Department of Housing and Urban Development
Office of Public and Indian Housing

HUD MAINTENANCE GUIDEBOOKS

GUIDEBOOK 7

TERMITE, INSECT, AND RODENT CONTROL

September 1995

HUD MAINTENANCE GUIDEBOOKS

GUIDEBOOK SEVEN

TERMITE, INSECT, AND RODENT CONTROL

Department of Housing and Urban Development
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HUD Maintenance Guidebook Seven
Termite, Insect, and Rodent Control

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TERMITE, INSECT AND RODENT CONTROL

CHAPTER ONE - INTRODUCTION

SECTION A WHY WAS THIS GUIDEBOOK PRODUCED?

The purpose of this Guidebook is to introduce public housing agencies and Indian housing authorities (jointly known as HAs) to current pest-management methods and principles that will make their task more rewarding and effective. In order to reduce risk from exposure to toxic pesticides, these methods are less dependent upon chemical pesticides. The old ways no longer work well since pests developed resistance to many pesticides. This Guidebook provides information on modern Integrated Pest Management (IPM) to control pests, a new approach which provides a higher level of control at lower costs to HAs.

SECTION B PEST MANAGEMENT—WHAT IS IT?

1. GENERAL

What is a pest? Living organisms fulfill their natural roles wherever they are, but only when they impact unfavorably on human life and activities are they considered pests. A "pest" then is any living organism that interferes with human objectives.

The goal of the IPM approach is to manage pests, reduce costs, and protect human health and environmental quality. IPM systems combine technical information on the pest and how it interacts with its environment with known and available pest-control methods. Because IPM applies an overall approach to pest-management decision-making, it takes advantage of *all* appropriate pest-management options including, but not limited to, pesticides. Thus IPM is:

- A system utilizing multiple methods,
- A decision-making process,
- A risk-reduction system,
- Information intensive,
- Cost-effective, and
- Site specific.

Unlike any single method or tactic of pest control, the IPM approach to pests employs a combination of tactics, including sanitation, monitoring, habitat modification, and the judicious use of pesticides, when necessary. IPM is equally suited to the pest-management needs of single and multi-unit housing

structures and surroundings, while it reduces the exposure of children and adults to potentially hazardous pesticides. Additionally, IPM provides low-cost and effective pest management in the long term. The repetitive, so called "preventive" pesticide treatments are eliminated, thus reducing costs and unnecessary exposure, and the likelihood that pests will develop a resistance to pesticides. The best available technical information about the pest and its interaction with its surroundings is employed with IPM, which relies on permanent modifications of the pest's habitat to achieve control. The system requires careful attention to sanitation, preventive building maintenance, and exclusion and mechanical means, as well as appropriate pesticidal methods of pest management.

A successful IPM system for urban sites has five major components. All of them should be addressed and implemented in some form for the system to be most effective. Deletion of portions of the system will lead to poor results. These components are:

1. Definition of Roles and Responsibilities:

   Define the roles and responsibilities of all involved in the pest-management system (for instance, resident and HA's staff or contractor pest manager). Ensure understanding and establish communication links between them.

2. Develop Pest-Management Objectives and Action Thresholds:

   Determine the management objectives for each specific area of the development, having identified those organisms that constitute pest problems. Set action thresholds—the point at which pest populations or environmental conditions indicate that some action must be taken.

3. Inspection and Monitoring:

   Inspect the development and monitor the pest population on a consistent basis to determine when the action threshold is reached, and to determine whether the actions taken have been sufficient.

4. Management Methods:

   Take action that reduces the number of pests the habitat can support, exclude the pest, or otherwise make the development's environment incompatible with the biological needs of the pest. Take appropriate pesticidal action, utilizing the least toxic, most effective and efficient application technique. The method employed should provide the longest contact time between pesticide and pest, when the pest is in its most vulnerable stage, and should offer the least possible hazard to people, property, and the environment.

5. Evaluation and Record-Keeping:

   Evaluate the results of habitat modification and pesticidal treatment actions by periodically monitoring the development's environment and pest populations. Evaluation compares the pest-management objectives (how many pests are too many) with the level achieved, and determines what more needs to be done. Keep written records of the development's pest-management objectives, monitoring procedures and data collected, actions taken, and the results obtained by the pest-management methods.

2. ROLES AND RESPONSIBILITIES

The concepts and methods of IPM were developed for agricultural settings. Later, its value in urban pest management was recognized as well. Key to the success of this system in a residential development is the interaction among the people involved in pest management—residents, pest managers (HA staff or contractors), and decision-makers (HA staff)—who share the information necessary to achieve the pest-management objectives. Their functions and responsibilities, identified below, should be included in the pest-management plan.

a. Residents' Roles and Responsibilities

Residents are concerned about the effectiveness and possible adverse effects of the pest-control methods used. They should receive information addressing these concerns as well as their roles in the development's pest-management system. When everyone's role in the system is agreed upon, and when communication is good, effective and inexpensive protection of the development and the residents can be achieved with reduced risk.

Sanitation and Elimination of Pest Harborage: The most important responsibility of the residents is sanitation. Extremely small amounts of crumbs, grease, or water can meet the food and water needs of most pests for many days or weeks. Much of the prevention and reduction of pest infestations depends on clean-up of food leftovers, paper clutter, and proper housekeeping. Kitchens, where food is prepared, and dining rooms, where food is consumed, are especially vulnerable to pest infestation, so special attention should be given to washing dishes and cooking utensils after every meal, and storing food in pest-proof containers. Food should not be left out overnight. All spaces should be thoroughly cleaned and vacuumed, and wet garbage and other trash removed from the premises often. Food should be stored in glass, plastic, or metal pest-proof containers and rotated (first in, first out).

Observation and Early Detection of Problems: Since residents spend a great deal of time in the home, they should be aware of signs indicating the presence of pests. Noting and reporting these signs to the HA will help in the detection and control of pests. Things to look for are live or dead insects, droppings, holes in paper or cardboard food containers, brown spots in corners of cabinets or rooms, "salt and pepper" droppings, fine sawdust piles, olive-pit shaped droppings, holes in cabinets or woodwork, gnawing, scrambling or scratching sounds in walls.

b. The HA's Pest-Management Role and Responsibilities

The HA's staff or pest-control contractor should evaluate the extent of the pest infestation and the development's environment and decide how to achieve the pest-management objectives. Then the pest manager designs a system that takes into account potential liability, applicator and resident safety, costs, effectiveness, time required, and resident concerns. The pest manager also performs the necessary pest-management actions or directs others to take action.

Response to Resident Pest Observations: Residents should have the means to report any signs of pest activity, and the HA should respond quickly to such observations.

Inspect and Monitor the Development: The pest manager should respond to resident observations by initiating a thorough inspection of the environmental conditions of the development to determine how they provide the biological needs (food, water, shelter) for pest populations, where pests are, and the size of the pest population.

Identify the Pest(s): The pest manager identifies the pest (to species, if possible) and determines the necessary sanitation and exclusion methods, and biological and physical control measures that can be used to achieve control.

Educate the Resident about IPM: The residents need to be informed about the importance of their roles in IPM for the successful management of pests.

Identify Preventive Measures: Residents should be advised of their responsibilities in pest management, such as vacuuming, sanitation, removal of clutter, handling of wet garbage, food-storage methods, and other cultural means to remove what pests need to survive in the home.

Make Recommendations: Some necessary actions to be taken, such as repairs of leaks and exclusion measures, may not be the responsibility of the pest manager. Such actions should be recommended by the pest manager for the HA's staff to accomplish.

Manage the Pests: The pest manager should take whatever means are needed to manage the development's environment and pest populations, including the use of pesticides, if necessary.

Provide Risk Communications: The pest manager should communicate any potential risks from pesticide use to the residents and the HA's staff. The system for the development should achieve the goals within the limitations posed by safety, time, money, and materials available. Pest managers monitor the development's environment and pest population to determine if actions

tions taken are successful, and keep accurate records of any pesticides used, the amounts and treatment dates for each development.

c. The HA Decision-maker's Role and Responsibility

HAs authorize the IPM program, control the money for pest management, and should be directly involved in its management. The HA should rely on the expertise of its certified staff in purchasing pesticides, especially when ordering restricted use pesticides, or request assistance from the local public health department or local cooperative extension service or hire a consulting entomologist or pest control specialist.

The HA is responsible for determining whether the pest manager is performing at an acceptable level and whether the pest-management objectives are being met by performing the following:

Developing a Pest-Management Plan: The HA's staff should help develop the pest-management plan. The plan should include at least the five steps of a successful IPM system described in Section B-1 in this chapter. A good pest-management plan will ensure the success of implementing IPM in the development.

Providing Maintenance Procedures: Proper maintenance of residential buildings will eliminate opportunities for pest populations to develop. Routine maintenance includes leak repair, exclusion measures to keep pests out, and provision for timely garbage and trash removal.

Seeking Recommendations of a Professional Pest Manager: The pest manager should be a professional who knows the biology and behavior of pests and will make recommendations for structural changes, repairs, and innovative approaches that will economically achieve long-term control without the added risks of excessive pesticide use.

Understanding, cooperation, and commitment, from everyone is needed in order for IPM to succeed.

d. Educating and Training IPM Participants

An IPM program should include the education of residents and training for maintenance and other staff. Residents should understand the basic concepts of IPM and the importance of their cooperation. They should know whom to contact with questions or problems. Specific instructions should be provided on what to do and what not to do. Pesticide applications by residents should be discouraged.

The application of pesticides should only be done by the HA's designated certified and licensed pesticide applicator, in compliance with state laws. Training and certification in IPM of HA staff, especially the pest manager, is important to the success of an in-house IPM program. Universities and State Cooperative Extension Services have the expertise to meet most IPM training needs. There are also private organizations which can provide IPM training.

SECTION C PEST-MANAGEMENT OBJECTIVES AND ACTION THRESHOLDS

1. PEST-MANAGEMENT OBJECTIVES

A pest-management objective is like a road map for pest control. It tells us what we are trying to accomplish (where are we going) and when we have done enough. The pest-management objective should be as specific to the development's needs as possible, considering the residents, conditions, pest problems, and resources available.

Pest-management objectives will differ among developments. Some of the objectives might be preventing termite damage or cockroach populations. Pest managers should clearly identify specific objectives in pest-management plans, such as the following: Manage termites that may occur in the development to prevent or minimize damage to buildings, using appropriate monitoring, remedial, and preventive methods that also minimize injury or health risks to residents or HA staff, and preserve the integrity of the development buildings and structures.

a. Is Zero a Real Number?

In managing pests to a level where they do not have adverse impacts upon health and property, "zero" pest presence may not always be achievable. However, with the utilization of IPM principles and practices, very low levels (near zero) of pest presence can be achieved with reasonable expenditure of money, time, and material.

b. Realistic Pest-Tolerance Levels

Realistic tolerance for the presence of pests is relative to the risk posed by exposure to that pest. A rat in a bedroom is not tolerable, and requires immediate action. However, the presence of a fruit fly or termite does not pose a threat to life, and may not call for action immediately. Individual tolerance for some pests will be different from person to person, which should be considered in the development pest-management plans.

2. ACTION THRESHOLDS

An action threshold is a tolerance level determined by sensitivities of the residents, and should reflect the pest-management objective for the development. When pest populations exceed action thresholds, action should be taken. Precise recommendations or actions to achieve specific results are an essential part of an IPM program. Specific recommendations, including an explanation of the benefits, should be based on the evaluation of all available data obtained through monitoring. The presence of some pests does not, in itself, necessarily require pesticidal action.

SECTION D INSPECTION AND MONITORING

1. GENERAL

The identification of pests and the extent of infestation are vital in IPM to insure that the control methods will be effective. Eliminating the pest's desired habitat is another important step in IPM. Once the pests have been identified and the sources of their activity are pinpointed, habitat modifications—primarily, exclusion, repair, and sanitation efforts—may reduce the prevalence of pests greatly.

An IPM program consists of a cycle of monitoring, evaluating, and choosing the appropriate method of control. Monitoring includes inspection of areas for evidence of pests, entry points, availability of food, water, and harborage, and estimating pest-population levels. The information gained through monitoring is evaluated to determine whether the action threshold has been exceeded and what can be done in the way of prevention.

Residents' reports and observation of the development will give the pest manager an idea of the size of the pest population. An astute observation will provide signs or actual sightings of the pests for identification. On the basis of such identification (to species, if possible), information can be obtained about the behavior and preferred habitat of the pest, and what methods will achieve control of the population.

All organisms have basic life needs for air, food, moisture, warmth, harborage, and environments that will meet these needs. Unfortunately, buildings are constructed and maintained in ways that provide pests with access and environments which encourage them to stay and multiply. Further, residents sometimes do not keep their kitchens and other spaces adequately clean, which can invite and support pest populations.

One of the primary goals of an effective pest-management program is to identify realistic and economically sound ways that eliminate those elements which pests need for survival. Deny

harborage, food, and water to pests that enter the units to eliminate and help catch those that otherwise survive. Neglecting any of these methods strengthens the pests' ability to survive and flourish.

a. Who Monitors for What Conditions

Resident Observations and Reporting: The resident is perhaps in the best position to observe pests that occur within the development. Observations of pests, or the damage they do, should be reported to the HA's staff to allow the pest manager to conduct an inspection and monitor the location and extent of the pest population, and determine the corrective actions to be taken.

Maintenance Observations and Reporting: While performing inspections or repairs, the HA's maintenance staff also have opportunities to observe the presence of pests or the results of their activities, which should be reported to allow the pest manager to conduct a thorough inspection and monitor the pest infestation.

The Pest Manager's Inspections and Observations: The HA's pest manager should schedule periodic inspections at each development to determine that sanitation standards are maintained and to detect any environmental conditions that may be conducive to the presence of pests. Inspection and monitoring in an IPM program is the most important function of the pest manager.

b. Conditions that Support Pests

Moisture: Water is a basic element of life. Elimination of leaks, condensation, and other moisture sources will reduce pest presence and pest damage.

Food: Although many pests can go without feeding for a long time (weeks or months in some cases), eliminating access to food will reduce their number. Thus, keeping food in pest-proof containers, good sanitation, and exclusion are important aspects of controlling pests.

Temperature: Most organisms have a relatively narrow range of temperatures within which they can function. Low and high temperatures can be lethal to insects, whereas temperatures between 65°F - 90°F enable insects to function well and reproduce rapidly. Observing temperature ranges can indicate potential pest growth rates.

Shelter: Small, concealed, and protected spaces, that insects and other pests can use, may provide shelter and harborage. Preventing access to these shelters by caulking or other exclusion methods will reduce available shelters. The HA's pest manager should notice conditions that

provide shelter to pests so action can be taken for their elimination.

Light: Many insects and other pests are active in the absence of light. Thus, the presence or absence of light can be a pest-management tool. Observation of light conditions and placement of light can give clues to pest presence or potential.

c. Monitoring Methods

The pest manager may use many monitoring tools to assess the level of pest infestation. Since some pests are elusive, monitoring tools may be in place for some time. These tools may capture the pest for counting (cockroach sticky traps) or merely note its presence (tracking powder). Some monitoring tools may attract pests from a long distance, so placement is very critical to avoid inviting more pests from outside the managed development. The monitoring methods provide data, over time, which are recorded and enable the pest manager to select the methods to achieve the desired level of control.

SECTION E PESTICIDE SAFETY AND EMERGENCY PROCEDURES

1. GENERAL

Pest controllers should understand pesticide toxicity as it relates to human exposure, know the appropriate safety equipment, procedures, and handling of pesticides, know the signs and symptoms of pesticide poisoning in humans, and be able to provide appropriate emergency procedures.

TOXICITY x EXPOSURE = RISK, so reduced risk involves both selecting pesticides with lower toxicity, and reducing exposure to pesticides. There are over 25,000 pesticides registered for use. In order to select the right product, we need to know how each affects not only the target pest but also the people exposed to it. The pesticide probably works on people the same way as on pests. To reduce the risk poison, we need to protect our skin, respiratory tract, eyes, and prevent the pesticide from getting into the mouth. Containerized baits or baits injected into cracks and crevices pose less risk than open baits, granular materials have less risk potential than dusts, and sprays are less risky than fogs or vapors, assuming that all have the same toxicity. Therefore, the formulation of a pesticide is important, as is the use of protective equipment, which should reduce the risk inherent in the toxicity of pesticides. Use protection that is appropriate to the material being used.

2. APPLYING AND STORING PESTICIDES

Of the wide variety of pesticides available, the pest manger should choose the least toxic, most effective, most efficiently applied, which provides the longest time in contact with the pest and is applied during the pest's most vulnerable stage. Due to their toxic nature, these materials should be used only by certified applicators, in a manner to ensure maximum efficiency, with minimal hazard. Pesticides should be applied only when a unit is unoccupied and properly ventilated.

The following general recommendations should help to minimize exposure to people and other non-target species when pesticides are applied:

- Choose the right pesticide formulation. (The label will indicate if the product is suited for the development and pest to be controlled.)
- Limit the use of sprays, foggers, or volatile formulations.
- Use baits or traps and crack-and-crevice application. (Look for crack-and-crevice label instructions.) The treatments should maximize the exposure of the target pest to the pesticide with the least pesticide exposure for residents.
- Apply only when residents are not present in areas where chemicals are applied.
- Insure appropriate ventilation during and after pesticide application and use proper protective clothing or equipment.
- Notify residents and staff of upcoming pesticide applications.
- Maintain a voluntary registry of residents who could be adversely affected by exposure to pesticides. Provide them with information on how to contact the HA's staff or contractor pest manager's office if emergencies result from pesticide exposures.
- Keep copies of pesticide labels and MSDS easily accessible.
- Store pesticides off the development, or in locked buildings not accessible to unauthorized persons. Ensure adequate ventilation of pesticide storage areas. Liquid pesticides should be stored differently from dry formulations. Herbicides should be stored separately to avoid potential damage to plants from the absorption of vapors onto other pesticides stored nearby, and for safety. Check state recommendations and requirements for pesticide storage.

If pesticides are stored in occupied buildings, take special care to ensure that air in the resident-occupied spaces is not contaminated. Place a notice outside the designated storage area. All pesticide containers should be tightly closed; however, even closed pesticide containers may volatilize toxic chemicals to the air. Therefore, pesticides should be stored in spaces physically separated and closed off from occupied spaces, where the air is exhausted directly to the outside). In addition, ensure that storage-space air cannot mix with the air in the central ventilation system. The pest manager is responsible for periodically checking stored pesticide containers for leaks or other hazards.

SECTION F PESTICIDE LAWS—FEDERAL AND STATE

1. CERTIFICATION

a. General

Pest management is complex. Control of pests cannot be attained simply by spraying baseboards. Applicators need to know about all phases of pest control in addition to the chemicals. The number of pesticides has increased and their effects on wildlife, human health, and the environment are vital considerations. Such knowledge should also be passed on to residents and other maintenance staff.

Requirements have been established to protect the general public, the environment, and those who apply pesticides. Anyone using restricted-use pesticides in any category must be certified or apply pesticides under the direct supervision of someone who is certified. **Direct supervision** means that the certified applicator is available to the person applying the pesticide and is aware of what is being done. Certified applicators should be aware of all current requirements. **Restricted-use** indicates that the environment, user, or others, could be harmed, even when the pesticide is used as directed. Certification is carried out by the states or tribes (except in Colorado and Nebraska, which have federal programs).

b. Certification Standards

Standards and testing for certification (and recertification) are part of EPA-approved state and tribal plans for commercial applicators. Recertification intervals vary from state to state. Training necessary to obtain certification is provided by different sources, such as university extension services, state regulatory agencies, national and state pest control associations, pesticide manufacturers, and other pest-control industry representatives.

c. Certification Records

Certified applicators should maintain records verifying attendance and participation in certification training programs. Subjects covered, time, location, instructor, and testing results should be noted. It is also good practice for applicators to keep a personal training record that records classroom training or testing, on-the-job training, workshops, performance testing, and use observations.

2. CERTIFICATION CLASSIFICATIONS

a. Private

A certified private applicator uses, or supervises the use of, restricted-use pesticides only to produce agricultural commodities on property owned or rented by them or by an employer. Since HAs do not produce agricultural commodities, certified private applicators are not qualified to treat developments to control pests.

b. Commercial

A certified commercial applicator uses or supervises the use of any pesticide classified for restricted use, for any purpose, on any property other than those listed for private applicators. HA staff or other applicators hired to control pests on public housing property must be certified or under the supervision of a certified applicator.

3. FEDERAL COMMERCIAL CATEGORIES

Federal standards identify specific commercial pest-control categories. State certification standards must not be less stringent than these standards. Commercial applicators in some states may apply for certification in any or all of the categories, but they may practice only in categories for which they are certified. HA staff or hired pest controllers need to be certified in the appropriate commercial category to apply pesticides on public property.

4. FEDERAL PESTICIDE LAWS

The United States Congress established the Environmental Protection Agency (EPA) in 1970 and required that the agency regulate pesticides to make pesticide use safer for both people and the environment. The EPA sets standards through regulation for pesticide registration, handling, and use. Some practices which were only suggested for correct use in the past are now required by regulation. These regulations affect areas such as record-keeping, transportation, storage and disposal procedures, entry intervals, and filling and mixing methods.

a. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Through its Office of Pesticide Programs (OPP), EPA implements the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to fulfill its mandate. FIFRA was enacted in 1947, replacing the Federal Insecticide Act of 1910, and has been amended several times.

The most important amendment to FIFRA is called the Federal Environmental Pesticide Control Act (FEPCA) of 1972, which shifted the emphasis from pest-control regulations to the role of protecting public health and the environment.

FIFRA is the law which governs the registration of pesticide products. No pesticide may be marketed in the United States without EPA approval and its product registration number. Manufacturers must demonstrate that their pesticides will not have unreasonably adverse effects on human health.

In summary, FIFRA requires that:

- EPA register all pesticides as well their use, and approve the product label;
- Pesticides be categorized either for general use or restricted use; and
- Users of restricted-use pesticides be certified or apply such products under the direct supervision of certified applicators.

FIFRA also:

- Establishes tolerances for residues that may remain on raw agricultural products or in processed food;
- Provides penalties for "use inconsistent with the labeling" of a pesticide;
- Makes it illegal to store or dispose of pesticides or containers other than as directed by regulations, and provides penalties for illegal handling of containers;
- Provides civil penalties when the violation of a regulation is unintentional (fines can be as much as $5,000 for each offense by commercial applicators);
- Provides criminal penalties when the law is knowingly violated (commercial applicators may be fined up to $25,000 or one year in prison, or both);
- Permits states and tribes to establish more stringent, but not more permissive, standards.

Under FIFRA, the EPA has delegated substantial enforcement powers to the states.

b. State, Tribal, and Local Laws and Regulations

State, tribal, and local pesticide laws are written in compliance with federal law, and in response to specific pesticide-related problems. Such laws can be more stringent but cannot relax, overrule, or conflict with Federal law. In some states, laws further restrict the use of certain pesticides.

5. PROTECTION: THE APPLICATOR'S RESPONSIBILITY

a. Environmental Considerations

Protection of the environment from pesticides ultimately will fall to the pest manager. It should be ensured that the pesticides will not result in hazards to people in the dwelling units or on the grounds. Spills or leaks during mixing, loading, transporting, and disposing may wind up in ground or surface water or in the habitat of nontarget organisms, and should be prevented.

b. Pesticide Label

The pesticide label is the law. The key parts of the label are the signal word signifying the risks, precautionary information for protecting the applicator, others, and the environment, information on the pest, and where the pesticide can be used. Directions concerning the use of pesticides should always be read and followed.

END OF CHAPTER ONE

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER TWO - TERMITES AND THEIR MANAGEMENT

SECTION A INTRODUCTION

Termites are the most destructive wood-destroying insects in the U.S., costing hundreds of millions of dollars each year in prevention efforts, direct damage to structures and trees, and corrective costs. In an older housing development, about one of every ten houses is infested to some degree, while in newer housing, perhaps one in twenty houses is infested.

Termites are social insects of the order *Isoptera* (meaning equal wings) and, like their close relatives the cockroaches, have been around for hundreds of millions of years. As inhabitants of forests, they serve the ecosystem by consuming dead and decaying wood. When people began to live in wood structures, these structures became additional food sources and habitat for termites.

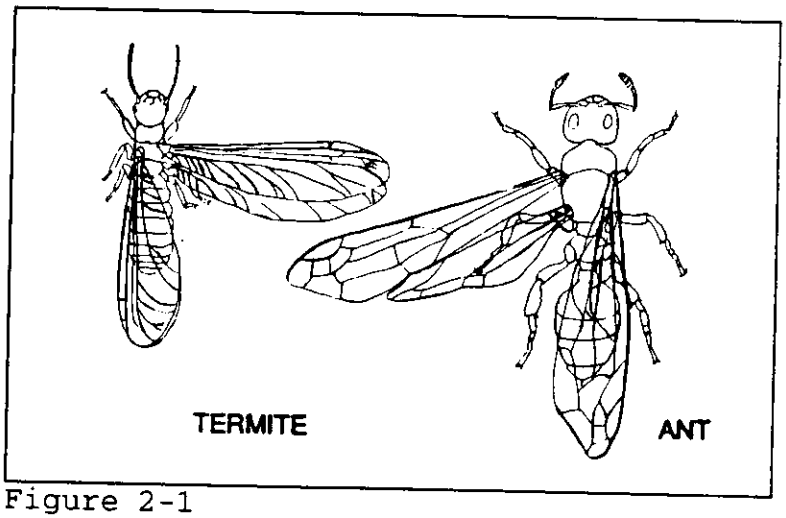


Figure 2-1

Termites are classified according to their primary habitats: subterranean, dampwood, and drywood termites. By far, the subterranean termites are the most widely distributed; they occur throughout most of the 48 contiguous states, Hawaii, lower Alaska along the Pacific Coast, and the Caribbean territories. Drywood termites, by contrast, inhabit coastal areas in the southeastern U.S. from South Carolina throughout the Gulf states, along the border with Mexico, and up the coast of California. They also occur in Hawaii, Puerto Rico, the U.S. Virgin Islands, and the Pacific Territories. Dampwood termites inhabit the states west of the continental divide, some of the southwestern states, Puerto Rico, Florida, and the U.S. Virgin Islands. Because of the ever-present threat to housing and other wooden structures, vigilance is necessary to prevent, mitigate, and eliminate termites.

SECTION B CHARACTERISTICS AND RECOGNITION

Usually, the first experience people have with termites occurs when they swarm around their homes by the thousands during spring, when they begin mating and spreading to new areas. People usually report "flying

ants" and immediately call their exterminator. It is the pest-management specialist who points out the differences between true flying ants—which have two pair of unequal wings, elbowed antennae, and a narrow waist—and termites, which have two pair of nearly equal wings, straight antennae, and a thick-waist (Fig. 2-1, previous page). Close inspection of the building may reveal piles of termite wings, small white worker termites (less than 1/4 inch long) in wood below ground, and their galleries in wood structures.

SECTION C BIOLOGY OF SUBTERRANEAN TERMITES

Subterranean termites, the most widespread and destructive termites in the U.S., nest underground and within easy access of the wood which is their only food. They are social insects with a complex division of functions, including a queen, king, soldiers, supplementary reproductives, and workers (Fig. 2-2).

