their larvae is often found in mausoleums, decaying organic matter, or dirty, moist mop heads made of long cotton fibers (*fly on the right*).

Hydraulic agitation -- *Stirring or mixing provided by the high-pressure flow of surplus spray material from the pump.*

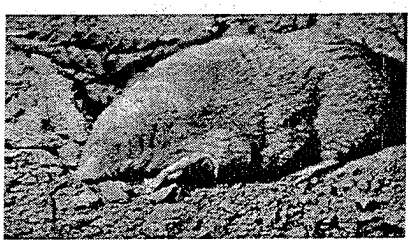
Hydraulic -- Operated by the *pressure created by forcing liquid through a narrow opening.*



Indian Meal Moth -- Makes *web-like debris in packages of grass and silk.* A pest that is often associated with stored-grain products. This pest has a very short life span and is very attracted to pheromone lures (pictured on left).

Mechanical agitation -- *Stirring or mixing done by rotating paddles* or propellers in the sprayer tank.

Mild steel -- *Steel that contains a very low percentage of carbon*; also called "soft steel."



Mole -- A vertebrate pest that *can inhabit an inaccessible wall void* where bathtub lines penetrate through a concrete slab floor (*pictured at right*).

Nontarget -- Any site or organism *other than the site* or pest at which the pesticide is being directed.

Personal protective equipment -- Devices and clothing worn to *protect the human body* from contact with pesticides or pesticide residues.

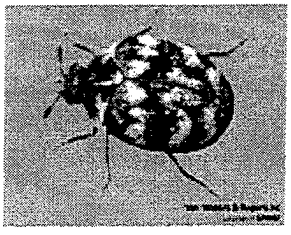
psi -- *Pounds per square inch.*

Soluble powder -- Dry pesticide formulation that *forms a true solution when mixed with water.*

Solvent -- A liquid, such as water, kerosene, xylene, or alcohol, that *will dissolve a pesticide* (or other substance) to form a solution.

Suspension -- A substance that consists of *undissolved particles mixed throughout a liquid.*

Target -- The *site or pest toward which control measures are being directed.*



Volatile -- Evaporating rapidly; *turning easily into a gas or vapor.*

Varied Carpet Beetle – their larvae like to feed on woolen fabrics; also causes damage to natural fibers in homes. (*pictured on the left*).

Vitamin K -- The *antidote for all anticoagulants.*

Wettable powder -- A dry pesticide formulation, usually mixed with water for application. *Does not dissolve in water, but forms a suspension.*

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