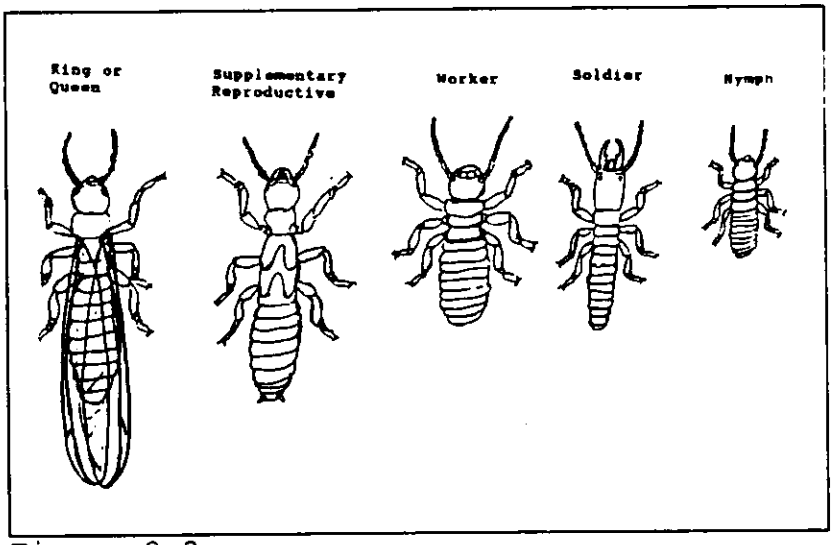


Figure 2-2

The life of the colony depends on the queen, which is a greatly enlarged, light brown, winged pest about 1/2-inch long. The queen can lay millions of eggs over her lifetime of over 25 years. Her egg-laying activities are augmented by supplementary wingless reproductives as the queen ages or the colony outgrows its original nest. The king is the same size and color as the queen and also has two pair of wings. It exists only to mate with the queen, and lives, as does the queen, entirely within the subterranean nest once it is established.

The supplementary reproductives are light in color, about 1/4-inch long, and have two pair of wing pads. They also stay entirely within the underground nest. The soldiers are white, except for an enlarged brown head capsule, and are about 5/16-inch long. They defend entrances to the nest against enemies, particularly ants, which are the primary enemies of termites. The workers, which are actually nymphs, are entirely white, about 3/16-inch long, and do all of the foraging and feeding of the colony. They may live up to five years, and are the ones that venture above-ground into structures, construct the galleries, bring wood back to the nest, and build the mud tubes that connect the nest to the galleries and the structure. They also feed the young nymphs and other castes which cannot feed themselves.

Since the termites' ability to digest cellulose is totally dependent upon the protozoans living within their

midgut, it is imperative that workers exchange anal fluid containing these organisms so that young termites can digest their food. This is accomplished by grooming among workers, a process which is important in selecting a pest-management strategy.

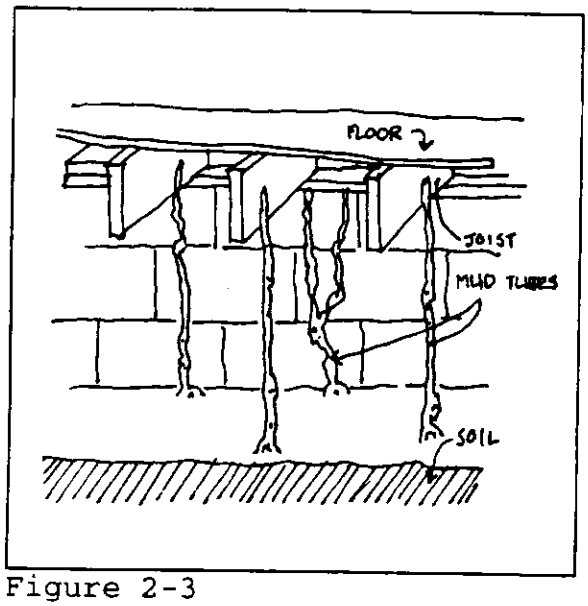


Figure 2-3

The conditions that termite colonies need to flourish are rather basic, but critical. They include relatively high moisture content in their living and feeding areas, adequate shelter and temperature, and a plentiful food source. The colony will not flourish if any of these is lacking. The high moisture content need is met by the soil in most parts of the country. Even coastal beaches, deep in the sand, provide ample moisture for termite colonies. The soil also provides termites the necessary protection from desiccation, since their cuticle is rather permeable and they can easily die from exposure in air. It has been theorized that the connecting mud tubes from above-ground food sources to nests (built from mud, digested wood, and termite secretions and excretions) protect termites against dehydration along the journey from the nest to the food source and back (Fig. 2-3).

These tubes, however, may provide protection against enemies, primarily ants. The minimum tolerable temperature for termites is -22°F. This does not mean that termites can flourish at this temperature, but rather that they can withdraw deep enough into the ground to survive that outside air temperature for a short period, usually a matter of weeks. If they have to stay too deep for too long, however, they are deprived of their primary food source, decaying wood.

Human habitats are ideal for termites. Not only do they provide the cellulose needed for food, but also the temperatures beside and underneath the building allow year-round activity by the colony. It does not take much wood to attract a mated pair of termites to set up housekeeping; a piece of a discarded 2x4 in a front porch void will do it. Of course, once that food source is exhausted, termites will move on through cracks in the foundation to find another food source, usually in the interior of the house.

1. DAMAGE

The damage done to wooden structures may take years to reach the point when any evidence is visible. Often the area of damage is inaccessible, such as behind basement walls, in crawl spaces, or where floor joists meet the wall studs. Termites preferentially eat the softer portions (the spring

sapwood) of beams, joists, studs, door jambs, window sills, or wood panelling, leaving behind enough the of the harder summer sapwood to keep the structure intact (Fig. 2-4).

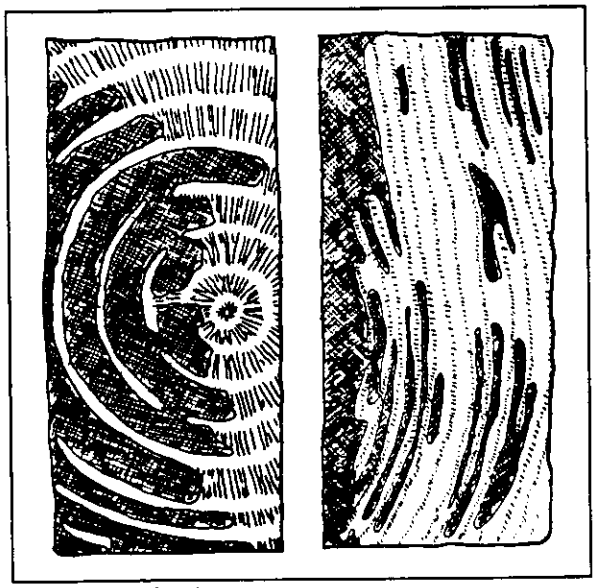


Figure 2-4

They will also eat through plastic sheathing, foam insulation, and any other soft obstacles on their path to their foraging sites. If there is moisture in the wood, the destructive process is accelerated by fungi which are carried on termites' bodies. Their activities also tend to increase the moisture content in the wood they forage in. Termites deposit their frass (droppings) inside the galleries or use it together with earth and decayed wood to construct mud tubes. The mixture of feces, frass, and decaying wood give the galleries a dirty appearance. Over a period of years, the wood may become so thin that literally only paint is holding it together and just touching it can cause the wood to give way. Ultimately, the building may become structurally unsound, and major supporting members may require replacement.

SECTION D FORMOSAN SUBTERRANEAN TERMITES

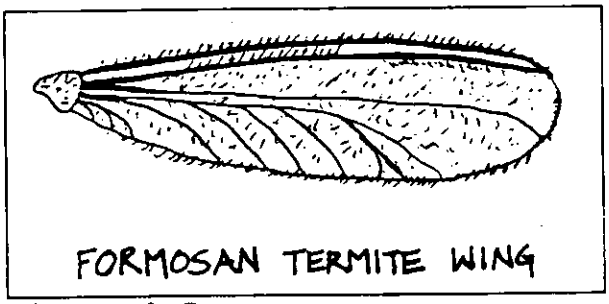


Figure 2-5

The territory of these potentially very destructive termites includes the Pacific territories, Hawaii, California, Texas, Louisiana, South Carolina, and Florida. Their caste system and general biology are similar to the eastern subterranean termite's, but they are much more aggressive, develop more rapidly than our native species, and quickly exploit new food sources. They are also somewhat larger than eastern subterranean termites (swarmers are about 5/8-inch long), yellowish- brown in color, and have hairy wings (Fig. 2-5). They swarm between dusk and midnight instead of during the day.

Formosan termites also build mud tubes to protect themselves and interconnect food sources and nests. They attack wood in buildings, underground electrical and telephone cables, and over 50 species of trees and shrubs, and can kill a tree by girdling the trunk. Formosan termites have the unique ability to form aerial colonies, for instance when wood containing high moisture is exposed. Their nests are made of a durable, hard, sponge-like material called carton, composed of chewed wood, feces, saliva, and soil, and

may either be underground or above ground in voids or walls of structures. Their galleries are much cleaner of debris than those of the eastern subterranean termite. Aerial colonies are formed when:

- The primary king and queen find a suitable aerial location;
- A colony finds a more suitable setting above ground and moves the king and queen; and
- Part of the colony is cut off from the ground.

From a control standpoint, it is more tolerant of insecticides applied to soil than are our native species.

SECTION E DRYWOOD TERMITES

Drywood termites live in wood that is extremely to moderately dry. They require as little as 3% wood moisture and no contact with the earth to survive. Their castes and general biology are also similar to subterranean termites, although the colonies are smaller, usually on the order of a few thousand individuals. They can occupy relatively small structures, and are often introduced with furniture, dimensional lumber, sash and door frames, firewood, fiber boards, or other cellulose-containing products.

DRYWOOD TERMITE FECAL PELLETS

Figure 2-6

The swarmers usually fly at night, but not far (a few hundred yards or less). They gain entry into buildings through ventilation ducts to crawl spaces or attics, or small cracks in the walls, and begin tunneling. No earthen tubes are constructed, so often the first evidence of their infestations are sand-like masses of six-sided fecal pellets about 1/25-inch long, which are kicked out of galleries through round holes (Fig. 2-6). The pellets may accumulate in spider webs or on surfaces below the infestation. Unlike those of subterranean termites, their galleries often go across the grain, leaving larger, more interconnected galleries. Drywood termite damage may be hidden from sight by a thin veneer-like layer of surface wood.

SECTION F DAMPWOOD TERMITES

This group is similar to the subterranean termites in terms of castes and general biology, but seldom lives in soil without wood present. Some species belong to the drywood termite family, but require more moisture than drywood termites, although not so much as subterranean termites. They nest in decayed, moist wood, and do not construct tubes, which limits the extent of their infestations. In some cases they may extend their galleries into relatively dry wood. The winged reproductives may establish colonies

directly in wood, usually near already established colonies. Once a colony becomes established, the workers can move long distances through wood, but generally do not forage outside of it.

The workers and soldiers of the Pacific Coast species are large (9/16-inch to 3/4-inch long), and the swarmers are up to an inch long in some parts of their range. The dampwood termites of the southwestern states are brown and only 1/2-inch long (including wings). They are most common in late summer and early fall. The swarmers (usually dark brown) become active in late afternoon. Dampwood termites penetrate moist wood just under or near the surface of ground. Thereafter, the colony remains in the ground. Since shelter tubes are not built, their distribution above ground is limited.

Dampwood termites of Florida and the Caribbean belong to the same family as the subterranean termites, which they closely resemble, although they are slightly larger. They often swarm in the winter months. Damage done by dampwood termites varies according to species and locale, although it is less than that caused by subterranean and drywood termites. If the wood is relatively sound, Pacific Coast species will attack just the softer sapwood, as do the subterranean species. However, if the wood is decayed, they will excavate both hard and soft sapwood. Small exit holes are sometimes found between the galleries and the wood surface. In the Southwest, dampwood termites most often damage buildings having crawl-spaces. The Florida species only attack severely decayed wood, so the damage created is of secondary importance to the wood decay itself.

SECTION G INSPECTION AND MONITORING

1. FOUNDATIONS

In order to inspect and monitor for termites, it is important to understand the structural defects that permit termite infestation. For subterranean and dampwood termites, the most common routes of infestation are the basement or ground floors of structures, such as:

- Poured-concrete foundations,
- Vertical void concrete-masonry-block foundations,
- Brick foundations,
- Stone and rubble foundations.

Except for poured-concrete basements, the floor slab is usually supported by footings beneath and at the perimeter, and walls rest on top of the slab. There is usually a gravel bed under the slab. Caps at the tops of foundations can be:

- Solid block caps,
- Poured-concrete caps,
- Top course of hollow blocks filled with concrete, and
- Brick caps.

Sometimes, instead of bearing on a thickened slab, a post or stair penetrates the floor slab, bearing on a footing below. Wherever there is a joint between the wall and floor, or the wall and cap, there is opportunity for cracks to develop and become entry points for termites (Fig. 2-7). Similarly, cracks in the wall, mortar between blocks, bricks, or masonry provide entry points for termites (Fig. 2-8).

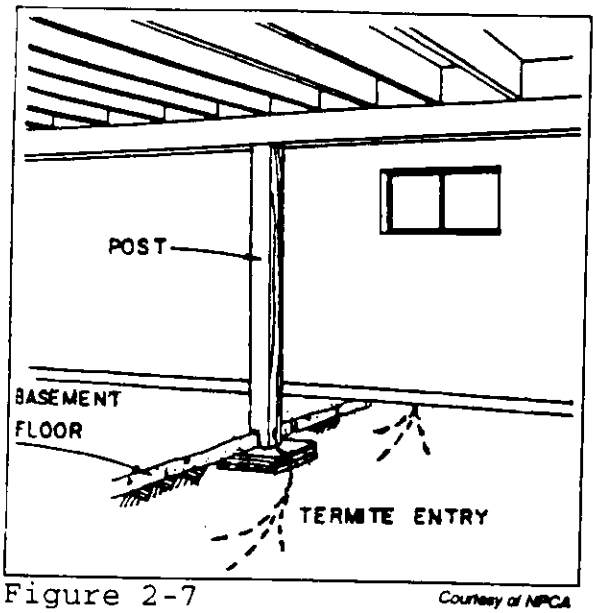


Figure 2-7 Courtesy of NPCA

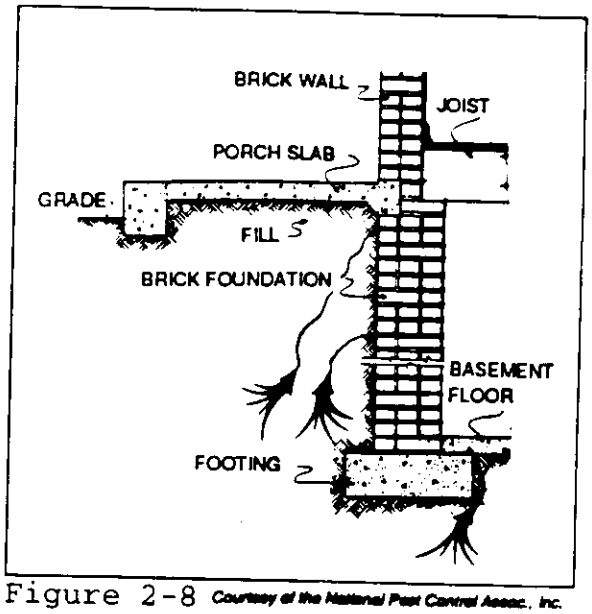


Figure 2-8 Courtesy of the National Pest Control Assoc., Inc. (NPCA)

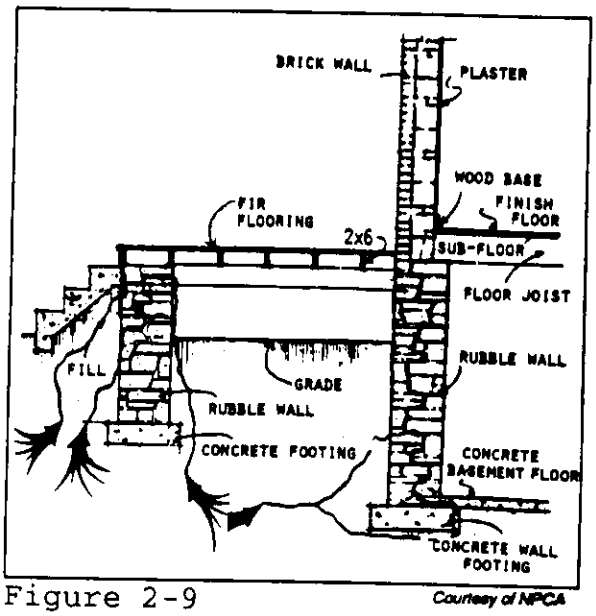


Figure 2-9 Courtesy of NPCA

Faults in blocks may also provide access for termites to the joists. Poured-concrete walls and piers, brick, hollow block, masonry walls, or wooden piers, are all used in crawl-space type buildings. Piers constructed of poured concrete, concrete blocks, bricks or treated wood provide support for the overlaying floor joists. Termite access is through cracks or voids that occur. Access through piers or directly from the crawl space itself are easy portals of termite entry, since the distance is short and mud tubes may escape notice (Fig. 2-9).

Slab-on-grade construction has become very common in the last 30 years. The best type from a termite-protection standpoint is a monolithic slab, consisting of a solid, unitized slab and footing (Fig. 2-10, next page). The supported slab (Fig. 2-11, next page) is tied at its ends to the foundation wall. The floating slab type "floats" over a gravel layer, and is structurally independent from the foundation wall (Fig. 2-12, next page).

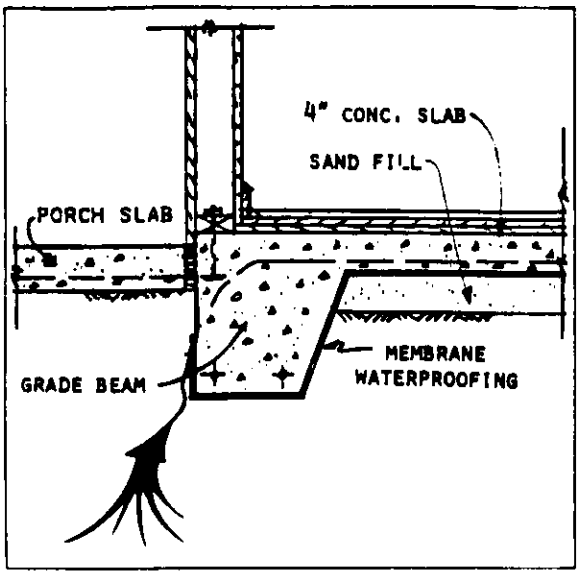


Figure 2-10 Courtesy of NPCA

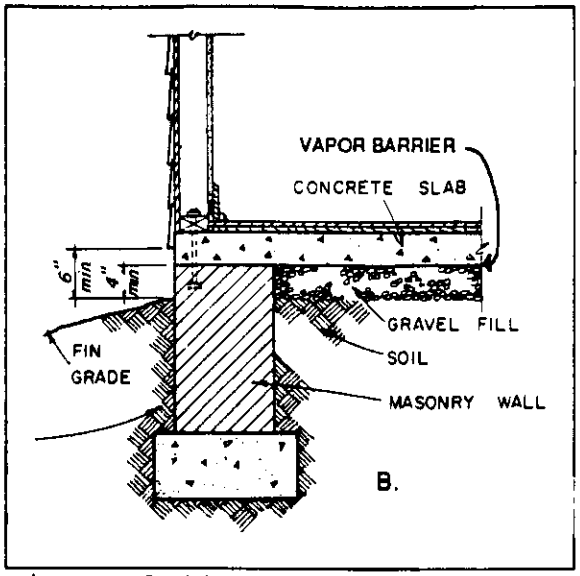


Figure 2-11 Courtesy of NPCA

All three types of slab provide access for termites once cracks develop in the slab or foundation wall. This is most likely to occur at the expansion joint of the floating slab. Once in the building, termites have ready access to the wooden studs, joists, floor sheathing, and finished interior wood.

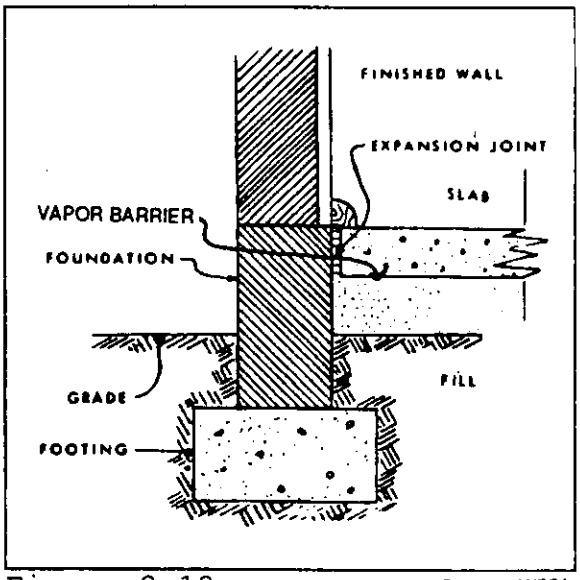


Figure 2-12 Courtesy of NPCA

2. SITE HISTORY

The pest manager should be familiar with the history of the site. Developments that were once heavily wooded areas, particularly with softwood trees, often have dense populations of termites. Sources of moisture in developments may also attract termites. Utility pipes and electrical conduits that run under a structure or up from the ground are natural paths for termites to invade, and should be checked carefully for mud tubes.

3. TOOLS

The tools of inspection are a flashlight, awl or ice pick, small hammer, moisture meter, hacksaw blade, measuring tape, a stethoscope or other sound-listening device, and graph paper to diagram termite entry points and damage. In addition, an inspector needs coveralls and a bump hat to get safely into tight areas under the structure.

4. THE INSPECTION

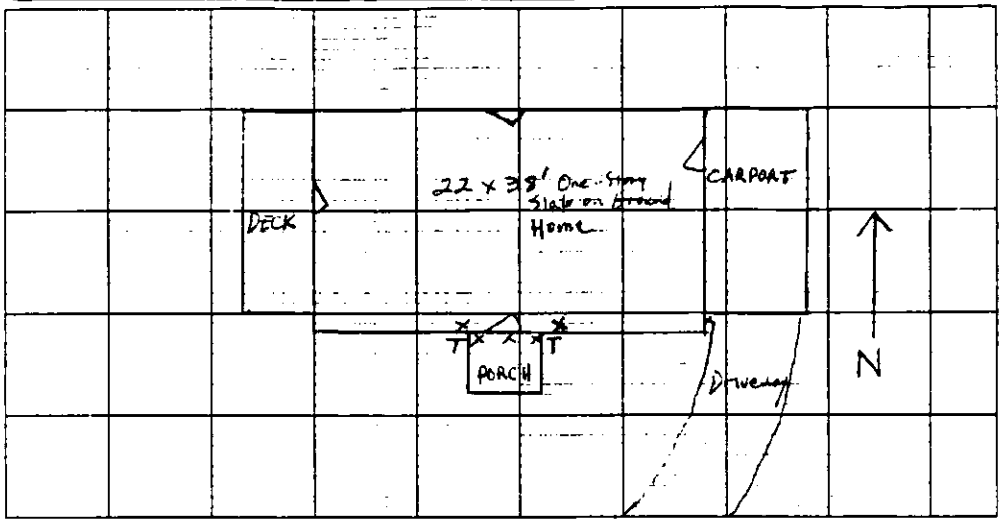
Before starting the inspection, always interview the residents, who often they have some knowledge of previous termite problems, where moisture occurs, and possible hidden joints or voids. Next, size up the exterior of the structure and draw a diagram on graph paper (Fig. 2-13), noting dimensions, grading, drainage, carports, garages, decks, any structural wood in contact with soil, and location of wood piles. The graph should account for hidden joints, voids in porches, and moisture-laden areas.

Note any exterior wood that shows excessive moisture or decay, and give that area a close look when surveying the inside. Also, observe any possible roof-leak problems, either under the shingles, around chimneys, or toward the structure near downspouts. Blistered paint, insect or woodpecker attack areas, and evidence of insect exit holes, feces, or sawdust are additional points of concern. Outside, in areas where there are planters or earth-filled porches, use a hacksaw blade to insert under window and door sills. The blade should not penetrate beyond the sills or headers.

In the interior, examine every room systematically. Look for possible signs of decay, damage, and moisture in all wooden structures. For example, if there is a drip or leak under the sink, fill up the sink and examine underneath after it empties to see if water appears at the bottom of cabinet. If water is leaking from any area, "sound" (tap and listen for a hollow sound) the nearby wood with a hammer, then look for possible mud tubes on adjacent water pipes. In walking through a residence, notice whether or not floors seem to sag or buckle in places; sagging members may indicate termite damage. Similarly, water stains, buckling paint, or bulging plaster are indicative of moisture-laden areas which need further scrutiny. There may be stained walls where Formosan termites have deposited mud on the interiors of walls. Sound baseboards as well—these are primary areas of attack. Examine cracks occurring around door or window frames since these may be portals of entry for drywood termites.

AAAA Termite Company
4 Greenback Way
Woodstock, MD

OWNER: T.J. Wood | OCCUPANT: Same | DATE: July 4, 1994
TREATING ADDRESS: 2 Ivywood Drive | CITY: Woodstock | STATE: MD | ZIP CODE: 22222
BUSINESS PHONE: 111-1111 | HOME PHONE: 999 999-9999 | ACCOUNT #: 00001-94



BASED ON CAREFUL VISUAL INSPECTION OF THE READILY ACCESSIBLE AREAS OF THE PROPERTY:

☐ A. Visible evidence of wood destroying insect infestation was observed. No control measures were performed. Evidence observed: _____

☐ B. No visible evidence of infestation from wood destroying insects was observed.

☒ C. Visible evidence of infestation was noted; proper control measures were performed. Insects or infestation observed:
Termites active in porch support posts, wood paneling next to door. Mud tubes on concrete porch

☐ D. Visible damage due to _____ has been observed in the following areas. (including, but not limited to)

☐ E. Visible evidence of previous treatment

DAMAGE OBSERVED ABOVE, IF ANY: *(Check One)*

☒ A. Will be/has been corrected by this company.
☐ B. Will not be corrected by this company.
☐ C. Recommend that damage be evaluated by a qualified building expert and repairs be made, if necessary.

ADDITIONAL COMMENTS *(If necessary, continue on reverse.)*
Shrubbery cut back to observe front of house. Excessive moisture due to heavy mulch present. Gravel driveway

OBSTRUCTIONS AND/OR INACCESSIBLE AREAS OBSERVED

BASEMENT	N/A
CRAWL	N/A
MAIN LEVEL(S)	Floor covering (carpet) replaced
ATTIC	Not observed
EXTERIOR	Dense shrubbery
ATTACHED GARAGE/PORCH	Firewood present

1. JOISTS HIDDEN: (a) suspended ceiling, (b) fixed ceiling, (c) insulation, (d) floor over joists, (e) ducts.
2. WALL COVERINGS: (a) paneling, (b) dry wall, (c) plaster, (d) tile, (e) cabinets, (f) shelving, (g) wallpaper.
3. FLOOR COVERINGS: (a) tile, (b) carpet, (c) linoleum, (d) built-ins
4. PERSONAL POSSESSIONS: (a) stored material, (b) boxes, (c) pictures, (d) clothing, (e) furniture, (f) appliances
5. RAFTERS HIDDEN: (a) suspended ceiling, (b) fixed ceiling, (c) insulation
6. RAISED FLOORING: (a) flooring elevated with sleepers beneath
7. EXTERIOR: (a) dense shrubbery, (b) siding, (c) window well covers, (d) planters.
8. PORCH: (a) no access or entry beneath floor surface, (d) debris.
9. ADD'L ITEMS: (a) standing water, (b) debris, (c) firewood, (d) no access or entry, (e) absence or safe or stable access

DIRECTIONS
Treated entire perimeter of house at 12" intervals with rods. Also, rodded perimeter of house on interior by drilling through slab at 12" intervals. Drilled through and treated concrete porch slab underneath. Used Dragnet TC, 84 gallons.

KEYS: AI = ACTIVE INFESTATION; O = OHB; T = TERMITES; P = PPB; M = MOISTURE; PR = PRIOR REPAIRS; PT = PRIOR TREATMENT; X = DAMAGE; CA = CARPENTER ANTS; CB = CARPENTER BEES; PI = PRIOR INFESTATION

INFESTED AREAS	TYPE	LOCATION	INFESTED AREAS	TYPE	LOCATION
SILL PLATE	X	Front door	SIDING		
JOISTS			SOFFETS		
SUB FLOOR			CEILINGS		
WALLS			LINTELS		
STUDS			STAIRS/STEPS		
FINISHED FLOOR			SUB ROOF		
TRIM	X	Front door	RAFTERS		
DOOR FRAMES	X	Front door	SHEATHING		
WINDOW FRAMES			LEDGERBOARD		
SHELVING			BASEBOARD	X	Around door
ATTIC			POST OR COLUMN	AI	Porch
BAND BOARD			OTHER Plumbing	X	Under sink

AUTHORIZED SIGNATURE | PURCHASER/OWNER SIGNATURE

Figure 2-13

In the basement, carefully examine areas around the base of stairs, and columns which may extend through the floor slab. Also, examine the floor joists where they meet the basement wall for signs of sawdust, feces, and spider webs; their presence usually indicates some insect activity. Probing suspect timbers with an ice pick or sounding, using a small ballpeen hammer, may yield a positive finding. Inspect plumbing accesses throughout the house, as these often will reveal sawdust, mud tubes, or feces if termites are present.

In slab-on-grade construction, look carefully at the expansion joints, even if it means pulling up wall-to-wall carpeting. Although termites rarely occur in the attic (except for drywood termites), inspect bracing and rafters carefully for evidence of damage or mud tubes. Note any unseen areas in the report. Pay particular attention to evidence of leaking water, especially around chimneys, vent pipes, and sheathing on eaves.

Carefully inspect every part of the crawlspace by using a flashlight, since it is a likely area for hidden mud tubes or dampwood termites because of the proximity of ground and the first floor wood substructure. Also check the storage sheds and garage which usually give termites easy access to the house, if attached or nearby. Finally, review carefully any unseen areas and voids, and record this data in the inspection graph.

Regardless of the type of termite infestation, it is imperative to describe as thoroughly as possible its origin as well as its extent. In addition to the graph, a descriptive report needs to be prepared for future reference, whether or not there is an actual infestation.

SECTION H PREVENTIVE MEASURES

The implementation of preventive measures discussed here can minimize costly repairs of termite damage.

1. SUBTERRANEAN AND DAMPWOOD TERMITES

Dampwood and subterranean termites cannot thrive without ample moisture in the wood of structures, in the adjoining soil, or both. Therefore, repairing defects and correcting patterns that allow water or excess moisture into any part of the house will help minimize termite damage. For example, if the ground slopes toward a structure, it should be regraded to redirect the runoff away from the structure. It is also necessary to ensure that water from roof, downspouts, porches, driveways, patios, and slabs runs away from the structure, and that leaky drains, baths, toilets, and plumbing are repaired inside the residence. If crawl spaces have no ventilation, installation of vents will prevent moisture accumulation. Gutters should be clear of debris so that water does not pour over their tops during rain storms. Roof flashings must not allow water to flow under the membranes and shingles. Flashing

around chimneys and vents should be tight and sealed so that water cannot run down into the structure. Damp tree branches close to the structure should be cut back.

It is also necessary to remove wood debris from under the building or near the foundation, firewood that is closer than 6 inches to the building, and wooden planters next to the building. Modify untreated wooden structural members so that they are more than 18 inches away from the soil. This may involve regrading if siding or joists are too close to the soil, or installing a metal termite shields or a concrete barrier beneath the wood. If decay is evident but slight, treat unpainted wood with a suitable wood preservative (see Section J). Paint exposed untreated wood. Replace supporting posts, stairs, and fences made of untreated wood with pressure-treated wood (see Section J). Caulk areas where moisture can enter around windows, door frames, or sills.

Foam insulation has become a problem in recent years since while termites cannot digest foam, they easily tunnel through it to reach wood. Where foam insulation is in close contact with the ground, it might mask termite tunnels and hide structural damage. Therefore, it is essential to ensure that it does not extend closer than 18 inches from the soil. Even with this precaution, most termite-control companies will not guarantee against termite infestation if a building has foam insulation, because of the high risk that infestation will go undetected.

2. DRYWOOD TERMITE INFESTATIONS

No single measure can prevent the possibility of drywood termite attack; however, several measures can be taken that can reduce the threat. Sanitation is critical to successful prevention. It is also important to avoid importing drywood termites on furniture, crates, and cellulose building materials. Remove stored lumber, firewood, and dead branches nearby, since these are ready sources of drywood termites. Exclusion of swarmers by screening ventilation portals to the attic or crawl spaces used to be recommended, but such screening often becomes clogged with debris and cobwebs, leading to moisture problems. Painting or preserving untreated wood and caulking cracks between wooden joints in siding or around windows and doors yields better results. Chemical treatment of wood with boric acid derivatives is an effective barrier to attack, although in high-risk areas it is probably better to use pressure-treated wood for framing subflooring, exterior doors,

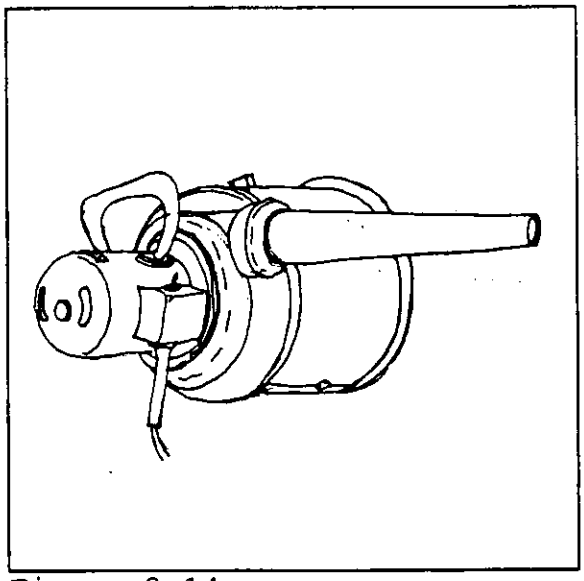


Figure 2-14

windows, and trim. In recent years, prevention of drywood termites by applying fluoridated silica gel dusts to attics, wall voids, and crawl spaces has proven effective. The dust is applied at the rate 1 pound per 1,000 square feet using an electric dust blower, and even a thin film of dust is effective for the life of the building (Fig. 2-14, previous page). It has the added benefit of being lethal to other pests, particularly cockroaches.

SECTION I CHEMICAL PREVENTIVE BARRIERS

Since few buildings are termite-proof, a preventive chemical-barrier treatment around buildings located in high risk infestation areas is an excellent precaution. Preconstruction treatment of structural wood can be accomplished with a dip-diffusion method, using a 10% disodium octaborate tetrahydrate solution. Such "Timborized" lumber is available in many areas commercially. Additionally, sodium-borate solutions can be applied to exposed structural wood during construction ("dry in" stage) or after construction is completed, which is also suitable for all wood not in contact with the ground and not exposed to rain. Applications can be made to wood in attics, walls, around windows, floors and subfloors, joists, and sill plates.

Sodium-borate solutions penetrate into the wood, treating more than just the surface, and protect and preserve the wood permanently. Sodium borate functions as a slow-acting stomach poison in insects and decay fungi. Termites accumulate the active ingredients while they feed. These slow-acting poisons allow the termites to move throughout the colony to spread the insecticide by the feeding of nymphs, soldiers, and reproductives. Sodium-borate solutions can be brushed or sprayed onto bare wood or drilled and pressure treated into known infestations.

A soil pre-treatment performed during construction provides the most effective barrier. The principle is to provide a pesticidal barrier in the soil that will be in contact with the foundation. For basement construction, after excavating the building site and putting down the gravel or dirt fill, treat the soil in the whole area with a power spray under low pressure. Upon completion of foundation walls, treat the soil in a trench on the inside of the wall. After grading is complete, treat the soil in a trench along the exterior of the wall. Treat any voids in concrete masonry blocks with the chemical. Finally, treat fill dirt where porch or attached garage or carport pads will be poured, at the rate recommended on the label of the termiticide container. Before pouring concrete slabs, a moisture barrier of polyethylene sheeting should be in place.

For slab-on-grade construction, the procedure is basically the same, except that less pesticide will be needed along the outside walls, since the depth from grade to footing is generally 2-3 feet or less. Treat wherever utility chases enter the slab at the labeled rate. In crawl-spaces, apply the pesticide in a trench along inside walls and partitions, around utility entrances, and around piers (Fig. 2-15, next page). Soil-treatment termiticides must be applied in strict accordance with the recommended rates of the manufacturer, which are shown on the container label.

REMINDER: Due to the sensitivity of chemical treatment, it is strongly recommended that such work be contracted out to a licensed professional termite-control contractor.

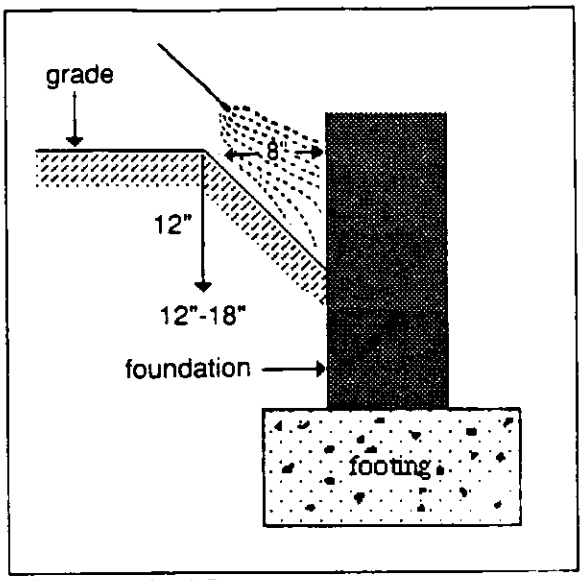


Figure 2-15 Courtesy of NPCA

1. POST-CONSTRUCTION TREATMENTS FOR SUBTERRANEAN TERMITES

If a residence has had termites in the past, or if there are conditions conducive to termites (evidence of infested wood around the foundation and cracks in the foundation or porch voids), it is reasonable to assume that a chemical barrier is necessary to protect against future infestation. When an infestation occurs, the *entire* barrier requires reestablishment. Treating just the area of infestation often fails to prevent termite entry, and results in costly callbacks.

Unpainted or unsealed termite-infested wood can be remedied by painting (brushing) or spraying sodium-borate solution on it. At the same time, eliminate moisture problems that may have led to and sustained the moisture needs of the colony. Wood with known infestations or galleries should be drilled and pressure-injected wherever possible.

In buildings with basements, the typical treatment includes long-rodding (36-inch long injection rod) to inject pesticide along the wall perimeter (Fig. 2-16). A tentative guide for spacing injection rods may be every 12 inches in loam soil, every 6 inches in clay soil, and every 18 inches in sandy soil.

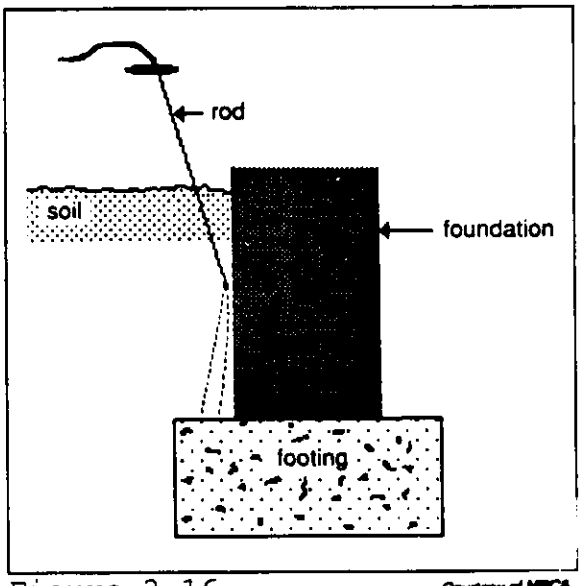


Figure 2-16 Courtesy of NPCA

Since significant portions of all breaches in chemical barriers occur at porch stoops containing voids, a recommendation is to drill through to the voids on each side of the porch, and inject the pesticide (Fig. 2-17, next page).

In basements having other than a monolithic slab, drill through the slab next to the expansion joint along the walls, and inject. In areas with low-lying decks, short-rodding may be needed to get into the foundation area. If there is a fireplace, apply

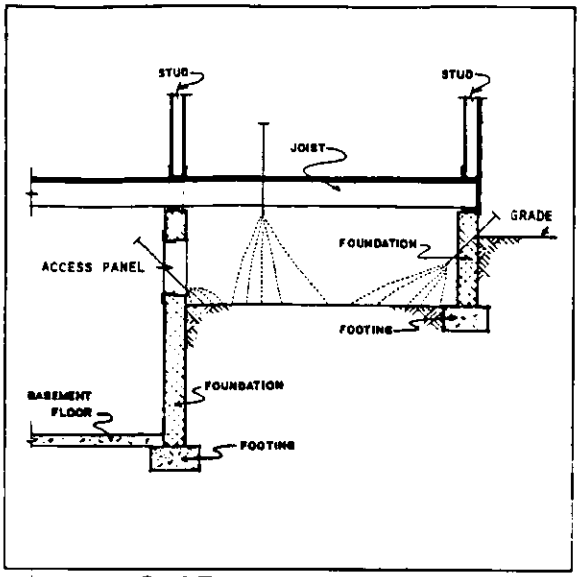


Figure 2-17 Courtesy of NPCA

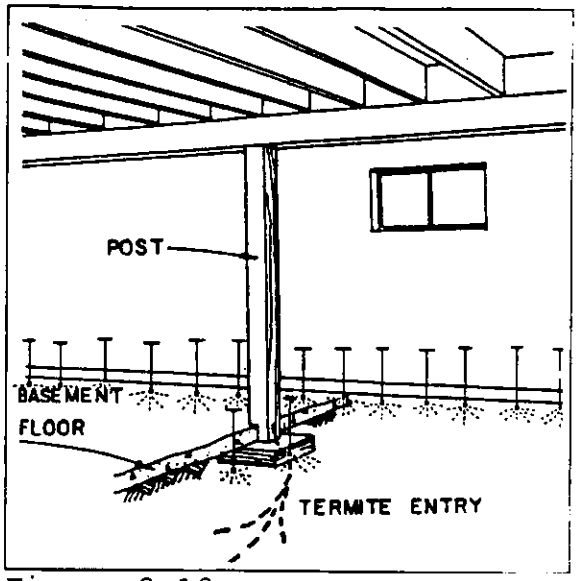


Figure 2-18 Courtesy of NPCA

pesticide to its base area, as low as possible. Drill and inject adjacent to any utility line or structure extending through the basement floor (Fig. 2-18).

Slab construction requires that pesticide not only provide a barrier around the outside, but also underneath the slab, so that any possible cracks are protected. Special formulations (see Section J) may be needed to get pesticide all the way under slabs. Also, drill through the slab and inject wherever there are expansion joints, including any junction between the slab and the wall (this is unnecessary in monolithic slabs). In crawl-spaces, treatment along walls is the same as for other construction, except there should be rodding around support piers and entryways for utilities.

2. POST-CONSTRUCTION TREATMENTS FOR DAMPWOOD TERMITES

The chemical barrier used for subterranean termites is also effective for dampwood termites. Eliminate excess moisture in wood to prevent attack by dampwood termites.

3. POST-CONSTRUCTION TREATMENTS FOR DRYWOOD TERMITES

The type of treatment required depends largely on the location and extent of infestation. If the infestation is light and accessible, 1/4-inch holes drilled into infested timbers at 12-inch intervals, and insecticidal dust (one ounce of boric acid per 30 holes at a minimum) blown into the holes, would be sufficient. Taking advantage of termites' mutual grooming, this small quantity would exterminate the termites. The holes can also be injected with a residual termiticide (see Section J) combined with a suitable fumigant. After treatment, the holes should be plugged with dowels or corks.

If the infested areas are mainly structural, extensive, and inaccessible, fumigation may be the best treatment. This is an expensive and highly technical procedure that should be undertaken only by licensed fumigators. However, it offers no protection against future infestations. The basic procedure is to wrap the entire building in gas-tight tarps made of nylon, rubber, neoprene, or plastic (Fig. 2-19, next page). Seams between sheets of the tarps are rolled together and joined with metal clamps or heat-sealed. The bottoms of the tarps are anchored to the ground with "sand snakes" (sand-filled canvas bags). It is essential that the entire structure be airtight for fumigation, so careful attention to each detail is necessary. The building is fumigated with sulfuryl fluoride, or other suitable fumigant.

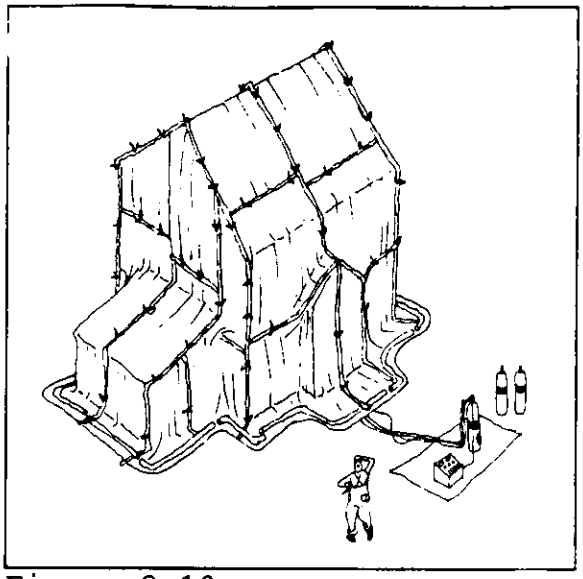


Figure 2-19

The structure must remain closed for a couple of days or so, and monitored with a gas meter (fluoroscope) to assure that adequate concentration is maintained throughout the treatment period. Warning signs should be posted and entrance to the building prohibited until the building is cleared by the fumigators. After fumigation is complete, the tarp is opened and the fumigator monitors the gas concentration until it reaches a safe level. Failure to do so represents a safety hazard.

Infested, stand-alone items such as furniture, construction timbers, or crates can be treated in a fumigation chamber in similar fashion to buildings. Termite experts recommend that, following fumigation, attics and voids be dusted with silica gel to minimize the possibility of reinfestation.

SECTION J CHEMICALS REGISTERED FOR TREATMENT OF TERMITES

CHEMICAL	TYPE	PRIMARY USE	SITES
Boracare (sodium isoborate)	Boric acid derivative	Treatment of infested wood, drywood termites	Unpainted structural timbers
Chlorpyrifos	Residual Organophosphate	Pre-treatment Post-treatment	Soil, inside and outside
Demon (cypermethrin)	Residual synthetic pyrethroid	Pre-treatment Post-treatment	Soil, inside and outside
Dragnet (permethrin)	Residual synthetic pyrethroid	Pre-treatment Post-treatment	Soil, inside and outside
Dri-die (silica gel)	Fluoridated silica dust	Pre-treatment especially for drywood termites	Voids in walls and attics
Ethylene dibromide	Fumigant	Post-treatment of serious infestations above ground	Voids, wood members
Methyl bromide	Fumigant	Post-treatment drywood, Formosan termites	Whole house, wood members above ground
Pentachlorophenol	Wood preservative	Pre-treatment	Unpainted structural members
Tim-bor (disodium octaborate tetrahydrate)	Boron derivative (dust or 10% solution)	Pre-treatment of wood, post-construction treatment of galleries and infested wood	Unpainted wood, injection into galleries, unpainted structural members
Vikane (sulfuryl fluoride)	Fumigant	Post-treatment drywood, Formosan termites	Whole house, wood members above ground

END OF CHAPTER TWO

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT AND RODENT CONTROL

CHAPTER THREE
MANAGEMENT OF OTHER WOOD-DESTROYING INSECTS

SECTION A GENERAL

1. INTRODUCTION

There are several hundred species of beetles, ants, and wasps that attack the wood in human-made structures. However, most of their damage is minor, except that caused by the powderpost beetles, carpenter ants, and old house borers discussed below. For more information on groups not covered here, please refer to Moore's *Wood-Inhabiting Insects in Houses.*

2. POWDERPOST BEETLES

There are several groups of powderpost beetles, and it is critical to know which type of beetle is present in order to determine the necessary control methods, or if control is necessary at all.

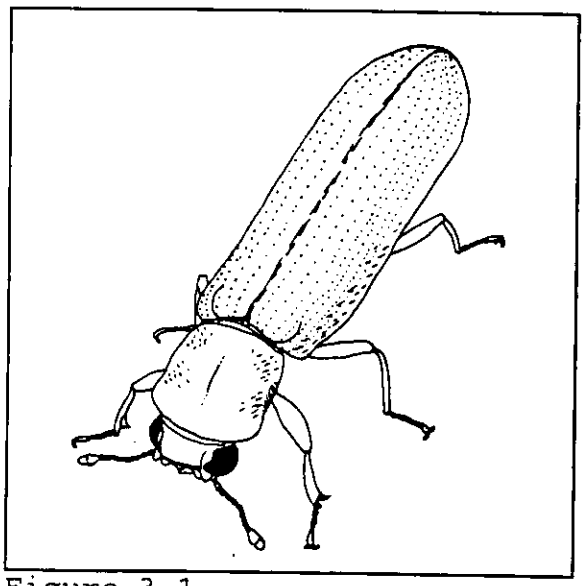


Figure 3-1

The first group is known as **lyctid powderpost beetles**. Lyctids are small, reddish-brown to black beetles about 1/8 to 1/4-inch long (Fig. 3-1), whose life cycle is a year or less, and takes place entirely within the wood, except for mating. They only attack the sapwood of hardwoods with large pores, such as oak, hickory, ash, walnut, pecan, and many tropical hardwoods. Since they attack both new and seasoned wood, they may infest structural members and panelling, furniture, and flooring.

Their damage appears when larvae construct numerous galleries, about 1/16-inch in diameter, throughout the wood. Exit holes 1/32 to 1/16-inch in diameter on the wood surface (made as newly emerged adult beetles escape from the wood), coupled with fine sawdust-like frass, may be the only evidence that lyctid beetles are at work. The frass may collect below the infested wood on spider webs, or it may fall out when the wood is lightly tapped. The interior of wood may be so riddled with galleries that the remaining structure is only a

veneer of surface wood. Replacement or removal of panels may be the best method if the infestation is not structural. However, if structural members are involved, the treatment depends on the extent of the infestation. If only exposed timbers are involved, an insecticidal spray may be the best treatment. But if the extent of the infestation is uncertain, one should carefully examine and probe-delineate the infested wood before treatment.

Anobiid beetles, also known as "death-watch" or "furniture beetles," belong to the powderpost beetle group. The adult beetles are 1/8 to 1/4-inch in length and reddish-brown to black in color. However, adults are rarely seen, and it is the fine frass, pellets, and exit holes (1/16 to 1/8-inch in diameter) which indicate their presence. Their damage includes boring in the sapwood of both hardwoods and softwoods, and reinfestation of seasoned wood if conditions are favorable. Attacks often begin in attics or in poorly ventilated crawl spaces, then spread to other parts of the house.

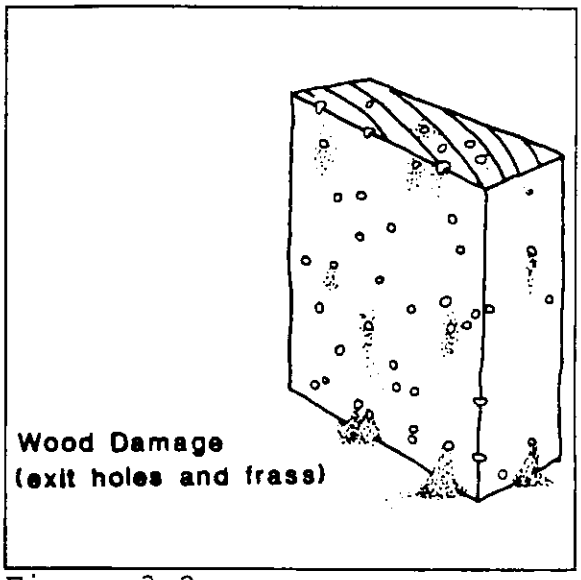


Figure 3-2

If the frass is yellowed or partially caked on the surface where it lies, the infestation is probably old or already controlled. It may take ten years or more for infestations to become significant enough to be noticed. At this point, both large numbers of exit holes and large quantities of whitish frass are observable (Fig. 3-2). Once the infestation is noticed, control, as with lyctids, depends on the extent of the infestation. The options are essentially identical to those listed for control of lyctid beetles.

3. BOSTRICHID (FALSE) POWDERPOST BEETLES

The size of various species ranges from 1/4-inch (most common species) to 2 inches (uncommon species). All of the species are elongate, cylindrical, compact beetles with a flat-headed appearance in profile. The whitish larvae are similar to other powderpost beetle larvae. Their life cycle is relatively short (about a year). There are several species in this group. Among the well-known species are the bamboo borer, the red-shouldered shot-hole borer, the oriental wood borer, the black polycaon, and the lead cable borer. Some of the species are pests of stored products such as grains.

Although this group reinfests wood, it rarely does severe economic damage. Most damage noticed in construction timbers occurs before curing, while moisture content of the wood is high. An exception is bamboo and weakened (from moisture or other damage) structural timber, in which considerable

damage may occur. The appearance of frass is similar to that of lyctids, except that it often forms small cakes or clumps. However, unlike the lyctid powderpost beetles, exit holes are free of frass and are 1/32 to 3/8-inch in diameter, depending upon species.

4. OLD HOUSE BORER

This pest, a native of northern Africa, spread to the US through Europe, and is now ranked second to termites as a pest of seasoned wood in structures. Its distribution is primarily along the east coast, with occasional findings in other states east of the Mississippi River. The old house borer, *Hylotrupes bajulus*, is a large brownish-black, slightly flattened long-horned beetle (Fig. 3-3) that ranges from 5/8 to 1 inch in length and has two prominent bumps on the prothorax. The larva is also large (up to 1-1/4 inches long), and residents may hear their gnawing sounds (clicking). Unfortunately, evidence of their presence, bulging of the surface wood, only occurs when larvae are near maturity. Eggs are placed in small cracks or in the joints between floor joists and other structures.

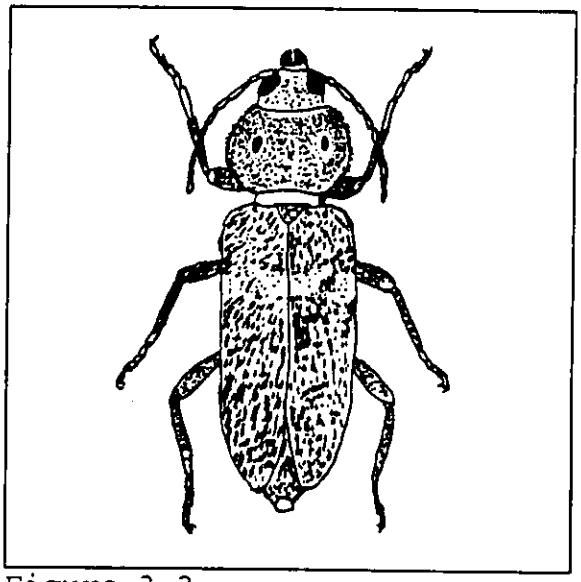


Figure 3-3

Figure 3-4

Their life cycle in the northeastern states may be more than six to eight years, while in the southeast it is only three to five years. Adults may remain in galleries for up to ten months before emerging, but when they do, usually in June or July, they live just weeks before they mate, lay eggs, and die.

The old house borer usually occurs in new, not old wood, as the name implies. However, it usually escapes notice until years after the completion of the structure. Infestation by a second generation of borers occurs rarely in well-ventilated, centrally heated structures. When such reinfestation occurs, there may be overlapping generations of borers in the structure for many years.

Favorite attack sites include attic framing, floor joists, and wood studs. The larvae may reduce the

sapwood area of these timbers to mere powdery frass, but fortunately the damage is localized. The fecal pellets are rod-like and crumble easily. The most characteristic feature of infestation is the damage, which is striking because of the size (up to 3/8-inch in diameter), shape (oval), and rippled appearance in the galleries (Fig. 3-4, previous page). Just prior to emergence, larvae may create bulging in the wood. Exit holes are also oval in shape and surrounded by frass and feces.

5. MISCELLANEOUS BORERS

There are many other borers that live in wood, although most do not survive to reinfest seasoned wood. One of the exceptions is the flat oak borer (*Smodicum cucujiforme*). This species infests seasoned dry oak heartwood from New York to Florida and west to Texas. Adults are medium sized (5/16 to 7/16-inch long), brownish, elongated, and slightly flattened like typical long-horned borers. They have an extended life cycle of one to two years in the south, with longer life cycles in northern regions. In the Gulf Coast states they can cause severe damage to stored lumber.

The appearance of other long-horned beetles and metallic wood-boring beetles may cause concern because their iridescence readily attracts attention. These beetles come into the house in already-infested wood, and, once emerged, do not reinfest. Other species that may appear in houses, but do not reinfest seasoned lumber, include the ambrosia beetles and bark beetles. They are brought into the house with firewood and when the bark falls off, their intricately carved galleries become visible.

SECTION B INSPECTION FOR WOOD-BORING BEETLES

Careful inspection is the key to determining what species is causing damage and is worth treating. It is essential to note the appearance of wood, moisture conditions, location of infestation, type of frass, beetles found, fecal pellet presence and appearance, appearance of galleries, and size and shape of exit holes. It is advisable to collect as many specimens as possible and, if necessary, give them to an expert for identification. This means that the HA's pest manager will have to work not only with a flashlight, but also with sample-collection vials, a knife, forceps, and perhaps a hand lens.

SECTION C PREVENTION AND CONTROL MEASURES

Prevention and control require thorough knowledge of beetles, their life cycles, and damage potential, on which a meaningful inspection can be based. Using kiln-dried lumber or pressure-treated wood is one preventive measures. Another is sealing moisture out by painting, and ensuring good ventilation, as most wood-infesting beetles need a 10 to 15 percent moisture content to flourish, depending upon species. Another method for prevention and treatment is pre-treating wood members by painting or spraying wood

with sodium isoborate products. This reduced-risk compound can be applied to wood either before or after installation, so remedial treatment as well as prevention is possible in existing residences. It should be remembered that only currently registered pesticides should be used.

If there is reason to suspect that beetles are present in finish or trim wood to be installed in areas which will be difficult to treat or replace later, heat sterilization or fumigation with pesticides may be advisable. Heat treatment of infested wood requires wood temperatures of 120 degrees F for four hours, or up to 140 degrees F for two hours, with wood temperature measured in the center of the wood member. If bostrichid beetles are involved, the higher temperature should be used. In cases of severe infestation, fumigation, as described in Chapter Two, Section I-3, may be the only option.

SECTION D CARPENTER ANTS

Carpenter ants (*Camponotus spp.*) are social insects which live in small to occasionally large nests. Unlike other ants found in structures, they excavate wood and build nests in it, but they do not eat wood as do termites. They occur throughout the contiguous 48 states and Hawaii, especially in the Pacific Northwest and the northeastern states. Carpenter ants are nocturnal forest-dwelling insects that, in nature, live in dead and rotting logs and trees, under stones, and in leaf litter at elevations up to 9,000 feet. More than fifteen kinds of carpenter ant are serious structural pests in this country, some more common in or restricted to certain geographic areas than others. All carpenter ants show good cold tolerance.

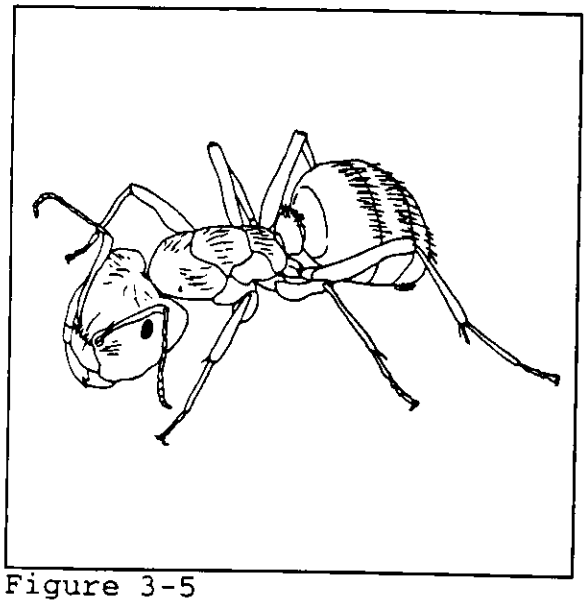


Figure 3-5

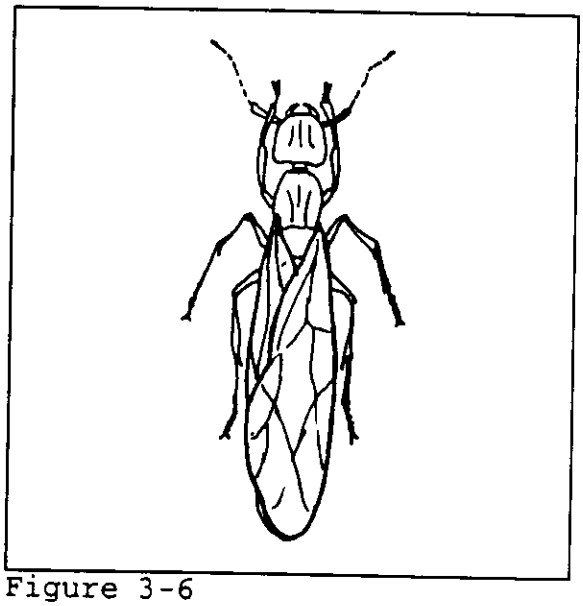


Figure 3-6

Carpenter ant workers are large, 3/16 to 5/8-inch long, and usually black (although not invariably so) and can inflict painful stings. As distinct from most house-infesting ants, the waist between the thorax and abdomen has a single node, and the overall profile is continuous (Fig. 3-5). The queen is up to 9/16-inch in length, and, as with the male, may bear wings during the swarming season (Fig. 3-6). Eggs, larvae, and

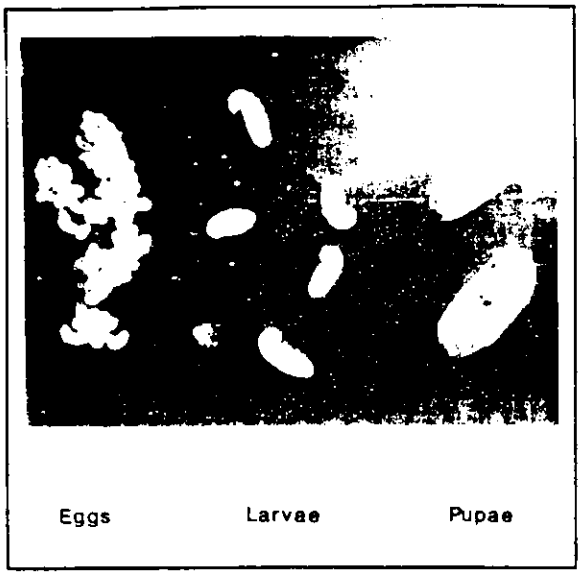


Figure 3-7

pupae occur in the nest (Fig. 3-7).

The larvae are white, legless, and are fed by the workers. Pupae are also white and are often carried about by workers if the colony is disturbed. Adults eat sugar and sometimes proteins found in or around a residence. Adult ants often feed on aphid honeydew found on plants infested with large populations of aphids. Winged adults emerge from about March to July, depending upon location, and establish a nest in moist wood or a cavity adjacent to wood. The colony grows over a three-to-six-year period before it matures; in late fall, winged swarmers appear in the nest, but do not fly and start new colonies until the following spring.

Swarming begins during the first warm or wet days of the year. New housing developments built on cleared woodlots that previously supported carpenter ants are generally the most troubled. Nests are found in water-rotted wood under shower stalls, under leaking roof-valley downspouts, window sills where water accumulates, poorly ventilated areas, and sometimes under insulation in attics. The larger and more long-lived a carpenter ant colony is, the greater is the structural damage.

Outside, carpenter ant workers forage for such foods as honeydew, insects, and ripe fruit juices; ants are not as active during winter. Carpenter ants often move into residences during fall to forage for sweets after plant aphids disappear. Those that have invaded structures seek out sweets, meats, fruit juices, and moist kitchen refuse. Since carpenter ants are usually not very active indoors during winter, a resident's ant complaint during winter is a sure sign of an indoor nest. Carpenter ants usually leave structures for the outside during summer.


Figure 3-8

Carpenter ant nests are galleries that normally run with the grain of sapwood, but unlike termite galleries, have large interconnections, are free of wood shavings, mud, and feces, and appear smooth or sanded (Fig. 3-8).

Wood shavings and frass are thrown out of the nest through slit-like exit holes in the surface. Small piles

of sawdust-like material may build up below tunnels. During summer months, when ants are active at night, chewing sounds are audible. The nest location may not necessarily be in the dwelling; it may be a hundred feet or more away in a stump or decaying log. As with termites, access to buildings is through ground connections, utility wires, or branches touching the building. Since moisture is required to sustain a colony for any length of time, a carpenter ant nest indoors is normally near a moisture-laden area. Indoor nest locations may be in door and window frames, wall voids, roof/ceiling of flat deck porches, and hollow porch columns or behind fascia boards.

Carpenter ants and their relatives are multi-queened and usually excavate wood previously decayed or damaged by other agents. They generally forage in humid atmospheres (under debris, in damp crawl spaces, or in vegetation on building walls) where they find softened wood. Carpenter ants are not thought to be able to start tunnels in wood drier than 15 percent moisture content, and some species require high humidity for the nest.

SECTION E DAMAGE AND PREVENTION AND CONTROL

If undetected for many years, structural damage caused by carpenter ants may be extensive and severe. The damage rarely causes structural failure unless the wood is stressed by strong winds or heavy furniture placed on the infested timber. Prevention methods are similar to those used for termites. They include eliminating moisture sources in the house, breaking connections to the outside, ensuring good ventilation to crawl spaces, sealing all gaps in wood members, removing wood debris from around the house, and using "Timborized" lumber or pressure-treated lumber in areas subject to moisture.

The most difficult part of treatment is locating the nest, which is necessary for elimination. If the nest is outside the house, the structure housing it should either be eliminated or removed. Inside the building, the surface of infested areas may be sprayed with a residual insecticide. In inaccessible areas, wood may require drilling and injection with sodium isoborate, carbaryl, baygon, chlorpyrifos, silica gel, or bendiocarb.

END OF CHAPTER THREE

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT AND RODENT CONTROL

CHAPTER FOUR - ANTS

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

Of the 750 different kinds of ants found in almost every North American habitat, only about 30 species cause problems in dwellings. Because their small size permits ants to enter tiny holes, ant problems may be a common resident's complaint. Since ant-control methods are rather similar for various kinds of ants, this chapter will describe methods for controlling ants frequently found in kitchens, pantries, and food storage areas. Structure-damaging carpenter ants are covered in Chapter Three—Management of other Wood-Destroying Insects.

Most ants swarm once a year, when winged queens and drones leave the nest to initiate new colonies. Winged ants are easily mistaken for termites, especially when they appear in large numbers in a basement or next to the dwelling. The easiest ways to distinguish ants from termites are:

- Ants have a thin or "wasp-like" waist, while termites have straight-sided waists without constriction;
- Ants have elbowed antennae while the antennae of termites are entirely flexible;
- Both winged ants and termites have two pair of wings, but an ant's front pair is wider and longer than the rear pair, while a termite's are long, narrow, and both are the same shape and length.

Ants are attracted to a wide variety of foods, including other insects, seeds, nectar, meat, grease, sugar, and honeydew (a liquid produced by plant-sucking insects). Some ant species seem to wander randomly while others form trails from the colony to a food source. Most ants bite when disturbed and many species sting. They are distinguished by a number of characteristics including size, color, numbers of nodes on the petiole, range within a specific region, food habits, nesting locations, and whether they are trailing species or not. However, because of their similarities and small size, they are not easily identifiable. To best identify ants, collect a few, place them in alcohol, and forward them to a state or university taxonomist.

2. ARGENTINE ANT

The Argentine ant (Fig. 4-1, next page), native to South America, now widely ranges throughout the United States and the world. This highly adaptable ant is the most common of the trailing ant species that invade dwellings in search of foods; its range is only limited by cold. The Argentine ant has one

node on the petiole, a musty odor when crushed, carries no known diseases, and has no public-health importance. It is very aggressive, has no natural enemies, and drives other ants away; it bites but doesn't attack human beings.

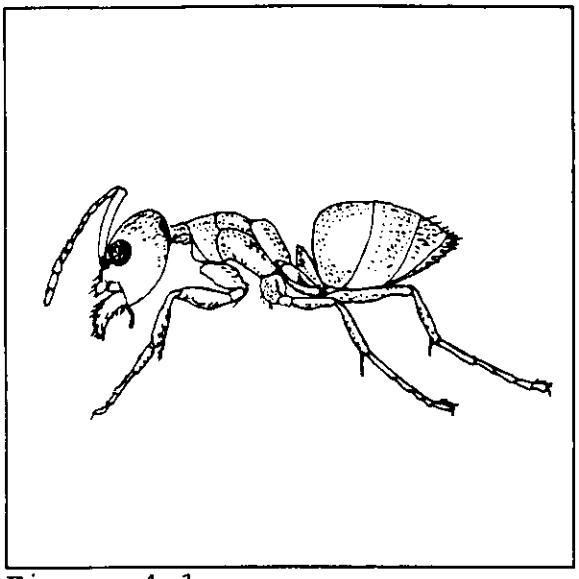


Figure 4-1

Argentine ant nests are usually located in moist areas around refuse piles, under stones or concrete, and in tree holes. In winter, colonies move deep into the soil. Although it seldom nests indoors, nests are sometimes found in buildings near heat sources. This ant is multi-queened, very prolific, and supports large colonies but seldom swarms, because breeding takes place in the nest. The Argentine ant is a major pest in residences, usually seen near baseboards, windows, and water pipes, seeking food or to escape too-wet or too-dry outdoor conditions. It is often found on potted plants because it tends aphids, from which it obtains honeydew. Argentine ants also feed on termites, other ants, fly larvae, and cockroaches. Argentine ant eggs hatch in 28 days, the larval stage lasts 31 days, the pupal stage lasts 15 days, and complete life cycle is 78 days.

3. THIEF ANT

The native thief ant is one of the smallest of ant species, only about 3/32-inch long. It has two nodes on the petiole and is really smooth and shiny, although it appears somewhat hairy. Thief ants resemble pharaoh ants in size and color but they have a two-segmented club on the end of the antennae, while pharaohs have a three-segmented club. Thief ants range from Canada to the Gulf Coast in the eastern and central United States, but are uncommon in the rest of the country (Fig. 4-2).

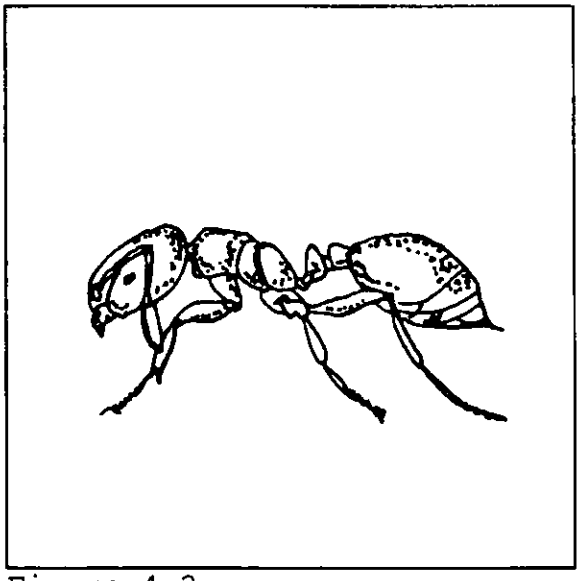


Figure 4-2

This trailing, yellowish to dirty-brown-colored ant usually nests indoors in walls, voids, cracks, and cupboards, and is also found near sinks where it contaminates food and becomes a nuisance. Outdoors, thief ants nest in bare soil, under rocks, logs, or debris, and often near other ant species they prey on. Normally, there is only one queen per

colony, but some colonies are multi-queened. Swarms occur in late spring or early summer.

Their extremely small size permits thief ants to enter containers that other ants cannot, and because of that small size, thief ants may be present in food without being noticed. The thief ant is a persistent nuisance pest which is difficult to control. Although omnivorous (feeding on insect larvae, seeds, and honeydew), it prefers greasy and high-protein foods (meats, cheese, grains, fats, or live and dead insects) but will not eat sugar.

4. PHARAOH ANT

Originally from the African tropics, the pharaoh ant is a trailing species with two nodes on the petiole, twelve segments in the antennae, and a three-segmented antennal club. It's color is yellow-to-red, and is 1/10 to 1/16-inch long. This ant forms extremely large colonies (a million or more workers) and is becoming a dominant indoor pest because of its broad-based diet and habit of colony budding. Infestations may be already established months before being recognized. Pharaohs are one of the few North American ants that are active all year long (Fig. 4-3).

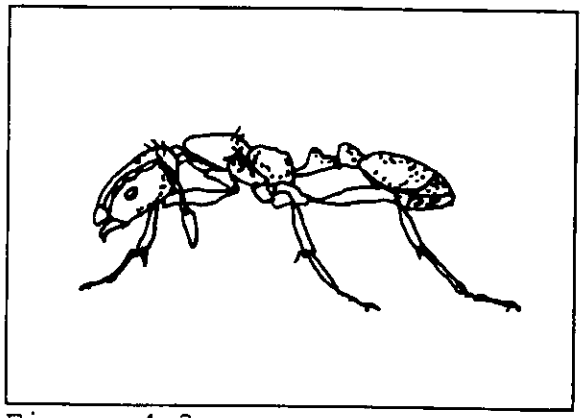


Figure 4-3

The pharaoh ant prefers to nest at temperatures between 80 and 86 degrees F. In the South, it sometimes nests outside, from which base it invades buildings. In the North, pharaoh ants do not nest or survive winter outdoors. Indoors, this is a species commonly transferred between buildings in furniture, food packages, laundry, and other items. Indoor nests may be found by examining areas adjoining heating systems and searching for ant trails near hot-water pipes.

Although pharaoh ants forage on many household foods (they are especially fond of mint-apple jelly), worker ants need protein and carbohydrates (from dead insects, meats, blood, and honey). A constant food source seems important for pharaoh ants, since removing the food source has sometimes caused pharaohs to leave the building. Pharaoh ants penetrate packaged food and may gnaw holes in silk and rubber. Sources of moisture draw foraging ants to kitchen and bathroom faucets, dishwashers, and water coolers.

This ant is extremely difficult to control in residences because colonies tend to multiply (or bud) when treated with chemicals. Since most buildings provide abundant habitat, budding often produces more colonies than the original one that provoked the use of pesticides.

The entire life cycle of workers is complete in 38 to 45 days at room temperature, and life span is about 60 to 70 days. There may be twelve or more pharaoh ant colonies in a building; however, only ten percent of the workers forage for food or water at any given time.

5. PAVEMENT ANT

Pavement ants, originally from Europe and Asia, are distributed mostly in urban areas. They are common along the Atlantic seaboard, less common in the southern states, and uncommon inland except in large cities such as Cincinnati and St. Louis. Pavement ants are rarely found in California. Although this ant does not compete well with native ants in rural areas, its range seems to be increasing.

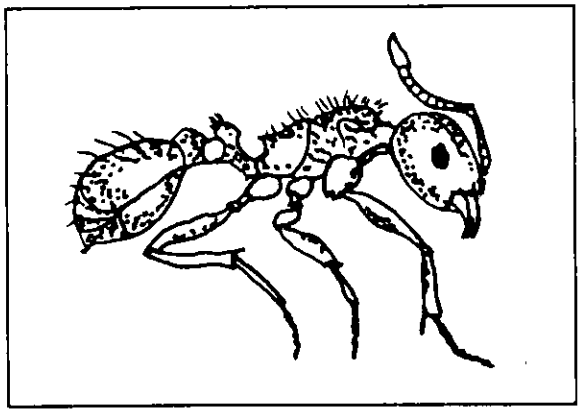


Figure 4-4

The pavement ant (Fig. 4-4) is a small, 1/8-inch long, blackish-brown species with two nodes on the pedicel, a twelve-segmented antennae, a shiny abdomen, dull red-brown head and thorax (caused by minute, but easily visible parallel grooves), and pale legs and antennae. The thorax bears two small spines on the top rear. Most complaints about small ants are caused by annoying pavement ants which invades homes throughout the year, especially during summer, and get into everything from food to shoe polish.

Pavement ants nest outside under rocks, next to pavement edges, and on door stoops and patios, but also establish colonies inside buildings between foundations and sill plates. This species enters homes through heating ducts, cracks in the slab, and other open areas, and nests in wall voids and bath-trap areas.

Pavement ants store debris (such as sand, seed coats, dead insect parts, sawdust from house construction) in the nest, which the workers dump out when the nest needs to be expanded. This material is often seen in small piles on the basement floor (it should not be confused with carpenter ant frass). Pavement ants normally swarm in late-spring, but large swarms may originate inside heated structures at any time of year.

Pavement ants are omnivorous scavengers with few food preferences, but they seek sweet and greasy materials, dead insects, and seeds. Outside, they tend honeydew-producing insects, and are often pests on eggplants, peanuts, and strawberries. Closely related, trailing species are often introduced

via tropical plants into dwellings, where they flourish in warm, moist environments.

6. ODOROUS HOUSE ANT

The odorous house ant (Fig. 4-5) is a trailing, nonstinging, native species that occurs in all 48 continental states from sea level to over 10,000 feet in elevation. It has a single node on the petiole, is brownish to black in color, and 1/8-inch long. Colonies are multi-queened and seldom swarm. Except for the Argentine ants in their primary habitat, the odorous house ant is probably the most common found in North American buildings. It is primarily distinguished from the Argentine ant by a darker color and unpleasant odor when crushed.

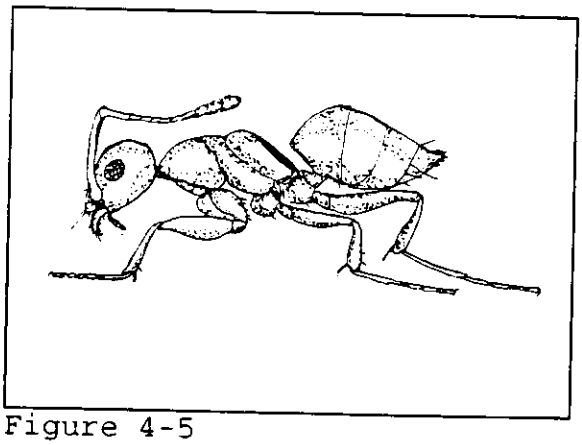


Figure 4-5

Outdoors, odorous house ants tend honeydew-producing insects. Inside, workers prefer sweets but, strangely, sweet baits are seldom effective in control. Although this ant may invade residences at any time of the year, it becomes an indoor pest at the start of the rainy season, when aphids and honeydew are washed down from plants by rain, and then again late in the year when leaves fall.

Odorous house-ant nests outside are usually shallow and located under boards or stone. Indoors, the nests are found in walls, woodwork, under floors (especially around heat sources), and sometimes in old termite tubes. Nesting sites should be treated if controls are to be effective.

SECTION B HAZARDS OF INFESTATION

Regardless of damage, ants are generally considered to be beneficial. Like spiders, ants kill and eat many insects, including flea and fly larvae, bedbugs, and subterranean termites. Ants are important in soil aeration and recycling of dead animal and vegetable materials. However, their control in households is necessary because they contaminate food, damage structures, and some (pharaohs) transmit disease organisms. Several ant species, for instance pavement ants, are annoying because of their painful stings.

1. THIEF ANTS

Thief ants rarely sting human beings and even when they do, due to their small size, the stings are insignificant. Large numbers of thief ants, however, may kill small chickens; further, this ant is an intermediate host for the poultry tapeworm.

2. PHARAOH ANTS

Pharaoh ants prey on bedbugs, and pose significant health threats, especially in hospitals. They may carry more than twelve different pathogenic disease organisms picked up from bedpans, toilets, drains, and washbasins. Once the ants are infected, pathogenic organisms quickly spread through the colony from direct contact as well as through food exchange.

3. PAVEMENT ANTS

Pavement ant workers bite or sting, which cause allergic reactions and rash.

SECTION C INSPECTION AND MONITORING

The basic need in exterior inspections is to find and correct breaches where ants are entering the dwelling from outside, as described in Chapter Five, Section D—Cockroach Controls. The only difference is that ant entry sites are much smaller than those for roaches, and require more care to find holes unless lines of trailing ants can be found. The following are offered to assist in interior ant inspections:

- Study ant trails and identify where they are entering the space. Place bait stations or sticky traps which attract ants, and count their numbers and times when they are at stations. Determine if ants are nesting inside or outside, and what food and water sources are attracting them.
- Inspect flower pots for possible ant nests; inspect under carpet edges, behind baseboards, inside heat registers and ducts, and bath drain-trap areas.
- Find, map, and count nests and use that and other information to select controls.
- Carefully inspect foundations, areas behind insulation, and under grass, mulch, rocks, and logs for possible nest sites and trails.
- Take good notes and use them to plan effective control.

SECTION D ANT CONTROLS

1. MAJOR MISTAKES

Major mistakes usually made in ant control are:

- Failure to accurately identify the ant so that its biology can be used to control it. For example, attempting chemical control of worker ants (for example, pharaoh ants) without first killing or sterilizing the queen results in nest division and greatly increases indoor problems.
- Failure to exclude ants through caulking and sealing, removing vegetation "ladders," and preventing importation of ants on vegetation or potted plants.

- Failure to thoroughly inspect the building to find nests and sterilize or kill the queen or queens.
- Attempting to treat only the five to ten percent of worker ants seen foraging without controlling the colonies.
- Failure to treat contributing conditions such as damp wood, bad sanitation, poor crawl space ventilation, and over-watered or aphid-infested potted plants.

2. PREVENTION OF ANT INFESTATIONS

Established ant infestations can be difficult to control. The best control is good sanitation practices, which eliminates the conditions attracting ants. Although practices are not different from those required for cockroach control (see Chapter Five—Cockroaches), the following are very important to follow:

- Clean up all food particles after meals, and frequently sweep, vacuum, or mop up all scraps, lint, or dead insects.
- Store all ant-attracting food in pest-proof plastic or glass containers or, if possible, in the refrigerator.
- Rinse all food residues from glass, metal, or paper food containers before discarding them in trash containers; wash meat and fast-food wrappings in dishwater before discarding. Do not leave dirty dishes on counters; if they cannot be washed immediately, immerse them in soapy water.
- Thoroughly rinse garbage disposal after use and put a lid on it.
- Use tight-fitting garbage receptacles and take the garbage out every night.
- Trim back vegetation and trees next to buildings that harbor ants or aphids.
- Keep bowls of pet food and water empty and as clean as possible.
- Don't import ants into the home: carefully inspect all cardboard boxes, bags, and sacks before bringing them inside to be sure they do not contain ants.
- Eliminate all sources of water for ants; check and repair leaking or dripping faucets and plumbing; keep kitchen sink and cupboard surfaces dry; repair wood surfaces that have been damaged by water and could attract carpenter ants.
- Remove all old and decomposing wood debris, shrubs, or tree trunks that could provide nesting possibility for ants; control honeydew-producing insects.

3. CONTROL OF ANT INFESTATIONS

a. Action Thresholds

Because ants readily communicate the location of food and water sources to other members of the colony, it is imperative that ant control begin immediately upon seeing them feeding on food sources in the dwelling. The initial response may be to follow the line to and seal up the point of entry, or to remove the food attraction. The presence of swarming or winged ants should

always suggest the presence of nests indoors, and the kind of ant and possible nest location should be determined.

b. Physical, Mechanical, Cultural Controls

Limiting Entry: The basic "Rule of Thumb" in ant control is exclusion not eradication. Simply killing worker ants seldom controls a colony and may, indeed, result in colony multiplication. The following exclusions are suggested:

- Place sticky barriers (Stickem or Tanglefoot) on legs of free-standing tables and furniture or place table legs in cups of water.
- Caulk all interior and exterior cracks and crevices; ants will stop coming into structure when the distance from the nest to food becomes too long.
- As an additional precaution, dust cracks with boric acid, diatomaceous earth, or silica aerogel before caulking.

Physical and Mechanical Controls:

- Sponge mop with soapy water or vacuum to remove trailing ants. Soapy water washes away trailing odors and forces ants to find other food sources.
- Boiling water poured into holes that are probed into ant nests is somewhat effective against harvester and carpenter ants.

Using old-fashioned remedies like scattering mint or pennyroyal around shelves, planting tansy, or coating points of entry with powdered bone meal, charcoal, cayenne pepper, or lemon juice have not proven effective.

Heat Sterilization: If the affected items can tolerate it, equipment, rooms, and furniture infested with ants can be sterilized by steam cleaning or dry heat (130 degrees F for 30 minutes).

c. Pesticide Treatments

Chemical controls generally provide only temporary relief from pests in buildings. Moisture, heat, soap, and grease, which are common in kitchens, quickly render most insecticides inert. When chemicals dissipate, ants often re-invade dwellings. Exterior sanitation should be used in combination with interior treatment and good sanitation. Chemical treatment should be aimed at destroying the nest or sterilizing the ant queen. Follow-up monitoring will determine whether additional treatments are necessary.

Before any chemical control is applied, it is vital to know the kind of ants present, what they are

feeding on, and whether their nests are located indoors. Boric acid dusts and sprays are very effective chemical treatments, which are applied through a narrow-diameter tube into harborage cracks and crevices of ants and other pests. Boric acid dust may also be applied under furniture and in drawers, voids, under sinks, in high cabinets, and around pipes. When applying in cabinets, be sure to remove utensils and supplies, and apply dust only in cracks, not on shelf surfaces. Use only refined, pesticide-grade, 99% boric-acid dust for pest control.

Boric acid dust is harmful to breathe; therefore, a dust mask, goggles, and gloves should be worn. Various brands and formulations of boric acid are commercially available, some in aerosol carriers, making application to small cracks easier. Boric acid requires seven to fourteen days to kill ants, but it remains active for a long time. It is carried into the nest where it is ingested by the queen during grooming. Caulk cracks and crevices after inserting boric acid into them to eliminate future harborage areas and keep the chemical dry.

Various types of solid, semi-solid, and liquid ant-bait stations are commercially available. Many contain low-risk chemicals like boric acid that are readily taken into the nest and to the queen. These baits are attractive to ants, and help to control ant populations. Place stations along ant trails where ants quickly find them. However, where sanitation is poor, bait performance will also be poor because of the availability of alternative food sources.

END OF CHAPTER FOUR

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER FIVE - COCKROACHES

SECTION A GENERAL

Cockroach infestations are among the most widespread and persistent of all pest problems. An infestation does not always indicate untidiness or dirt—cockroaches can inhabit even the cleanest kitchens. The five most common types of cockroaches in urban areas of the United States are: German, brown-banded, American, Oriental, and smoky-brown cockroaches. Five additional cockroach species sometimes found in other than buildings include: brown, Australian, Surinam, woods, and Asian roaches.

Except for size, most cockroaches are relatively similar in overall shape and appearance. They like tight places where their bodies touch surfaces both above and below them. Once inside a building, cockroaches find harborage (living areas) in cracks, crevices, and voids, and easily move among floors, rooms, and apartments through hollow walls, electrical and plumbing access holes, conduits, and garbage chutes. In dining halls, cockroaches are commonly found under work benches, tables, and counters where spilled food accumulates; behind and under refrigerators, stoves, and other bulky equipment; in serving-line areas; near raw garbage storage; in wall voids; and in hollow legs of equipment and tables.

These most common cockroaches inhabiting buildings are nocturnal and remain in the dark whenever possible, only emerging to search for water and food. Large infestations should be suspected when cockroaches are seen in the open or in the light.

Cockroaches are strongly attracted to food and water. Although they can survive many days without food, they must have frequent access to water. Newly hatched cockroaches die in three days without water, and although adult cockroaches may live 20 to 30 days without it, during that time they are unable to reproduce. Because of the wide range of food available to cockroaches (see Hazards of Infestation), they cannot be starved out of a building; but, good sanitation and cleanliness may prevent cockroach populations from increasing.

1. GERMAN COCKROACH

The German cockroach (Fig. 5-1) is the most common, and most rapidly reproducing of this country's cockroach species. It is also responsible for most calls requesting help with pest control. A German cockroach population, given favorable conditions, can increase in number at least 20 times within three months.

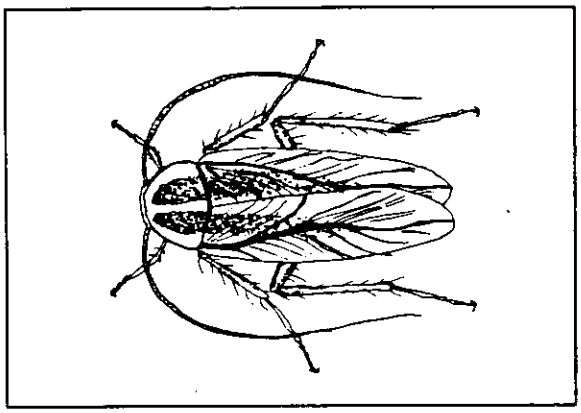


Figure 5-1

The German cockroach is 1/2-inch long, honey brown in color, with two dark streaks on the pronotum (first body section behind the head). Both adult males and females have fully developed wings and can fly short distances. Incubation of young lasts about two weeks at 80°F. The female protects the eggs by carrying a 1/4-inch-long egg case, containing from 30 to 40 eggs, until a day or so before hatching, when she deposits it in a protected area. A female produces from four to eight egg cases in her lifetime, during which time she mostly remains hidden in cracks and therefore less exposed to pesticides. Young (nymphs) German cockroaches resemble adults but are smaller and lack wings. Nymphs shed their skins (molt) six to seven times before they mature in about twelve weeks. German cockroaches complete a generation in four to six weeks, and the entire life cycle lasts from 14 to 28 weeks. Household infestations can be detected by finding shed skins and empty egg cases on shelves and in cupboards, even when cockroaches themselves are not noticed.

The optimum indoor harborage for German cockroaches is inside the motor area of refrigerators and around stoves, under kitchen and bathroom sinks, undisturbed cabinets, and around toilet bowls where protection, food, and moisture are available from poor sanitation, leaking sink traps and faucets, condensation, standing water, and wet sponges. Although bathrooms have less food available, cockroaches may live in bathrooms and move through electrical and plumbing pipe chases and floor and wall cracks into adjacent rooms containing food. Small nymphs use 1/64-inch cracks for harborage, but larger adults require crevices about 3/16-inch wide.

German cockroaches are usually imported into tightly constructed homes with bottled-drink containers, in potato, onion, dried pet food, and grocery sacks, and in furniture and corrugated cardboard. When German cockroaches are moved into buildings from outdoors, they may be accompanied by American or Oriental roaches.

2. BROWN-BANDED COCKROACH

The brown-banded cockroach (Fig. 5-2) is the second most typical U.S. species, but it does not generally constitute a problem as widespread as the German cockroach. The brown-banded cockroach is about the same size as the German cockroach (1/2-inch), but does not have two dark stripes on the pronotum. Wings of both sexes of brown-banded cockroaches show a light, brownish-yellow, horizontal band across the pronotum, and at the base of wings, another partial band about one-third down from the pronotum. Recently hatched young (nymph) brown-banded cockroaches resemble adults, but are smaller and lack wings. Nymphs are dark; the two light bands separated by a dark band behind their pronotum is more obvious than banded markings on adults. Adult males fly readily, but females do not fly.

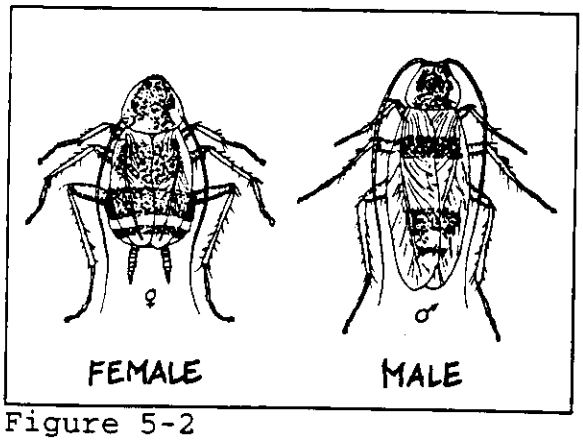


Figure 5-2

Brown-banded female cockroaches produce up to fourteen 1/8-inch-long egg cases (each containing 13 to 18 eggs) during their lifetime. The female carries the new egg case less than two days and then attaches it to the underside of furniture, behind kitchen-cabinet drawers, and in corners inside cabinets and cabinet frames. Incubation time is about 50 days, similar to that of the American cockroach. Nymphs molt six to eight times before reaching maturity in five to six months. Time required for their complete development varies from three to nine months.

Brown-banded cockroaches occur throughout the United States and become established in warm apartments and office buildings, where infestations may quickly build to rival those of German cockroaches. Lesser water requirements allow them to occupy more locations in a building than German cockroaches. Brown-banded cockroaches flourish in rooms with high temperatures and, like German cockroaches, build up the largest populations in kitchens. Brown-banded cockroaches more often frequent cabinets near ceiling level, but also find harborage behind picture frames, in areas near stoves, and other warm equipment (refrigerators, electric clocks, light timers, televisions, radios, and computers), as well as in ceiling voids, clothing, drapery, and clutter.

Brown-banded cockroaches gain access to buildings by being imported, along with supplies and containers (particularly corrugated cardboard boxes). Eggs and adults may often be introduced into structures on furniture. After gaining entry, infestations can quickly spread throughout a building.

3. AMERICAN COCKROACH

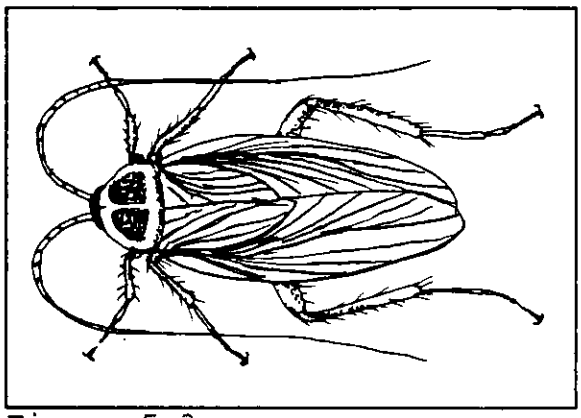


Figure 5-3

The American cockroach (Fig. 5-3) is very common in the southern U.S., where it is sometimes called "waterbug" or "palmetto bug." It also occurs worldwide. This cockroach is about 1-1/2 inches long, reddish-brown with light markings on the thorax, and has fully developed wings. True flight is not common; flying American cockroaches are usually found in the southern states. Adult males, however, can glide extended distances. The pronotum on this cockroach may be ringed by various irregular patterns of light color that darken toward the center, the rear margin is always light colored. Females can produce a 5/16-inch long by 3/16-inch wide egg capsule each week during the 12 to 24 weeks of spring and summer, each containing 14 to 16 eggs. She carries an egg case for about a day and then deposits it in a protected spot. A very high population should be suspected when egg cases are found in the open. Incubation lasts from one to two months. Mature American and Oriental cockroach nymphs can be difficult to tell apart. American nymphs normally go through 13 molts before reaching maturity in from 7 to 20 months.

Where climate allows, American cockroaches normally live outdoors and enter buildings through holes from crawlspaces or underground ducts, steam tunnels, manholes, and sewer line drains. American cockroaches are found in warm and moist basements, around water heaters, in boiler rooms, floor drains, and water sumps. Large numbers of American cockroaches may move into buildings when triggered by blocked drainage systems, heavy rains, or changes in barometric pressure.

4. ORIENTAL COCKROACH

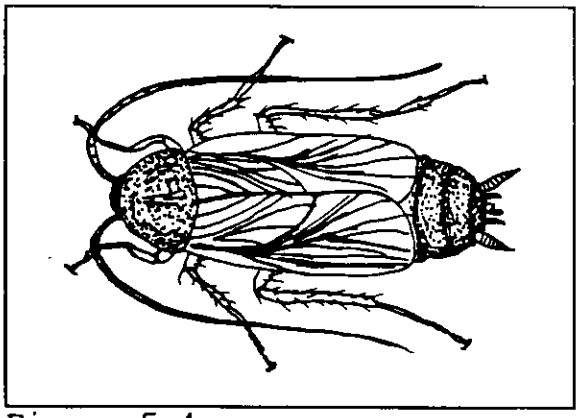


Figure 5-4

The Oriental cockroach, sometimes called "waterbug" or "black beetle" (Fig. 5-4), can be a serious household pest. It is dark-brown to shiny black in color. Females are 1-1/4 inch long, about 20 percent longer than males. Males have fully developed but short, broad wings extending over about 70 percent of their bodies; females only have short triangular wing pads resembling lobes. Neither males nor females fly. Unlike other cockroaches, Orientals lack specialized pads on

their feet and cannot climb smooth surfaces. Each year a female produces about five to ten egg capsules (3/8-inch long by 1/4-inch wide) containing 14 to 18 eggs. She carries the egg case for about 24 hours before leaving it in a warm, sheltered spot near available food. Incubation lasts about two months, and nymphs undergo seven to ten molts before reaching maturity in about 1-1/2 years. Mature American and Oriental cockroach nymphs may be difficult to tell apart.

Oriental cockroaches are more sensitive to a scarcity of water than other cockroaches, but are able to survive 13 weeks of continuous freezing temperatures outdoors when protected under stones and leaf debris. The Oriental cockroach is normally an outside species and its activity is usually restricted to ground or below-ground level. It favors crawl spaces, gaps between the soil and building foundations, underside of stoops and sidewalks, landscaping mulches, sewers, storm sewers, trash receptacles, and water meters. Large numbers of Oriental cockroaches enter dwellings to find moisture and optimum temperature, and are often triggered by drought, approach of winter, flooded drains, heavy rain, or changes in barometric pressure. Oriental cockroaches mainly invade dwellings under doors and through holes, cracks, and pipes joining crawlspaces, underground ducts, manholes, and sewer line drains. The Oriental cockroach prefers harborage on damp, porous surfaces, such as concrete or brick, and is mostly found in dark and damp basements, floor drains, and other moist places having a temperature between 68 and 82 degrees F.

Reducing food is not an effective control for Oriental cockroaches because they feed on a wide assortment of naturally occurring organic matter such as animal wastes (including rodent feces), rotting grass and weeds, bird and rodent droppings, human garbage, and dead insects, slugs, and animals.

5. SMOKY-BROWN COCKROACH

The smoky-brown cockroach (Fig. 5-5) resembles its relative, the American cockroach, in size and shape. This cockroach is dependent upon high moisture; in humid coastal areas, smoky-brown populations can infest every level of a structure. Adult smoky-brown cockroaches average just over 1-inch long and have wings longer than the abdomen. Both sexes fly. Their dark-brown mahogany color is striking, and they do not have light markings on the pronotum nor on the wings.

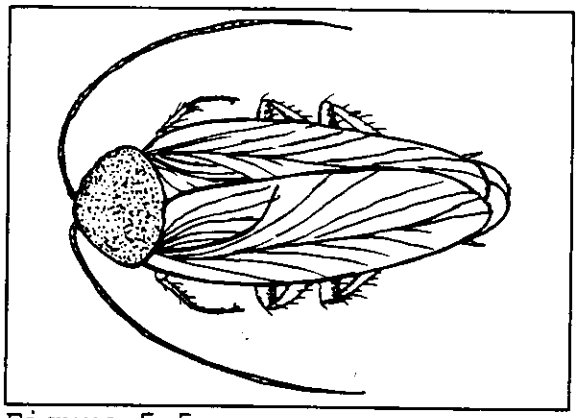


Figure 5-5

Antennal tips of young nymphs are white, as are the base antennal segments of older nymphs. The egg capsule of the smoky-brown cockroach is generally longer than that of the American cockroach and is black-to-brown in color; it contains from 17 to 24 eggs. The female usually carries an egg case

for one to two days and, if outside, glues it under bark or to a building surface. Inside, egg cases are glued to walls, ceilings, drapery, or sometimes just dropped on the floor. Nymphs hatch within 50 days and mature in about a year. The life cycle of the smoky-brown cockroach is about one year, and usually ends with a large adult die-off each fall.

The smoky-brown cockroach is basically a plant feeder found in warm and moist areas. It forages in mulch, trees, and vegetated areas near dwellings. It may invade structures and, inside, feeds on human food, soiled clothing, and garbage. This cockroach is found in the South and southeastern sections of the United States, especially Gulf Coast regions of Texas and Louisiana. It may invade or is accidentally imported into dwellings. Cockroaches gain entry into dwellings with infested firewood, through doors and cracks in the structure, adjoining garages, and under roof eaves. This cockroach also lives in gutters and under roof shingles, from where it can invade attics. Smoky-brown cockroach infestations commonly begin on upper floors and attics of buildings, after gaining access from trees overhanging roofs, and are found at water-damaged areas because of their great need for moisture. This cockroach is one of those which is difficult to control because it lives in such a wide variety of outdoor and indoor sites. Effective control requires a complete and thorough inspection of the structure in order to find and correct deficiencies.

SECTION B HAZARDS OF INFESTATION

Cockroaches affect more people than any other insect. They vomit partly-digested food materials and continually defecate while eating and pose significant health hazards by transmitting diseases (bacillary dysentery, typhoid fever, cholera, polio, amoebic dysentery, urinary-tract infections, diarrhea, and infectious hepatitis). In some parts of the country, even human allergy is attributed to cockroaches.

Some apartment residents spend one to two percent of their annual income every year on cockroach-control. This unnecessary exposure to substantial amounts of insecticide for many years may have subtle and debilitating health effects, especially on children and the elderly. Ineffective insecticides may result in more pesticide use, or residents may give up all control efforts. This only allows continual cockroach increases. Dependence upon chemicals only increases the hazards of infestation.

Cockroaches are scavengers that live on food waste and are attracted to human foods, particularly bakery products, cereals, meat, and cheese, which they contaminate since they also feed on dead animals and animal feces. Meanwhile, they also feed on or damage items like leather, wallpaper paste, book bindings, soiled clothing, art work, books, legal documents, postage stamps, draperies, and banknotes. Cockroaches are attracted to electrical switches, outlets, and smoke detectors, where their bodies and body fluids corrode points, activate or deactivate alarm systems, create pump failures, and cause short circuits in or damage to computers and drive heads.

Cockroach droppings, body parts, and dead cockroaches may accidentally be incorporated into human meals. Cockroach excrement, scent-gland secretions, and regurgitations spoil the palatability of human food. They strongly attract more cockroaches to established feeding sites, causing additional staining and contamination of food, food packages, and kitchen cabinet cracks and crevices where cockroaches gather.

SECTION C INSPECTION AND MONITORING

1. INSPECTION

A careful flashlight inspection of a dwelling is necessary to discover the presence and centers of cockroach activities in order to identify them and the available harborage, food, and water sources before control treatments can be initiated. Further, estimates of the pre-treatment size of cockroach populations compared with post-treatment population estimates provide important data for evaluation of the effectiveness of controls.

Refrigerators pose weak links in cockroach-control programs because they provide heat, harborage around coils, constant water supply, and hiding places that are almost impossible to treat. The presence of surface molds and water damage under or around refrigerators will help pin-point concealed cockroach habitat.

Make inspections, if possible, during evening hours, when cockroaches leave harborage. During the day, cockroaches remain deep within cracks. Use a flashlight during inspections (even if the area is not dark) to help concentrate your focus. Inspect for cockroaches every two weeks unless a decrease in roach problems justifies extending the time between inspections.

2. MONITORING

Once infestations are identified through inspections, use sticky traps to determine approximate insect numbers and to provide pre-treatment data for evaluation of the effectiveness of control measures. There are several effective sticky traps, some with attractive food baits, on the commercial pest-management market. Numbering traps and analyzing their locations and captures, which should be indicated on room-diagram maps, helps to identify cockroach harborage and needs for additional attention to sanitation measures, exclusion, or pesticide treatments.

Monitoring is done by placing sticky traps strategically in rooms and kitchens where harborage, warmth, water, and food are plentiful. The best trap locations are in corners where cockroaches congregate. Place traps against walls, fixtures, and under appliances; do not place them in the open or where they may become wet. Cockroaches tend to stay close to cracks and crevices when foraging

for food. Study cockroaches found on traps to determine the direction from which they entered the trap, which will help point out likely harborage sites. Additional follow-up monitoring with sticky traps is necessary five to seven weeks after the first monitoring session to see if young cockroaches are still hatching.

SECTION D COCKROACH CONTROLS

1. ACTION THRESHOLDS

When an average of two or more cockroaches per night per trap is caught in a room, do spot crack-and-crevice pesticide treatment of cockroach harborage with boric acid, place bait stations, and follow the recommended guidelines.

2. PREVENTION OF COCKROACH INFESTATIONS

Infestations can be prevented by reducing conditions which support cockroaches, including access to dwellings and harborage, moisture, and food. Otherwise, cockroach populations are very difficult to control because small, residual populations can survive in even the most sanitary of environments. Residual populations can explode into major problems. The use of pesticides, however, can never be regarded as a substitute for either prevention or good sanitation practices. Pesticidal suppression of cockroach populations without a change in environmental conditions that support them only gives a false and temporary sense of security, and may result in chemical resistance in pest populations.

Good building maintenance is mandatory if cockroaches are to be denied access to dwellings. This requires elimination of holes and cracks used by cockroaches to gain entry into buildings through the following measures: installation of tight-fitting windows, doors, screens, and door sweeps; caulking of all exterior and interior cracks and holes in foundations, walls, sills, floors, splashboards, and water, heating, and electrical-service chases; screening open sewer lines and drains; and repair of leaking plumbing facilities and removal of other sources of moisture.

An effective prevention program should contain the following major elements:

- Careful inspections of areas surrounding the building, noting and correcting conditions which attract or provide cockroach harborage, such as stacks of firewood, dead tree stumps and branches, vines and other vegetation on or next to the building, piles of bricks, stones, or wood, and leaf litter.
- Careful inspections of building exteriors from foundation to attic, noting and correcting all possible points where cockroaches or other pests could enter the building.
- Careful inspections of building interiors, attics, and crawlspaces from floor to ceiling, noting and

sealing all cracks, crevices, holes, and voids which could harbor cockroaches or other pests. Stainless-steel baskets can be used in sink and floor drains to prevent entry of cockroaches from sewers.

- Inspection of dwellings for accumulations of cardboard or wooden boxes, paper and plastic grocery bags, empty aluminum cans, beverage cartons, furniture, dried pet foods, seasoned firewood, and potted plants, through which cockroaches are often imported into a dwelling and in which materials cockroach populations flourish. Tactfully advise residents about needs for improved sanitation.
- Inspection for accumulations of food scraps often found under refrigerators and other kitchen equipment and in cupboards. Tactfully advise residents not to leave dirty dishes or puddles of water on cupboards, to clean up all food scraps immediately after eating, to store food in pest-proof containers, to use tight-fitting lids on garbage containers, and take out garbage every day.

3. CONTROL OF EXISTING COCKROACH INFESTATIONS

Cockroach problems almost always indicate the presence of excessive moisture and poor sanitation. Effective control measures should include physical, mechanical, and cultural changes. When those methods are not sufficient, chemical measures should also be utilized.

4. PHYSICAL, MECHANICAL, CULTURAL CONTROLS

Because of adjoining apartments, attics, crawlspaces, pipes, and other connections, serious cockroach problems in multi-unit dwellings usually require an intensive control program for the entire building. One unit left untreated will supply cockroaches to other units.

a. Exclusion

The entire building should be adequately sealed and secured against cockroach entry. Carefully check for and seal cracks and crevices in walls, around sinks, and gas, water and electrical lines, cupboards, and baseboards to eliminate all cockroach hiding and breeding habitats. Cockroaches may travel between apartments in and along electrical conduits and enter rooms through open prong holes in electrical outlets; keep outlets covered at all times. Fit self-closing devices to screen doors and check that screens are not broken.

Repair leaking faucets and water and drain pipes, and ventilate or dry out moist areas such as crawl spaces. Remove any other sources of moisture available to insects. Be sure indoor plants are not overwatered; place screens on fish tanks. Cover all air and ventilation vents with fine-mesh wire screens.

Direct runoff away from buildings. Remove rotting leaves from window wells and dense vegetation from around building foundations, and trim trees that touch the building. Place outside lighting away from the structure to avoid attracting cockroaches and other flying insects to the building.

b. Sanitation

Residents should be instructed in the following procedures to eliminate all food, moisture, and harborage available to cockroaches:

- Unnecessary equipment and stored materials in which cockroaches can hide should be removed from the dwelling.
- Foods should be stored in insect-proof metal cans or plastic or glass jars with tight-fitting lids, or kept in the refrigerator.
- Food and grease should be removed each day from stove doors, hinges, burner tops, joints, and crevices. Thorough clean-up of food particles on and under tables and counters should be done as soon as possible after meals, and dishes not promptly washed should be immersed in soapy water. Discourage eating in non-dining areas. All leftover pet foods should be cleaned up as soon as pets finish eating; don't leave food dishes out between feedings. Do not use liners on shelves or in drawers, which provide harborage for cockroaches under loose edges.
- Place all food, garbage, empty drink and food cans, and other materials providing potential insect food in sealed plastic bags or tightly sealed canisters as soon as possible. Do not store inside the building empty aluminum cans or bottles for recycling. Keep garbage cans tightly covered and take garbage out daily; under no conditions permit garbage to remain exposed overnight in apartments.
- Clean cockroach infested "focus" apartments by emptying all kitchen cabinets, drawers, and pantries and washing them out with soapy water before replacing items. Empty stored clothing from boxes and bags and wash and dry them before repacking in sealed plastic bags or in new, clean boxes.
- Egg cases and adult insects are frequently imported into dwellings on foodstuffs and containers coming from other cockroach-infested areas. Cockroaches hide and breed among folds of paper sacks and in voids of corrugated cardboard boxes. Carefully inspect (or sterilize) all incoming containers and shipments for cockroaches and egg cases before putting items on shelves. Seal all paper sacks and cardboard boxes in plastic garbage bags as soon as they are emptied and properly dispose of them.

Provide written information and graphic handouts to familiarize residents with cockroach-control programs and the need for sanitation. Residents should understand and be willing to follow steps to reduce the availability of food and harborage to cockroaches and to take measures to prevent

reinfestation. No amount or frequency of pesticide application is sufficient to control or eliminate cockroach infestations where sanitary conditions are not met.

c. Direct Controls

Sterilize equipment and furniture infested with cockroaches or egg cases by steam cleaning or in dry heat (in excess of 140 degrees F.) for 30 minutes. This method is useful when residents move from an infested unit to a new one.

5. PESTICIDE TREATMENTS

Chemical controls provide only temporary relief from insects in dwelling units unless the moisture, food particles, and grease found in kitchens are eliminated. When chemicals dissipate, cockroaches may re-invade dwellings. Thus, good exterior area sanitation is just as important as inside sanitation and control. To be effective, any short-residual chemical treatment should attain 95 percent or greater cockroach kill within the first few days, and later follow-up treatments should concentrate on the remaining cockroach reservoirs. Before any chemical is applied, it is vital to know the kind of cockroaches present and where they are hiding so harborage areas can be effectively treated.

Boric-acid dusts and sprays are generally used for effective chemical treatments. This chemical is applied through a narrow-diameter tube into harborage cracks and crevices where cockroaches live and breed. Boric-acid dust may also be applied under cabinets, drawers, and around pipes. When applied in cabinets, be sure to remove utensils and supplies and apply the dust to cracks; do not treat shelf surfaces. Only refined, pesticide-grade, 99% boric-acid dust should be used. Since the dust is harmful (as are most pesticides), a dust mask, goggles, and gloves should be worn during the treatment process. Various brands and formulations of boric acid are commercially available; some use aerosol carriers that makes application to small cracks easier. Boric acid may take 7 to 14 days to kill cockroaches, whereas other pesticides may kill cockroaches in a shorter time (if the cockroaches have not developed resistance). However, boric acid remains active for a long time. Cockroaches may develop resistance to most pesticides but, after over fifty years of use, they are still not resistant to boric acid. After applying boric acid to cracks and crevices, caulk them to eliminate future harborage and to keep out moisture.

Various types of solid, semi-solid, and liquid cockroach bait stations are commercially available. Many contain low-risk chemicals that are attractive to cockroaches and help control populations. Generally, ten or more bait stations are placed in cockroach harborage areas in a normal sized kitchen. Some bait stations have sticky tape on the back for applying baits to vertical surfaces. However, if sanitation is poor in a dwelling, bait performance will also be poor because of the availability of alternative foods.

Several new toxic paste or gel baits have been developed that are attractive to cockroaches. These toxicants can be stomach poisons, nerve poisons, chitin inhibitors, or insect-growth regulators (IGRs). Bait guns have also been developed to inject paste or gel baits directly into the cracks and crevices or other places where cockroaches hide.

END OF CHAPTER FIVE

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER SIX - FLEAS

SECTION A CHARACTERISTICS AND RECOGNITION

Fleas are common indoor problems throughout the United States, except in very dry areas. Heat and humidity, such as exist during summertime, provide optimum conditions for flea growth. The most typical species, and the one used here as a model for flea control, is the cat flea. It feeds on a number of hosts, including cats, dogs, and rodents, and is found in a wide range of environmental conditions.

This flea prefers animal hosts, but also affects people. For instance, taking a host animal out of the building removes the fleas' main host, starving them. While the main host is gone, however, flea larvae continue to develop by feeding on dried blood in carpet, and pupae complete their life cycles and are ready to emerge from cocoons. After an absence of a host, large numbers of emerged and emerging adult fleas are ready to feed on any warm-blooded host, including human beings.

The adult cat flea (Fig. 6-1) is about 1/8-inch long, has sucking mouthparts, and exclusively feeds on a host's blood. A flea body can withstand substantial pressures. Egg production in the female begins two days after her first blood meal and peaks about the fourth day. She produces from 150 to 400 round, light-colored eggs the size of a fine-point pen tip, and lays about 20 of them per day for up to three weeks. Since about half of the fleas on a pet are female, up to 500 flea eggs per day can drop onto rugs, carpets, bedding, and other pet resting areas in a residence.

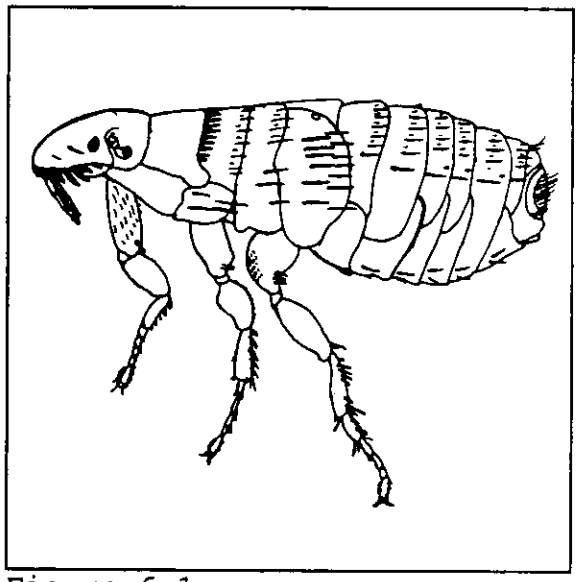


Figure 6-1

Larvae hatch in two to fourteen days and move to the base of carpet or other fibers seeking food. Cat-flea larvae are 1/8-inch long, have chewing mouthparts, and feed on adult flea feces (which are partly digested blood), and organic debris. They need a source of dried-blood or blood-containing materials to complete the three necessary molts of larval development. Cat flea larvae are not very mobile. They are usually either in the pet's resting areas or protected spots. They shun heat, sunlight, and decreased humidity but are attracted to moisture. They curl around carpet fibers if they are disturbed and are nearly impossible to remove by vacuuming (they are covered with backward-pointing bristles and spines).

When molts are completed, larvae spin a sticky silken cocoon within the carpet fibers and pupate (a protected, quiescent stage during which larval fleas change to adults). When pupal development is complete, the new adults may remain within the cocoon until some stimulus triggers their emergence—proximity of an animal, carbon dioxide exhaled by a host, vibrations, or increased temperature and humidity. Most adult fleas emerge from pupal cocoons in ten to fourteen days. However, adult fleas can remain in the pupal-stage cocoon, inactive but ready to emerge, for as long as a year while waiting for the proper stimulus.

Flea larvae and pupae are mostly found in undisturbed areas which provide optimum humidity and temperature, are regularly visited by pets, and contain larval food. Fleas may be imported into living rooms by squirrels entering the house through chimneys, and via pets.

SECTION B HAZARDS OF INFESTATION

Typical flea bites show as a central, small red spot where flea mandibles penetrated the skin, surrounded by a red halo. Some animals may be allergic to flea bites, which may be seen as dermatitis, hair loss, excessive scratching, and skin inflammation.

SECTION C INSPECTION AND MONITORING

1. INSPECTION

Conduct a close inspection of the living unit to find "hot spot" areas with flea development.

- Look under furniture and in rugs or carpets for granules resembling salt and pepper, which indicate flea presence. These salt-and-pepper granules are made up of flea feces, empty egg cases, shed larval skins, and dried blood.
- Collect fleas and have them identified. Fleas can be trapped in a number of ways:
    - Collect fleas that land on an inspector's white pants after a one-minute walk-through of flea-infested areas. Collection of five or more fleas might indicate infestation.
    - Make a night-time light trap by hanging an illuminated 25-watt light bulb a few inches over a shallow pan of water placed on the floor, with a few drops of detergent added. Be sure the light bulb or wiring cannot come into contact with the water.
    - Collect fleas from pet bedding, or by combing infected animals with a flea comb; place fleas in a plastic bag and kill them by freezing or heating (to 120 degrees F).
    - Use commercial flea traps available from pet-supply dealers.
- Watch for animals going into yards or under dwellings. Look for bird or mammal nests under the structure and in unscreened chimneys and pipes. (Opossums carry large populations of cat fleas,

and may infest areas, such as yards, they travel through.)

SECTION D CONTROLS

1. MAJOR MISTAKES IN FLEA-CONTROL PROGRAMS

The effectiveness of flea-control programs can be diminished by failure to:

- Identify fleas and find the source of the problem;
- Exclude or treat animals bringing fleas into the dwelling;
- Clean indoor areas where fleas find harborage, and to instruct residents on cleaning methods;
- Treat outdoor areas where fleas live;
- Gain resident cooperation or inform them of what to expect after treatment—because of the flea's life cycle, a few adult fleas will be seen after pesticide treatments;
- Use proper pesticide application techniques or rates.

2. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

a. Sanitation

- Once or twice a day for a month, thoroughly vacuum in a criss-cross pattern all flea "hot spots" and other areas used by animals (rugs, sofas, drapes) with a strong vacuum cleaner. Vacuuming can remove a high percentage of flea larvae and eggs. Good vacuuming can keep a flea population low. Removal of flea larvae from carpeting is the most important action in reducing an infestation; allowing pets to remain flea-infested, however, will minimize the success of treatment. Carefully dispose of sealed vacuum bags containing live fleas.
- Remove clutter, boxes, and other items stored on the floor to limit flea harborage. Store items on shelves or off the floor.
- Frequently shampoo or steam-clean carpets; remove rugs from public use areas. Wash floors with detergent before, but not after, application of residual pesticides.
- Wash pet bedding and clean the pet kennel box at least once a week to destroy flea eggs and larvae and to remove dried blood that fleas use for food; destroy all old pet bedding.
- If possible, lower the relative humidity in the house to less than 50 percent.
- Keep pets outdoors; establish grooming, washing, and feeding procedures that keep pets free of fleas. Limit a pet's contact with other animals.
- Remove vegetation near the structure that may provide rodent harborage.

b. Exclusion

- Screen vents, crawl spaces, and chimneys to keep animals out from under structures, outbuildings, or chimneys.
- Assure that pets brought into dwellings by other people are not infested with fleas.

3. OTHER CONTROLS

Fleas tend to prey on sick or poorly nourished animals; healthy dogs and cats can usually manage flea problems. Feed pets nutritious, well-rounded diets of whole grains, vegetables, and lean meats rather than commercial pet food.

Fleas die in dry or moist air temperatures above 110 degrees F.

Ultrasonic devices have not been shown to be effective for flea control.

4. CHEMICAL CONTROLS

Dusting cats with residual pesticide chemicals may cause them to ingest poison from their fur when grooming. Pets may also come into contact with grass or rugs that have been treated for fleas, become chemically over-dosed, and suffer adverse reactions. Excess exposure to pesticides can adversely affect not only pets but also people who handle them.

Chemicals alone will not eliminate flea problems. The control should be combined with physical and mechanical means. The following are additional items for flea control:

- Apply pesticides indoors after the dwelling has been thoroughly vacuumed.
- If pesticides are used on pets such as dogs, wear protective equipment such as gloves, face mask, and goggles, and ensure adequate ventilation.
- Do not allow children to contact surfaces or pets treated with residual pesticides before they dry.
- Dwellings and pets should be treated for fleas at the same time.
- Insect-growth regulators offer best results when used at least a month before spring flea activity begins. Follow label directions.
- Commercial flea soaps for pets are also effective against; follow the label directions.
- Flea collars impregnated with residual chemical toxicants are the least effective for flea control and may irritate animals.

END OF CHAPTER SIX

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER SEVEN - FLIES

SECTION A CHARACTERISTICS AND RECOGNITION

In terms of both numbers and health concerns, flies make up one of the largest groups of insect pests. Although the major features and control measures given here are for urban pest flies, the principles generally apply to all flies. The main urban fly pests in the United States are the house fly, fruit fly, hump-backed fly, bottlefly, moth fly, and fungus gnat, each of which have very similar life cycles. Adults seek moist garbage, dead animals, or manure in which females deposit eggs. Eggs develop into grub-like larvae (or maggots) that feed on the food source on which eggs were deposited. After a week or so, larvae leave the food source and spend another week or so in a non-feeding, cocoon-like form (pupa) from which adult flies emerge in a few days. Adult flies quickly mate and may move from the breeding site into human living quarters through open doors and windows, seeking food.

Food for a fly consists of almost any organic material. House flies (among many others) eat solid food by vomiting digestive enzymes onto the food source and macerating it into a liquid form that can be lapped up with sponging mouth parts. Since flies continually vomit and defecate while feeding, germs are deposited on the food they feed on.

1. HOUSE FLY

Worldwide, the common house fly (Fig. 7-1) is one of the most widely distributed insect pests. House flies are soft-bodied, gray-colored, about 1/4-inch long, and have only one pair of wings that span about 5/8-inch. Their faces have two soft stripes, silver above

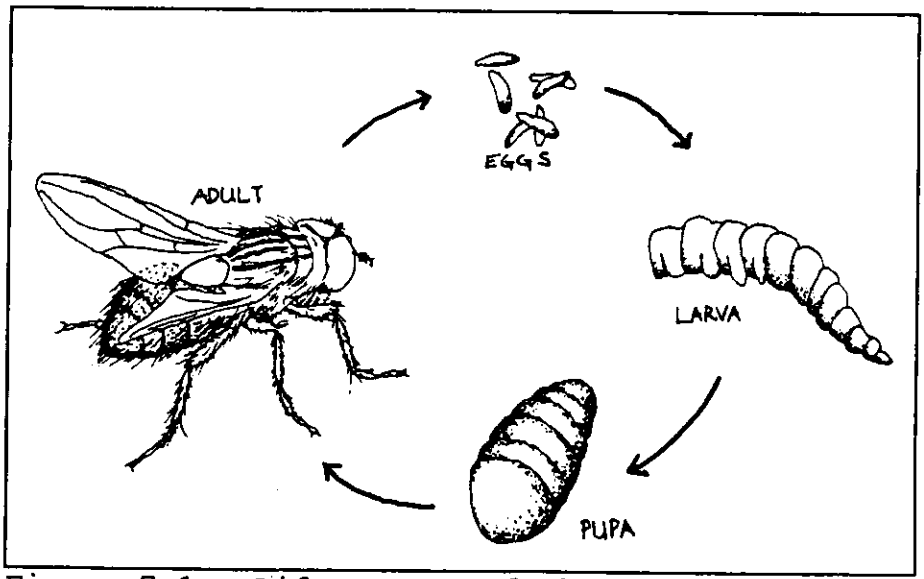


Figure 7-1: Life stages of the house fly

and gold below. The upper surface of the thorax is marked with four dark longitudinal stripes, and the abdomen is yellowish-white at the sides and base. They are active year-round outdoors in mild weather and indoors during fall and winter. House flies rarely moves more than a mile to food from their breeding sites. They have an excellent sense of smell, which leads them to food and water. Their range of vision is about eighteen inches, and they are attracted to the color red.

Over their lifetimes, female house flies will lay from 350 to 900 eggs in any moist excrement, garbage, decaying fruit, vegetable waste, and soil contaminated with organic matter. After eggs hatch, larvae feed, eventually migrate to cool sites (for instance, soil beneath boards or stones) where they pupate. In three days to four weeks, depending on temperature and humidity, adult flies emerge from pupae. Adult house flies live two to three days if denied food, but up to 54 days when food is present. The period from egg to adult stages ranges from seven to 45 days, and in warm weather two or more generations can be produced per month. House fly populations may be greatest in early fall (September and October). Because larval house flies produce a glycerol compound, which keeps their body fluids from freezing, they mostly over-winter as maggots or pupae. Various similarities in appearance and behavior make it important to be sure that suspected "house fly" problems are not really flesh fly problems, which originate with dead animal carcasses.

2. FRUIT FLY

Fruit flies, also called vinegar gnats and pomace or vinegar flies (see Fig. 7-2), are made up of a number of species with worldwide distribution, and are the most common of all small flies. They are 1/8- to 1/4-inch long, dull yellow to dark-brown, and some kinds have distinctive bright red eyes. They are small enough to pass through window screens with a mesh size larger than 12 per inch.

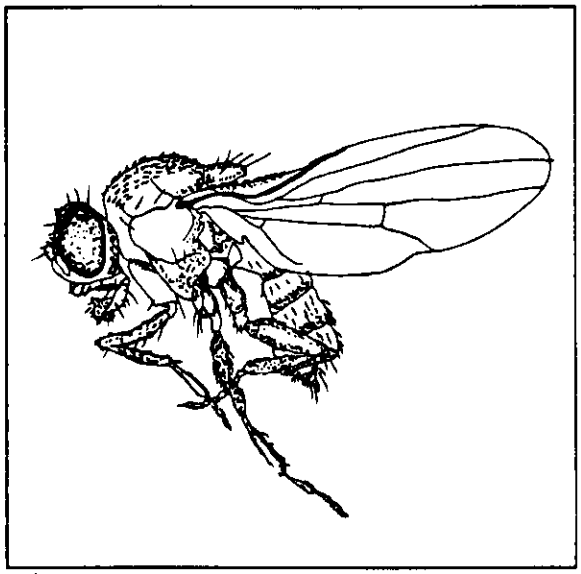


Figure 7-2

Fruit flies breed in decaying matter such as juices or other liquids in empty cans, ripe fruits and vegetables, drain slime, wet mops, and dumpsters. Female fruit flies lay from 400 to 1,000 eggs on the surface of decaying organic materials and in garbage cans; some species prefer briny or vinegary liquids around jar lids. Larvae hatch within 30 hours and begin feeding near the surface of the food source. Mature larvae move into dry areas to pupate, and development is completed in nine to twelve days. Outside in summer, fruit fly numbers quickly build until populations peak during fall harvest. They can be present year round, especially

indoors, where preferred foods and breeding sites are available. Their ability to quickly reproduce in large numbers gives them opportunities to contaminate food if not controlled.

3. MOTH FLY

Moth flies—or drain, moth, filter, and sewer flies or sewer gnats—(Fig. 7-3) are generally found in drains, especially in bathrooms. Adults resemble moths, and are about 1/8-inch long. They have light gray, tan, black, or brown bodies and lighter colored wings that are held roof-like over the back when at rest; both body and wings are covered with long hairs, giving the body a fuzzy look. Moth flies are poor fliers and are most commonly seen just walking or running along walls. Their flight covers only a few feet, and is short and jerky. Some species are active in winter.

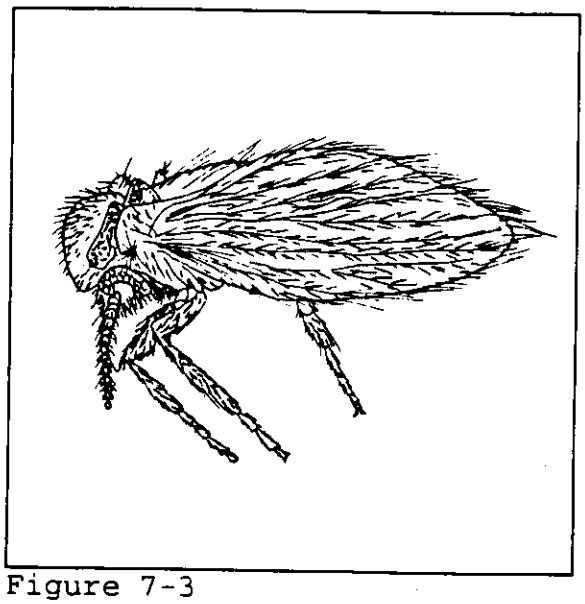


Figure 7-3

Moth flies breed in similar material to fruit flies; females lay masses of eggs, especially between loose floor tiles in wet areas, in drain pipes, dirty garbage containers, water traps, plumbing fixtures, around sinks, and near decomposing organic matter. Larvae (maggots) develop in shallow, polluted water and feed on sediments, decaying vegetation, and microscopic plants and animals found in gelatinous drain film. The life cycle is usually two to three weeks, but may be as short as one. Adult moth flies emerge from sink, tub, shower, and floor drains. Some species are small enough to pass through window screens. Moth flies are mostly active in the evening, around drains or sinks. Moth flies do not bite and are of little significance.

4. HUMP-BACKED FLY

Hump-backed, phorid, or coffin flies (Fig. 7-4), are 1/16 to 1/8-inch long and similar in appearance to fruit flies, except that they are more humpbacked. Most species are brownish-yellow with brown wings, small head, and have a large and humped thorax. Larvae are whitish, legless, worm-like and feed on sewage, dead animals, insects, rotting plant material, animal feces, and open wounds. They infest clogged drains and dirty garbage containers, and adults are attracted to light. These flies are active in buildings during winter. Hump-backed flies have strong legs and are reluctant to fly. They are seen running across surfaces in quick and jerky motions. Hump-backed flies can infest building complexes.

Hump-backed fly adults and larvae are common around decaying vegetation (mold and organic

matter). They can penetrate several feet into the soil to infest animal carcass or organic wastes. Flies emerging in large numbers inside a structure may indicate plumbing leaks in the crawlspace or beneath floor slabs, and considerable effort may be required to locate their hidden wet breeding areas.

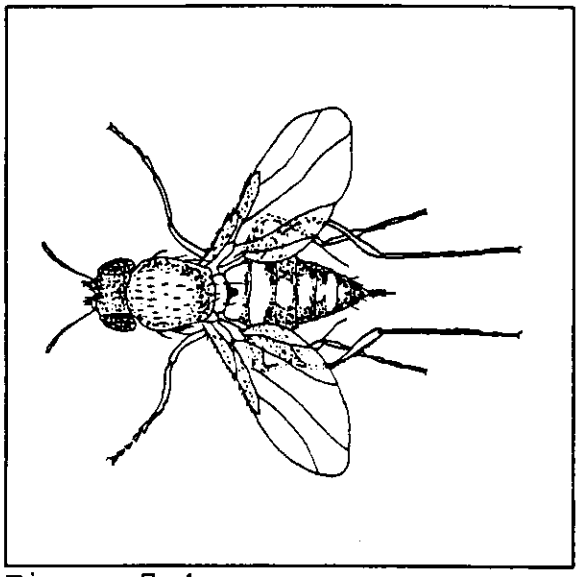


Figure 7-4

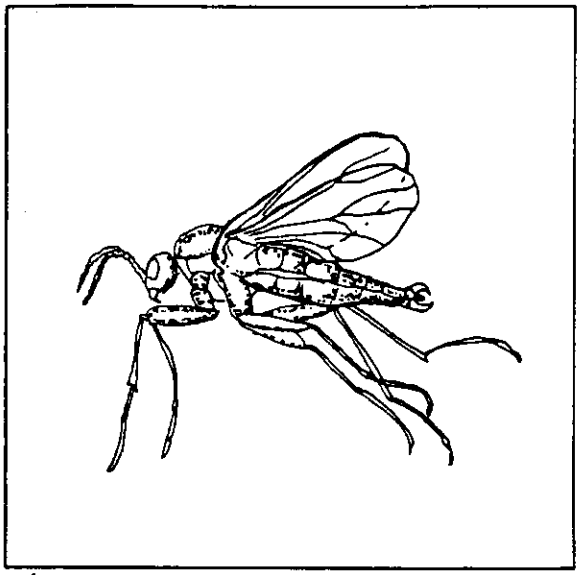


Figure 7-5

5. FUNGUS GNAT

Adult fungus gnats (Fig. 7-5) are 1/8-inch long and resemble small mosquitos, except that they do not bite. Fungus gnats are readily identified by their small size, distinctively long legs, and pointed abdomens. Adults are not strong fliers and are seen running across soil surfaces as potted plants are watered. Adults are also attracted to light and collect at windows. Larval fungus gnats are worm-like, about 1/4-in long, have a transparent body and dark head, and are usually found in the top layer of damp potting soil. Outside, fungus gnats are usually found in gardens, where some larvae live near the soil surface, and others are deeply buried where they feed on plant roots. They reproduce all year long indoors, and the life cycle is twelve to 27 days, depending on temperature.

Over-watering of potted plants supports fungal growth. Larvae thrive in dampness, decaying vegetation, and outdoor compost. These flies do not generally damage plants.

6. BLOWFLY OR BOTTLEFLY

A number of blowflies—blue, green, and black blowflies or bottleflies—(Fig. 7-6, next page) are common throughout the United States and may enter dwellings, where they are attracted to windows. Blowflies are common in populated areas, especially near slaughter houses, meat-processing plants, and garbage dumps. Blowflies are usually the first flies to appear in spring, sometimes emerging from

hibernation on warm, sunny winter days. Blowflies invade buildings mainly during cool weather, when they are readily attracted to garbage cans. At night blowflies rest on shrubs or building walls, from which they can easily enter buildings when doors and windows are left open. Blowflies are found in trash compactors and chutes, compost piles, on the ground, and in wall voids, attics, and chimneys. The larvae are sometimes observed on floors or falling from ceiling fixtures.

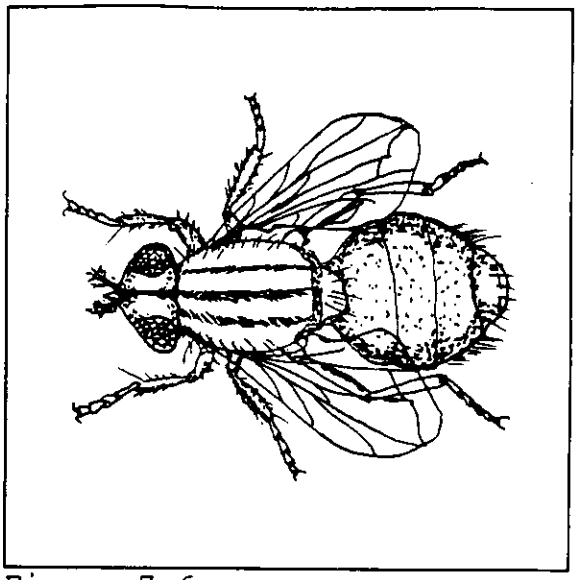


Figure 7-6

Adult blowflies are primarily scavengers. They are larger than house flies, make annoying buzzing sounds, and have metallic blue, green, or yellow or brown-colored bodies. They range in size from 5/16 to more than 1/2-inch long and have a single pair of wings.

Females usually lay 200 to 700 eggs (one species, up to 3,000 eggs) on meat, dead animals, decaying plant matter (such as lawn clippings), solid animal waste (dog manure is preferred), or at the edge of wounds on living animals. They can produce more than 30,000 flies per week. Larvae are large and develop fast; they feed for up to ten days on the surface of decaying matter and, when larger, burrow into less decayed areas. When mature (about 3/4-inch long), larvae wander away from the food source and burrow into the ground to pupate. In one to three weeks they emerge as adults. The period from egg to adult in some species is only nine to eighteen days, which allows four to eight generations per year. Some species over-winter in the soil as full-grown larvae, and others hibernate in attics, walls, and ceilings, but not in clusters. The life cycle is from two to four weeks. The presence of both adults and larvae in a structure indicates the presence of dead animals or rotting organic matter.

SECTION B HAZARDS OF INFESTATION

1. FLIES IN GENERAL

Flies provide great potential for disease transmission because of their feeding habits. Along with mosquitoes, flies are responsible for spreading serious diseases: malaria, sleeping sickness, leishmaniasis, and filariasis. Other disease-causing organisms that have been collected on flies include germs causing dysentery, tuberculosis, cholera, tularemia, anthrax, poliomyelitis, yellow fever, and typhoid.

2. HOUSE FLIES

House flies alone transmit more than 20 human diseases and parasitic worms (including salmonella, typhoid and paratyphoid fever, cholera, summer and infantile diarrhea and dysentery, tuberculosis, and anthrax) which adhere to the fly's sponging mouth parts, sticky foot pads, wings, body surface, or live within the fly's gut.

3. BLOWFLIES

Blowflies deposit eggs on meat, which, when eaten are responsible for cases of intestinal myiasis (caused when live fly larvae are accidentally ingested, causing nausea and other conditions similar to food poisoning).

4. EYE GNATS

Eye gnats are suspected transmitters of conjunctivitis.

SECTION C IDENTIFICATION, INSPECTION, AND MONITORING

1. IDENTIFICATION

If it is difficult to identify flies, request assistance from state health departments or preserve flies in alcohol and send them to university departments of entomology when necessary.

2. INSPECTION

Do not stop inspecting after finding the first breeding site, nor concentrate efforts only on those areas where flies were seen. Seek out all possible places which could contain decaying material, garbage, rotting fruits, vegetables, meats, or grass clippings.

When inspecting for fly-breeding sites, first search for wet areas: floor drains, open drums, buckets, cans, bottles, potted plants, dish washers, machinery, and around cracks, roof eaves, and loose tiles. Look for moist animal feces, garbage, wet mops, and towels. Housefly maggots on floors or pupae under carpets signal the probability of fly-breeding sites inside the building.

Begin inspections outside by intensively searching for breeding sites, first concentrating on garbage and refuse areas. Look under equipment for maggots in dead animal carcasses (mice, trapped

animals, dead rodents), and in garbage and drain sludge. Examine building cracks and crevices, dumpsters and garbage cans, drains and refuse piles. Cat, pigeon, and rodent feces and dead rodents are ideal breeding sources. Develop maps of likely breeding sites and periodically re-check those areas for live fly larvae.

Inside the building, inspect trash-container interiors and areas prone to litter (such as lunch rooms and lounges). Look for empty soda cans, coffee cups, rotting fruit products, lunch bags, wet towels, and debris in locker and lounge rooms. Inspect all cracks at baseboard level, crevices around loose floor tiles, hollows and voids, inaccessible areas in machinery that are caked with dirt and organic matter. Inspect potted plants and grease traps.

In kitchens and food processing areas, thoroughly search for decaying food. Inspect floor drains, floors under work counters and equipment, and enclosed counters which permit water or food to accumulate inside or beneath them. Look under ovens, in both hard-to-reach and hard-to-clean machinery at floor level.

3. GENERAL MONITORING

House flies have certain preferred resting places. During the day and when not feeding, adult flies may be found resting on floors, walls, ceilings, in cracks and crevices, and on other interior surfaces, as well as outdoors on the ground, fences, walls, privies, garbage cans, clothes lines, and vegetation. To monitor for adult flies, place scatter grids out for 30 seconds in locations near preferred resting places and count the numbers of flies landing on grids. Sticky tape, 3x5-inch wide sticky paper, or sticky strings can also be used to monitor adult flies. When problem flies are attracted to light (for instance, cluster and hump-backed flies), place light traps in dark places or capture flies at windows.

Use monitoring information to establish levels of infestation upon which to base control actions.

4. MONITORING INFORMATION ON SPECIFIC KINDS OF FLIES

a. House fly

Sticky or light-trap monitoring which produces, on the average, 50 to 75 house flies per trap per day indicates a moderately heavy population. More than 150 house flies per trap per day indicates a heavy population.

b. Drain Flies

To find possible entry points of drain flies:

- Place sticky traps near suspected sites;
- Set clear glass or plastic containers over drains or tape plastic bags over drains to capture emerging drain flies;
- Fit a piece of fine screen over the drain to see if drain flies stop appearing;
- Scrape a pocket-knife blade around the film inside the drain and look for tiny, worm-like drain fly larvae;
- Look for points of entry for drain flies through cracks in the slab or floor expansion joints, suggesting sewage-soaked soil or broken sewer lines.

SECTION D CONTROLS

1. MISTAKES IN FLY-CONTROL PROGRAMS

The following are the most common mistakes made in fly-control programs:

- Failure to properly identify flies and to find and correct conditions providing breeding sites.
- Stopping after finding the first breeding site; all possible breeding sites must be discovered and eliminated.
- Trying to control adult flies without first controlling larval breeding sites. Control of adult flies may be helpful to alleviate complaints, but it is not as important as controlling larval breeding sites.
- Attempting to control flies with only pesticide chemicals. Pesticides alone will not eliminate fly problems, and are only effective when good sanitation and exclusion are practiced as primary steps.

2. PHYSICAL, MECHANICAL, CULTURAL CONTROLS

a. Sanitation

The first step in any successful fly program is to reduce fly numbers; the key to that is an effective sanitation program for potential breeding sites.

Outside:

- Eliminate conditions encouraging fly-breeding sites around buildings by properly disposing of food and garbage (especially under dumpsters), preventing accumulations of moisture, and weed control.
- Do not throw waste water from cleaning operations onto the ground; pipe it into covered

drains. Keep areas around garbage cans clean. Ensure that tight-fitting lids on garbage receptacles are used.

- During warm weather, steam-clean and rinse out garbage cans and dumpsters with household disinfectant solutions on a weekly basis.
- Ensure twice-weekly garbage picked up so larvae will not have time to develop into adults.
- To ensure that fewer flies will enter structures, keep garbage cans and dumpsters tightly closed and as far from buildings as possible.
- Keep dumpster bottoms as dry as possible by installing bottom-drains and lead water drainage into sewer systems.

Inside:

- Fit garbage cans with tight-fitting lids and always keep receptacles closed;
- Routinely clean cans with household disinfectants;
- Seal up all wet and dry garbage in plastic bags before placing it into cans; this excludes flies and reduces both odors and the attractiveness of garbage to flies. Be sure to take garbage out every night.
- Keep floors, walls, cooking, and food-preparation surfaces clean and dry.
- Examine plumbing pipes for possible leaks and water condensation.

b. Notes on Control of Specific Flies

House fly: House-fly control requires a fully integrated approach based on exclusion and improved sanitation. Reliance on chemicals usually fails in long-term controls, since house flies develop resistance to pesticides.

Fungus Gnats: Allow potted plants to dry out between waterings. Remove potted plants if they supply flies food, water, or harborage sites.

Fruit Flies: Control of fruit flies first requires that sources of infestation be removed. This is often difficult because fruit flies feed on a wide array of organic materials, much of which may be well-concealed behind plumbing, janitor's closets, stagnant drain traps, bottoms of garbage cans, cracks, under appliances or counters, or outside the building. Unless thorough sanitation is practiced to achieve fruit-fly control, problems continue to develop.

Drain Flies: Finding and removing breeding sources and good sanitation practices are the only permanent solutions to drain-fly problems. Use a brush and industrial cleaner to remove slime and film from drains, and flush drains with hot water and commercial caustic drain cleaners or household disinfectants. Check carefully under the crawlspace for leaks or water backups from

possibly broken garbage disposal or sewer pipes. Inspect such other possible breeding sites as clogged roof gutters, air conditioners and cooling towers, clogged storm drains, septic tanks, loose floor tile, water beneath potted plants, rain barrels, sewage treatment plants, dirty garbage cans, and moist compost piles.

Hump-Backed Fly: The presence of hump-backed flies most often indicates that plumbing is leaking. Hang yellow sticky traps in various places in the room to show where flies are entering, or tape a plastic bag over suspected floor drains. Hump-backed flies are attracted to light, and windows are a good place to collect them. Electric-light traps can also be used in dark areas with no other source of light. Once found, eliminate larval food sources (there may be more than one). If broken pipes are found, excavate and discard and replace all gooey soils saturated with organic material. Ventilate and dry out areas so as not to support insects.

c. Exclusion

Exclusion is second only to sanitation in effective fly-control programs, because flies are always attracted to the warmth and odors of buildings.

- Assure that all doors, windows, air curtains, and door closing devices are in good repair and maintained to keep flies from entering the structure. Fit windows and doors with 16-mesh-to-the-inch, tight-fitting screens and install self-closing door devices.
- Screen doors should open outward; double sets of screen doors may be required.

d. Other Controls

Heat: Flies die in 30 minutes when exposed to dry heat at 120 degrees F.

Vacuum: A vacuum may be used to collect flies in groups (such as cluster flies).

Sticky traps: The best place to put sticky traps is where flies usually rest: in corners, on edges, on thin objects (suspended wires or strings), and on ceilings. Sticky paper and sticky strings are useful to capture house flies, but flies are also trapped when encouraged to alight on cotton balls.

Live-Capture Fly Traps: Outdoor, mechanical, and food-attractant fly traps are useful in some locations to lessen fly numbers, but they require attractive fly bait.

- Home-made fly trap: Place one cup of sugar, one cup of vinegar, and one banana peel in an empty two-liter bottle; fill with water to within four to five inches from the top; tie a heavy cord around the neck to hang it from a tree. This trap catches flies all season long.

- Fruit-Fly Trap: For fruit flies, use "fly-in" type traps having specialized saucer-like lids that fit a quart-size mason jar. Bait these traps with a one-inch piece of freshly sliced banana and add one teaspoon of water to keep the banana moist. Replace the banana every two to three days. In areas of high infestation, a trap may become filled with fruit flies in less than 24 hours. In kitchens, place traps out of sight and covered with paper. To kill flies before removing them from the trap, run hot water (150 degrees F.) into one of the entry holes. Keep the outside of the jar clean and dry, or fruit flies will feed on the outside and will not enter the trap. Since fruit fly eggs hatch in ten to fifteen days, clean the jar every two to three days. Meanwhile, carefully inspect the building to find the source of the flies.

e. Insect Light Traps

Electric and ultraviolet (UV) insect light traps (ILTs) offer good controls when used according to manufacturers' directions. Correct use of ILTs can help solve many flying pest problems in small facilities. Proper maintenance of ILTs requires annual (or more frequent) lamp replacement, weekly trap cleaning to control dermestid beetle problems, and a sufficient number of properly located traps. Locate traps twelve or more feet from doorways so flies cannot see them from the outside (to prevent attracting flies into the building), less than five feet from floor level, and at ceiling level in front of large overhead doors, but not facing outside. Each situation is different, and it should be determined in advance how flies enter and move through a building. Clean light-trap trays often, both to monitor efficacy and to prevent scavenger insect problems.

f. Outside Lighting

If practical, place outside lamps on poles away from buildings but shining onto doors, so as to attract night-flying insects away from the building. High-pressure sodium-vapor lamps help to minimize flies when installed at, but not over, entrance ways.

g. Temperature

Flies become sluggish or do not fly in lower temperatures. Keep inside temperatures as low as practical.

h. Other

Fungus gnats: Where fungus gnats are a problem inside, stir soil of potted plants so it will dry out. Begin watering to allow soil to dry out between waterings (just until plants begin to show very first signs of wilting). Discard dead plants, rotting vegetation, and infested soils. Pot new plants

and transplants only in sterile potting soil. Store unused soil separately in a covered container where it cannot become infested. Hanging yellow sticky cards (used by the greenhouse industry) above the plants will also help control white flies and other plant pests.

SECTION E CHEMICAL CONTROLS

Although many flies have developed resistance to pesticides, space treatments are effective in controlling adult flies. Space sprays, however, are not effective on larvae because aerosol mists do not penetrate breeding sites. Space treatments, however, are not long-term controls and need to be periodically repeated. Fly space treatments can be enhanced by turning off all but one light in one corner of a room to be treated and after several minutes, using an aerosol spray where the most flies have been attracted to the light. This reduces the amount of spray needed. Similarly, a light over a dishpan of water with a few drops of added detergent will also catch flies at night.

Commercial bleach is a good fly larvicide for dumpsters and garbage cans. Insecticide in or near food-service should be the last resort and carefully used.

END OF CHAPTER SEVEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER EIGHT - DOMESTIC MOSQUITOES AND THEIR MANAGEMENT

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

Mosquitoes usually are incidental pests in and around buildings, since their normal breeding habitats are outdoors. However, a few species can be considered truly peri-domestic, breeding regularly in urban settings and entering houses. Only those that are frequent pests indoors will be discussed in this chapter.

Mosquitoes invade dwellings during the warmer months from March to October, depending on the region of the country. They have an erratic hovering flight, and frequently make a high-pitched sound. However, other nonbiting flies such as crane flies, midges, or fungus gnats also have similar flight patterns and are mistaken for mosquitoes.

Adult mosquitoes have one pair of oar-shaped wings, as do most true flies, although mosquito wings are partially covered with scales. The females have sharp, lancet-like proboscises used for sucking blood, whereas the males do not, but do have large bushy antennae. Eggs are laid singly or in rafts (depending upon species) either on or near the surface of a body of water.

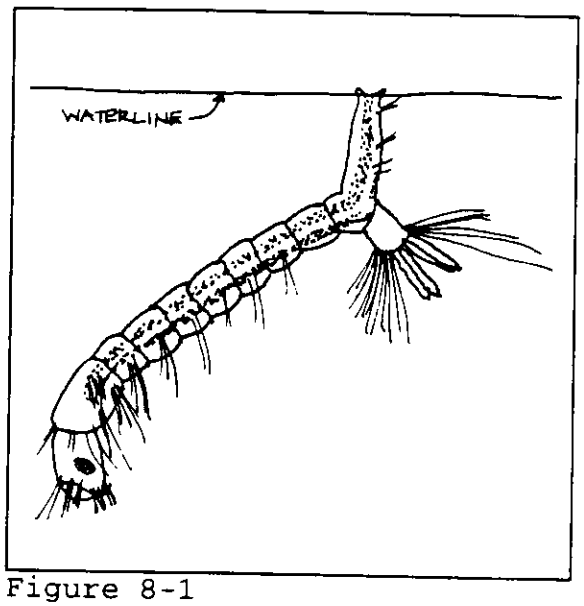


Figure 8-1

Larvae, sometimes called wrigglers, live in water, usually developing through four stages to become pupae. The larvae (Fig. 8-1) feed on organic debris on the bottom or suspended in shallow pools.

The depth of pools inhabited by mosquitoes is limited by the need for larvae to return regularly to the surface to obtain air through an air tube on their posterior ends. Pupae have a "question-mark" shape (Fig. 8-2) and are active swimmers, but do not feed.

Adult mosquitoes emerge from pupae at the surface of water, but usually do not feed until the second or third night after emergence. Their entire life cycle can take place in ten to fourteen days, depending upon temperature, with adults living less than two weeks on average.

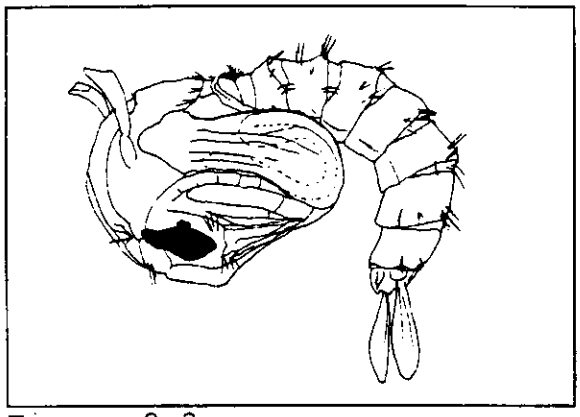


Figure 8-2

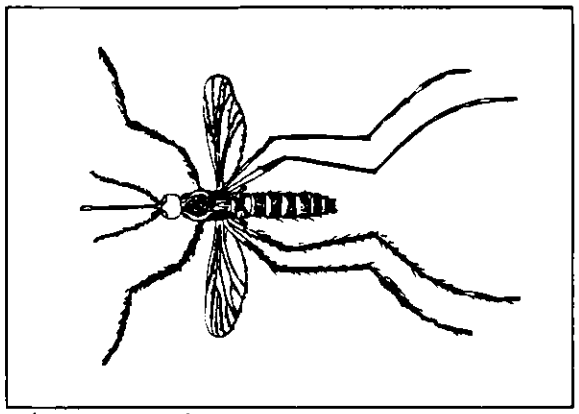


Figure 8-3

2. BIOLOGY OF DOMESTIC MOSQUITOES

a. *Aedes aegypti*

The so-called Yellow Fever mosquito is found along the Gulf Coast to Texas, and the Atlantic Coast from Florida to southern New Jersey. There is also a focal pocket of this species in the greater New York metropolitan area. Its distribution may, in some years, include the midwestern states east of the Mississippi and south of the Great Lakes. The adult has a black-and-white appearance, the thorax being black with a silvery white lyre-shaped marking on it (Fig. 8-3). The abdomen is pointed.

The female is a fierce daytime biter, and may drink nectar from flowers as an alternative food source between blood meals. Most breeding sites are within 100 feet or so of dwellings, since they prefer to feed on human beings. Adults also prefer to rest indoors in the heat of day, in closets, pantries, garages, and basements. As temperatures drop to 40 degrees F, these mosquitoes quickly die out. They do not truly over-winter, hibernating instead in structures or reinfesting an area each year from a base in more southern states where they may breed nearly year-round.

Eggs are deposited singly, but in groups, above the water's edge in artificial water-holding containers around or in the dwelling—flower pots, vases, old tires, or bird feeders. Hatching occurs when the container is flooded with water and covers the eggs. The preferred water habitat is relatively clean, still, and moderate in temperature. Larvae develop quickly, becoming pupae

in seven to ten days under favorable conditions. Adults generally emerge from pupae after two to three days.

Aedes aegypti is one of the most efficient carriers of arboviral diseases such as dengue, yellow fever, eastern equine encephalitis, and St. Louis encephalitis. Although dengue and yellow fever do not occur in the continental U.S., dengue is a problem in Puerto Rico.

b. *Aedes albopictus*

The Asian tiger mosquito, introduced from Asia in 1985, has spread from its entry point of Texas to the eastern states south of New Jersey and the midwestern U.S. east of the Mississippi and south of the Great Lakes. It also occurs in Hawaii and the Pacific Trust territories.

The adults are black-and-white in appearance, similar to *Aedes aegypti*, and differing principally in having a silver streak dividing the middle of the thorax instead of a white lyre-shaped marking (Fig. 8-4).

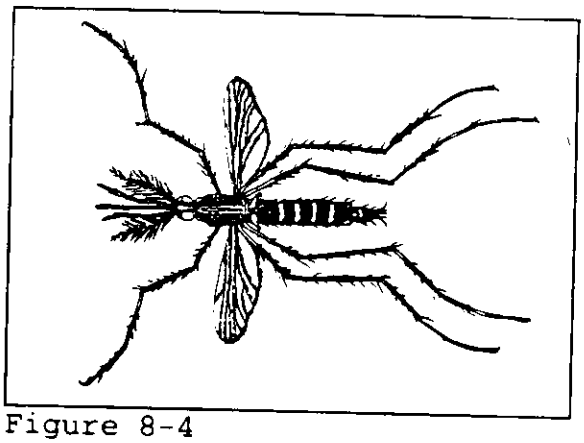


Figure 8-4

The biology of this species, including larval biology and biting behavior, is similar to that of *Aedes aegypti*. The main distinction is that females choose a broader range of egg-laying sites, often utilizing tree holes in addition to flower pots, vases, cans, and old tires. Females are less likely to feed on people than *Aedes aegypti*. The egg stage over-winters in the northern states, while breeding may continue year-round in the south.

This species is a known carrier of many arboviruses, including dengue, encephalitides viruses, and other viral diseases not normally indigenous to the U.S. Its presence in and around dwellings could become serious.

c. *Aedes triseriatus*

The tree-hole *Aedes* is generally considered a woodland species, and it has a wide distribution throughout the Mississippi Valley and eastward from Maine to Florida. It often occurs where homes are interspersed in woodland areas. Adults have silvery markings on the periphery of the thorax, which in turn surround a small elliptical silver marking on a background of brownish scales. Adults are fierce daytime biters and often enter homes. Eggs are deposited in tree holes or

domestic water containers, and can over-winter even in the northern states. Larvae live year-round in the south. Their biology, in terms of alternate food sources, life expectancy, and duration of life stages, is similar to other *Aedes* species. *Aedes triseriatus* frequently flies to lights at night. This species is a potential carrier of encephalitides viruses and also is a transmitter of dog heartworm. It is a serious potential threat if abundant around dwellings.

d . *Aedes vexans*

Aedes vexans occurs throughout the continental U.S. and Alaska. The adult has an unmarked thorax and white bands on the legs and abdomen. It is a true floodwater breeder. Its larvae develop in large numbers following spring runoffs, when meadows and woodland pools are flooded. Unlike the other *Aedes* species mosquitoes discussed, this species prefers to lay eggs in sewage-contaminated water.

The egg stage over-winters in the northern states, while in the south larval development may continue year-round. Biting occurs in the early morning, early to late evening, or even daytime hours in shaded areas. Adults readily fly toward lights at night; they also are migratory and may fly ten miles or more from the larval habitat to seek hosts. This species feeds on domestic animals much more readily than *Aedes aegypti* or *Aedes albopictus.*

Aedes vexans is a fair potential carrier of encephalitides viruses and a moderately efficient carrier of dog heartworm, so its presence should not be treated lightly. Moreover, it is such a persistent biter that even small populations are irritating.

e. *Culex pipiens* complex

House mosquitoes consist of several species, two of which are major pests in the U.S. The northern species, *Culex pipiens* occurs in a band across the northern tier of the U.S., while *Culex pipiens quinquefasciatus* occurs in a band across the southern tier of the U.S. from middle California to Delaware. These species overlap across the middle tier of states. They are a rather dull light-brown with light-white bands across the base of each abdominal segment.

The last abdominal segment is blunt at the end in contrast to the pointed abdomen of the aedine mosquitoes. The house mosquitoes lay egg rafts containing 200 or more eggs each in foul water such as ground pools, tire ruts, catch basins, open cesspools, and street and roof gutters. They may also lay eggs in basements, where larvae may continue to develop even in winter. Eggs hatch in a day or two and may develop through all larval stages in six to ten days if temperatures are high, or several weeks if temperatures are low.

Although house mosquitoes are capable of transmitting encephalitides viruses experimentally, they are unlikely natural carriers because of their low human-blood feeding preference and comparatively short life span.

Adults of *Culex pipiens* and *Culex pipiens quinquefasciatus* feed principally in the evening on birds and domestic animals, but will feed on people if given the opportunity. In southern states, *Culex pipiens quinquefasciatus* is a biting pest which is frequently found in dwellings. Adults hibernate in the northern states, while breeding takes place year-round in the southern tier of states.

f. ***Culex tarsalis***

Although not normally considered a domestic pest, *Culex tarsalis* is widespread (distribution includes the mainland states except the northeast and mid-Atlantic states from North Carolina northward excluding New Jersey). Its presence in peri-domestic situations can be a serious problem, particularly in western states where large populations develop rapidly. Adults are small brownish mosquitoes with white rings and lines on the legs and proboscis. Adults prefer to feed on birds, but will also viciously attack people and domestic animals. This species hibernates in cellars and rock piles in the northern tier of states, but may breed year-round in warmer areas. In domestic settings, adults will lay eggs in ground pools, tire ruts, seepage areas, sewage overflows, and even artificial containers. Larvae quickly develop in large numbers over a six-to-ten day period under favorable conditions, and a full life cycle can occur in as few as twelve days. *Culex tarsalis* is a frequent natural transmitter of encephalitides viruses, especially St. Louis and western equine encephalitis.

SECTION B INSPECTION

When residents express concerns about mosquitoes it should be determined which species are present, and where their larvae are. The best procedure is to aspirate biting adults or catch them in insect nets when they land on human hosts, and kill them for identification. The species can be identified by determining if the abdomen is pointed (generally aedine species) or blunt (generally *Culex* species). The inspection starts on the basis of such identification. The aedine larval mosquitoes may be found in domestic water containers and tree holes, while the *Culex* species larval mosquitoes are found in foul water areas in and around the building. Identification of adult and larval mosquitoes is work for mosquito taxonomy specialists, and if necessary, their assistance, or that of state health departments should be sought.

SECTION C MOSQUITO MANAGEMENT

The best approach to managing mosquito populations is eliminating the larvae in their breeding habitat or the breeding habitat itself. A first step is not to keep water in pots or cans. Often this just means letting plants dry out thoroughly between waterings. Sometimes major corrections have to be made to reduce runoff from rains, especially in catch basins or in ground pools. In other cases, it is better to catch the rain water in ponds so deep that larval mosquitoes cannot readily make their way from the surface to the bottom where the food is, and back to the top to gather oxygen. In addition, larger impoundments often produce predators such as frogs, fish, or predatory insects, so mosquitoes will not thrive there. Water in tree holes can usually be aspirated. If the water is removed in the spring, there will be no problem for months or perhaps even a year. Spaces having sewage backups or periodic flooding may require a permanent solution for continuous drainage.

If source reduction is not practical, mosquito larvicides may need to be used. This type of solution can become expensive if the larval habitats have to be continually re-treated. There are relatively few pesticides registered for larval mosquito control in the U.S. Some of them include *chlorpyrifos* granules or *Bacillus thuriengiensis* (a bacterial insecticide) impregnated granules or "doughnuts." These formulations can be spread with a manual spreader where the breeding pools are small. Light petroleum oils spread on the surface of waters also control larvae.

Adult mosquito control is frequently more challenging than larval control. Exclusion by use of screening is certainly the best means of preventing indoor infestations. Adult mosquito control, by black lights or "bug zappers" is ineffective outdoors and is destructive of the natural insect predators of mosquitoes such as crane flies and syphrid flies. Repellents continuing a high concentration of diethyl toluamide (25-33 percent) in an extender formulation provide the greatest protection, lasting at least six hours. Mosquitoes on screens can be killed by resmethrin. Fogging or ultra-low volume (ULV) treatment outdoors is rarely warranted.

END OF CHAPTER EIGHT

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER NINE - PANTRY AND STORED-PRODUCT PESTS

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

Stored food products are subject to infestation from the point of origin to consumer by different insects. Sites of potential infestation include fields where products are grown and harvested, storage bins where food is held for use or sale, mills where foods are ground, mixed, or packaged, warehouses, food-processing plants, food-service establishments, retail stores, and residential pantries and cupboards.

The most commonly attacked stored food products are cereal grains, spices, and nuts. Less commonly attacked are dried fruits, candy, rodent bait, dried dog food, and dried decorative flowers. Products that are old, or located in hard-to-reach places offer potential for infestation.

2. INDIAN MEAL MOTH

The Indian meal moth, *Plodia interpuntella* (Hbn.), (Fig. 9-1) is one of two major insect pests in this country, and it has become increasingly resistant to pesticides. The Indian meal moth is a small colorful moth about 1/3-inch long with a brown head and thorax. The base of its wings is gray with the rest copper-colored with dark bands. Larvae are caterpillar-like, about 1/2-inch long, and cream-colored with a brown head.

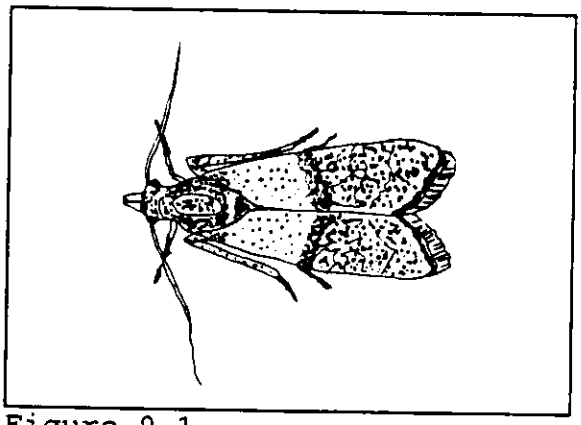


Figure 9-1

Even a small number of larvae constitutes infestation. As the larval population increases, they spin silken strands of webbing contaminated with excrement over their food. Indian meal moths can infest cereals and starch-containing products, such as crackers, cake mixes, pasta, dog food, and rodent bait. They are particularly attracted to nut meats, powdered milk, a number of spices, and dried fruits.

Control depends on finding and destroying the infested items. Sticky traps containing attractive odors are available to monitor the presence of adults, and can be used to determine the location of the

infestation. Other techniques include increased sanitation, treatment of surfaces, cracks, and crevices with pesticides, or, as a last resort, fumigation.

3. SAW-TOOTHED GRAIN BEETLE

The saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.), (Fig. 9-2) is another major stored-product pest in the United States. This is a tiny, slender, dark-brown beetle that measures a little under 1/8-inch long. It has three ridges on the top and six fine teeth on either side of the thorax. Adults are imported in infested packages. Saw-toothed grain beetles are scavengers that readily penetrate and feed on the same materials as do Indian meal moths. Since each female produces around 350 eggs and there is a new generation every 30 days, populations build quickly, making it important to find the infested products quickly. They can destroy a large amount of food. Pesticides are usually unnecessary when infested materials can be found and discarded and cracks and crevices thoroughly cleaned.

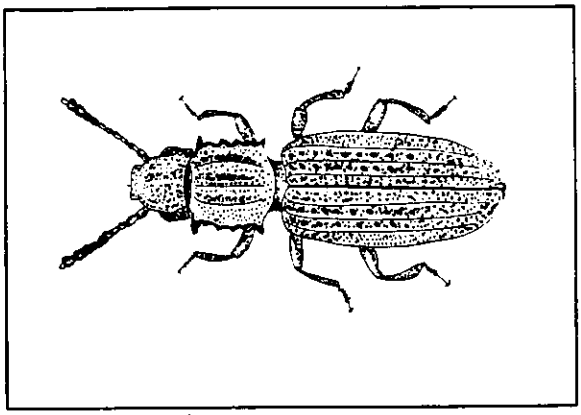


Figure 9-2

4. DERMESTID BEETLES

Dermestid beetles (Fig. 9-3) are a large family of similar-appearing, small beetles that also includes carpet beetles (see Chapter Eleven - Fabric Pests). These pests infest not only fabrics but also a wide variety of stored food products. If food is scarce, some species will cannibalize one another or feed on their own cast skins, and can survive for an extended time without any food. These are among the more common residential pests found in stored seeds, beans, grain, meal, cereals, meat, dry milk, milk products, spices, pet food, nut meats, and dried foods. Their presence usually draws attention when small, shell-like skins cast off from larvae are found in food and on shelves among food packages. For inspection and control see Chapter Eleven - Fabric Pests.

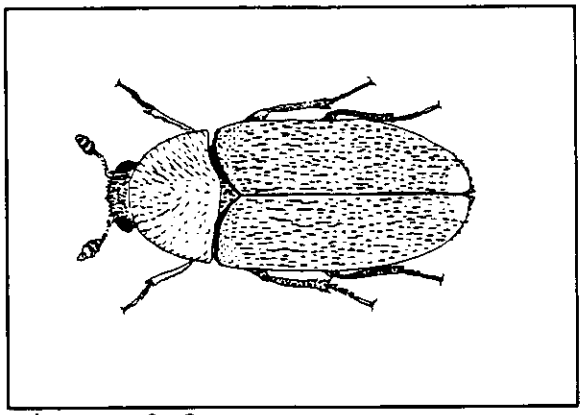


Figure 9-3

5. RICE WEEVILS AND GRANARY WEEVILS

Rice weevils, *Sitophilus oryza* (L.), and granary weevils, *Sitophilus granarius* (L.), (Figs. 9-4 and 9-5) are two similar-appearing snout beetles found and transported in whole-grain products throughout the United States. Adult beetles have long snouts with jaws at the tip; females use their jaws to drill holes into whole grains, where they deposit eggs. Larvae eat the interior of the seed during growth, pupate, and emerge as adults to renew the cycle. Rice weevils fly, but granary weevils do not. Although these two weevils are more common in granaries and mills than in housing, they sometimes infest a wide variety of cereal grains and seeds, including popcorn, puffed wheat, and decorative corn stored in residential pantries and garages. The presence of adults requires that all stored products be checked and that infested ones be discarded.

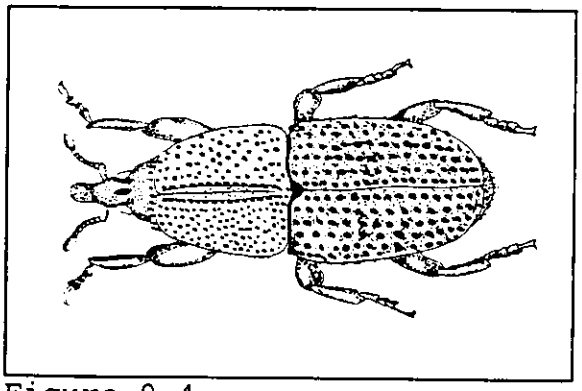


Figure 9-4

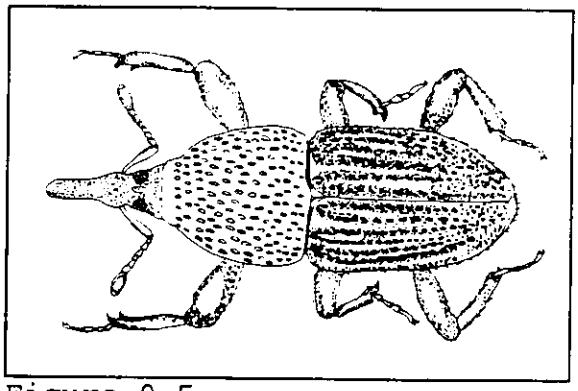


Figure 9-5

6. CIGARETTE AND DRUGSTORE BEETLES

Cigarette, *Lasioderma serricorne* (F.), and drugstore beetles, *Stegobium paniceum* (L.), (Figs. 9-6 and 9-7) are two similar-appearing pests about 1/8-inch long and reddish-brown in color. Both species fly.

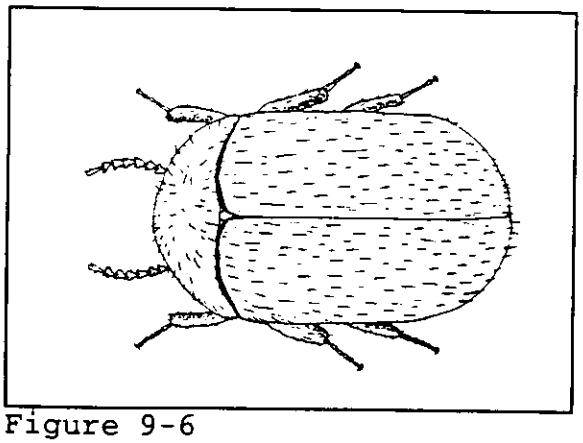


Figure 9-6

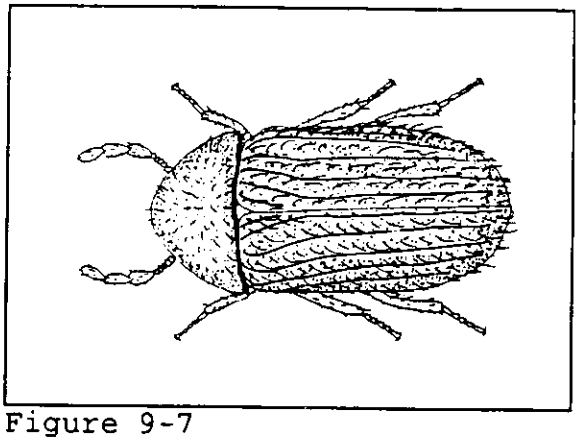


Figure 9-7

These destructive pests affect a wider range of foods than most other stored-food pests. They are found in stored tobacco, spices (especially paprika, ginger, and ground pepper), beans, cottonseed

meal, rice and other grains, milled flours and cornmeal, dry dog food, peanuts, dried fruits, cocoa, herbs, flax, books, some drugs and cosmetics, crackers, celery seed, and even some poisons. They also feed on hardwoods and softwoods (preferring older wood with fairly high moisture content), paper, cellulose, textiles, baskets, herbarium and insect specimens, furniture upholstered with flax tow, straw, fish meal, leather, grain-based rodent bait, and they may damage some protein materials like silk. The larvae cannot develop below 65 degrees F, nor survive in less than 30 percent humidity. Adults are attracted to high-moisture conditions. These beetles are brought into homes on firewood, outdoor furniture, and lumber. Their control requires finding and destroying infestations.

7. FLOUR BEETLES

Two common kinds of similar-appearing flour beetles are the red, *Tribolium castaneum* (Hbst.), and the confused flour beetles, *Tribolium confusum* (Duval), (Figs 9-8 and 9-9). These insects are about 1/8-inch long, reddish-brown in color, and have short, stout antennae. Larvae are only slightly longer than adults, cream-colored, and with few hairs. They infest packaged and milled cereals such as flour, cornmeal, and cake mixes. Bulk flour may remain stored long enough to allow eggs or larvae not killed during milling and packaging to develop. The presence of these pests enhances mold development and imparts disagreeable tastes and odor to flour. They also feed on spices, shelled nuts, dried fruits, and milk chocolate. Control requires that the source of infestation be discarded or sanitized, and the storage area thoroughly cleaned.

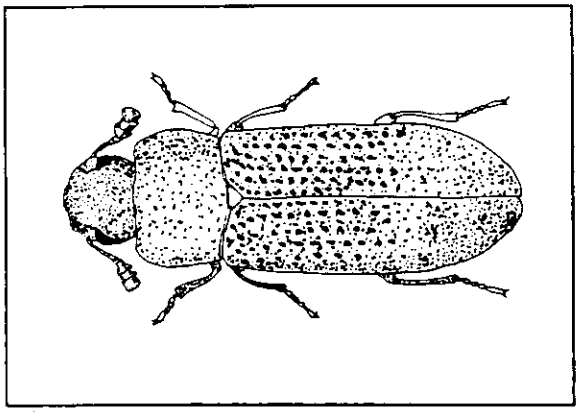


Figure 9-8

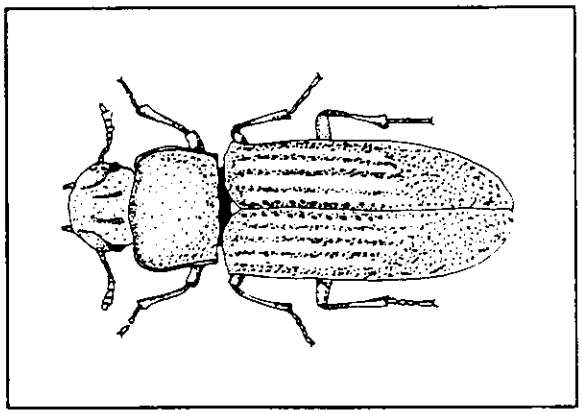


Figure 9-9

SECTION B HAZARDS OF INFESTATION

Worldwide, costly losses of food occur every year because of stored-product pests. When accidentally eaten, larval hairs in contaminated food may cause enteric irritation in infants or intestinal disturbances or allergenic conditions (urticaria, conjunctivitis, nausea, respiratory-tract irritations) in adults.

SECTION C INSPECTION AND MONITORING

1. GENERAL

There is a reason for pest infestation. The intent of inspection is to determine the kind and extent of infestations, how the pest got into the space, and what factors contribute to its survival.

2. INSPECTION

Conduct inspections with a bright flashlight. Special attention should be given to all food spills. To determine if insects have chewed their way into or out of a plastic bag, carefully examine the bag with a hand lens; insects will have entered from the direction in which holes are larger or from the side of the bag showing scratches where insects tried to rasp holes.

Since flour beetles are transported into residences with infested products, control cannot be complete until all infested material is found and removed. This can be a sizeable undertaking, based on the variety of places where stored-product pests may be found. Places where stored-product pests will most likely be found in households are:

- Indian corn decorations and popcorn packing;
- Animal food such as dried dog food, biscuits, and treats stored or spilled under appliances, and bird seed or feed;
- Children's bean bags, forgotten candy or party nuts hidden away;
- Ornamental and decorative foods and grains in printers' boxes, apothecary jars, picture frames, jewelry, and table centerpieces containing nuts or seeds;
- Old rodent bait;
- Spices in metal containers that have been kept for years;
- Ethnic and seasonal foods only used once a year, such as matzo meal or Christmas foods;
- Stuffed dolls and furniture padding;
- Turtle and fish food;
- Old books where insects are attracted to the glue in bindings;
- Old tobacco products forgotten by ex-smokers.

Other locations where stored-product pests may be found are:

- Cork boards and backings;
- Dead animal carcasses in voids, attics, or crawlspaces;
- Objects containing fur, skins, horn, hair, feathers, and bristles;
- Lint in cracks;
- Picture frames, decorations;

- Stored leather goods;
- Old drugs;
- Organic fertilizers and bonemeal;
- Garden seeds and bulbs;
- Insect displays and collections;
- Bird, rodent, wasp, bee, and bat nests;
- Smoked or dried meats.

a. How to Inspect

- Initially, look at products on the "Big 11" list of susceptibles: cocoa, corn meal, farina, grits, fry mix, pasta, barley, flour, dried beans and peas, and spices. Open the bags and examine the inside of bag edges with a flashlight. Pour part of the contents of the bag onto a white paper and look for insects; sometimes insects will "play dead" for a period of time. If insects are not seen, return product to container. Then inspect spices, corn meal, cake mix, other types of food mixes, and dog food. Never look at just the top packages in a stack, examine the second and third packages down where there is less light. Turn packages over and look at bag bottoms for pin holes, insect debris, cast skins, and holes drilled in beans or peas. Sources of infestation are usually old packages of pancake mix or cornmeal that have not been used for years.
- Inspect closets and pantries for forgotten bags of nuts, candy, ornamental corn, or grains. Wild birdseed is a good potential source for infestation. Provide residents instructions on what to look for and request their help in the inspection.
- Inspect the garage if food or pet food is stored there. Also look for containers of wallpaper paste, rodenticide, presence of rodent or insect feces, and bird or insect nests.
- Check to see that shelf paper is not being used in pantry or, if it is used, that it adheres tightly to shelves and doesn't provide insect harborage in folds and loose areas.
- Keep notes on whether the area being inspected is unduly attractive to pests.
- Check crawlspaces and attics, particularly around plumbing lines and bath traps. A commonly overlooked source of stored-product pest problems occurs when rodents store pet food or bird seed in inaccessible wall voids, which then becomes infested. When such "lost" foods gets wet, fungus-dependent beetles, flies, and mites become a whole new array of pests that may infest the residence. Locate and remove such food.
- Request that the resident mark on a floor plan of the residence places where pests have been seen, and then carefully examine those areas.
- Inspect all doors, windows, and structural openings to be sure they exclude insects and mammals.
- Keep notes on the kinds and conditions of outside vegetation. Many spring-flowering shrubs

(Spirea) attract adult Dermestids at a time when outside doors are most often left open. Beetles are attracted into dwellings by food odors and temperature differentials. Pecan and other nut trees harbor insects in fallen fruit which, unknowingly, may be brought into the residence.

- Inspect for the possibility of infestations inside seldom-used food-processing equipment and toasters. Also, regularly inspect dust collectors, look for pipes that connect to fabric sleeves.
- Inspect for infestations in candy and cigarette products in vending machines.

3. MONITORING

The following methods should be used for monitoring pantry and stored-product pests:

- Use a variety of traps to monitor and identify insect pests. Place sticky or attractant (pheromone) traps in a grid where there is a history of infestation and especially in high-risk food-storage areas; pheromone traps may attract beetles from over ten feet away. Replace traps periodically to assure that pheromones are fresh.
- Look for insect trails in dust and determine causes.
- Look for cast insect skins and spilled stored-food products on shelves.

SECTION D CONTROLS

The presence of stored-product pests generally indicates inadequate sanitation practices; control requires that sources of infested food be found and discarded and the storage area be meticulously cleaned. If the source of infestation is not removed, control programs will not be effective.

1. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

Use the following methods to control infestations of pantry and stored-product pests:

- Beverage and laundry trucks and pallets are potential pest sources which should be inspected and frequently cleaned. Store all cans and bottles to be recycled inside six-mil plastic bags and within a closed drum.
- Frequently vacuum up debris from around equipment, under pallets, and from cracks and crevices. Proper sanitation and cleaning programs are vital where foods are stored or processed. Cleaning denies food to pests, and this plays a vital role in reducing the number of insects that survive or reproduce.
- Replace or modify equipment having inaccessible spaces that accumulate food.
- Caulk all wall cracks and penetrations leading into other rooms or voids.
- Correct moisture problems; try to reduce relative humidity as much as possible in food-storage areas.

- Properly install insect electrocuters and frequently clean out collection pans.
- Proper disposal of refuse is vital; keep trash containers covered and regularly empty them.
- Advise residents to store corn meal and flour, if possible, in the refrigerator; store dog food in a tight metal can outside or in the garage; store spices in sealed glass bottles.
- Practice good sanitation. If active infestations are found in food packages, place the food in its original package in an oven at low heat for one hour (until the core temperature is 130 degrees F) to kill pests before throwing the food and package away; re-contamination often occurs when infested goods containing live insect pests are simply discarded into garbage cans. If infested packaged goods cannot be sterilized, seal them in plastic bags and put them into outdoor garbage receptacles; do not allow insects to spread indoors before disposing of infested food.
- For exterior lighting, use high-pressure sodium-vapor lamps that do not attract pests, or mount lights on poles at least 30-feet from buildings so they shine back onto buildings rather than mounting them above doors.
- Refrigerators will protect products from infestation.
- All screens, doors, and windows should be insect-tight, and roof vents/openings screened.
- Clean bulk food bins before refilling them; if different bulk foods are stored close together, establish barriers to prevent pest invasion.
- Regularly check packages to assure plastic wraps are not wrinkled, which allows pests to penetrate the fiber carton. Insects cannot penetrate one-mil polyethylene when the surface is smooth, but will invade creased or bent surfaces; four-mil polyethylene wrapping is resistant to insect penetration.
- Freeze all susceptible flour and cereal goods at 0 degrees F for two weeks when first bringing them into the residence, then periodically freeze them again if they are not promptly used up.
- Heat susceptible flour and cereal goods and hold internal temperature at 120 degrees F for an hour to kill most stored-product pests.
- Provide residents a checklist of the most susceptible products and information on how to monitor for infestations.
- Store susceptible foods in sealed glass or plastic containers.
- Frequently vacuum kitchen cabinets, dry-food storage areas, and under stoves and refrigerators where food debris accumulates.
- Purchase seldom-used foods only in small quantities and avoid long-term storage; rotate foods by a first-in and first-out method, using date codes to manage storage time. Remove and destroy old or suspected items.
- Place food-storage shelves and platforms three to four inches off the floor so floors can be inspected and cleaned; use metal shelving, if possible.

2. CHEMICAL CONTROLS

The use of pesticides, without cleaning and removal of infested foods, will not control stored-product pest infestations. Carefully follow label directions when applying pesticides registered for use in food-storage areas. Storage areas are best treated with spot applications to cracks and crevices that are then caulked.

The large number of chemical pesticides labeled for stored-product pest control includes sprays, aerosols, dusts, and fumigants. However, more and more insects show resistance to insecticides. Follow all safety precautions described on pesticide labels for application and subsequent contact with pesticide-treated surfaces.

Be sure all food products are placed in tightly sealed containers prior to pesticide treatment.

END OF CHAPTER NINE

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER TEN - BEDBUGS

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

At least 74 kinds of bedbugs across the world are noted as blood-sucking parasites on human beings. Although human beings rarely feel their approximately fifteen-minute-long bite, some people show sensitive reactions to them. After the use of DDT, the extent or bedbug infestation declined. Lately, however, there has been some resurgence of bedbug problems.

2. BEDBUGS

Bedbugs (*Cimex lectularius*) are wingless, dark, reddish-brown, oval, and flat insects (Fig. 10-1). The head bears a pair of four-segmented antennae and has piercing and sucking mouth parts that fold into a groove between the first pair of legs. Its body becomes greatly enlarged during blood meals and deep red in color. Adults are about 1/4-inch long and, when host blood is available and temperature, humidity, and harborage are favorable, they mature about four weeks after hatching. Where hosts are scarce, bedbugs can survive a year without feeding. They can also endure freezing.

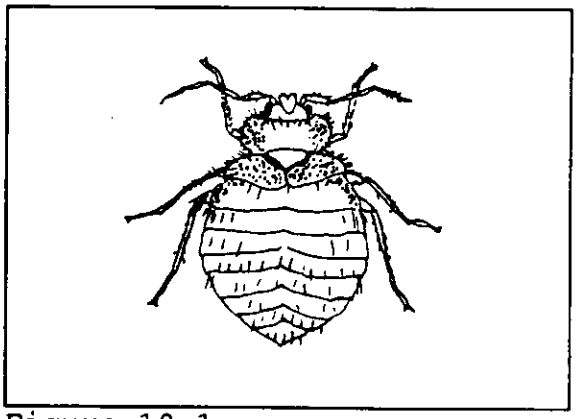


Figure 10-1

Bedbugs use a variety of vertebrate hosts besides man, such as poultry, rodents, dogs, and cats. The surprise occurrence of bedbugs in urban residences can usually be traced back to residents' use of recreational facilities. However, bedbugs are also accidentally introduced into homes on laundry, clothing, and possessions of individuals, by visitors, and from infested moving vans. These insects move between apartments in multi-unit dwellings along water pipes, electrical wires, and through voids and ducts. The bite of a bedbug is distinguished from that of a flea by not having a central red spot surrounded by a circular and reddish halo. Bedbug bites usually produce a small, hard, whitish-colored swelling. One indication of bedbugs is small blood spots on bed sheets after sleeping.

Bedbug females lay batches of one to five eggs (1 mm long) per day for a 60-day period until, over a lifetime, 200 to 500 eggs are produced. The female cements her eggs into protected cracks and crevices or to bedding near a host's sleeping quarters. Although humidity has no effect on development of bedbug eggs, temperatures below 55 and above 98 degrees F prevent development. Hatching takes one to two weeks at optimum temperature, and warmer weather shortens incubation time. Nymphs are tiny and colorless at first, developing color when taking blood meals between each of five molts. The nymphal period can last from several weeks (under favorable conditions) to a year (when hosts are unavailable and temperatures are low); adults mate soon after reaching maturity.

Under normal conditions, bedbugs feed at night. Their flat bodies permit them to hide in very narrow cracks in beds, bedside furniture, dressers, wall boards, door and window frames, behind pictures, under loose wallpaper, and in rooms near host sleeping areas. Heavily infested homes have a distinctive bedbug odor.

Batbugs are another kind of bedbug, found on wild animals, that may be seen filtering into residences through ceiling cracks connecting to bat-infested attics. Similarly, pigeon, swallow, sparrow, starling, and rat nests in attics or voids can be sources of bedbug infestation.

SECTION B HAZARDS OF INFESTATION

Immediately after feeding, a bedbug defecates semi-solid, sticky waste material from its last meal. Although this material may enter the bite and cause inflammation, bedbug bites have not been proven to transmit communicable diseases. However, in some people who are sensitive to bites, bedbugs cause dermatitis, nervous disorders, sleep problems, and contribute to ill health.

SECTION C INSPECTION AND MONITORING

1. INSPECTION

The bedroom is usually the center of bedbug infestation; dark cracks and crevices are potential harborage. Inspect as follows:

- Slide a large piece of butcher paper under the bed and spray the bed springs and frame with pyrethrin flushing agent. Bedbugs, if present, will fall onto the paper.
- Look for black spots near crevices on walls and in bed frames where bedbugs might hide after feeding.

SECTION D CONTROLS

1. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

Use the following methods to control bedbug infestations:

- Tighten and caulk, all possible routes of bedbug entry. Since bedbugs use hosts other than human beings (rodents and some birds), prevent all animals from entry to crawlspaces or entering attics of dwellings.
- In vacant dwellings, store mattresses in protected areas so mice cannot gain access to them.
- Leave unused mattresses in vacant storage space, unfolded.
- Keep weeds and shrubs trimmed back from foundations to prevent bedbug access.
- Eliminate garbage that attracts rodents and other animals.
- Remove bat and bird nests from attics and close access points.
- Steam clean all used furniture before bringing it into the residence.
- Practice good sanitation and good housekeeping; frequently vacuum rooms.
- Caulk and paint all cracks in bedrooms.
- Before placing bedding into moving vans, launder or dry clean it, then seal it in plastic bags.

2. BIOLOGICAL CONTROLS

Household predators of bedbugs include pharaoh and Argentine ants, spiders, pseudoscorpions, and reduviid bugs.

3. OTHER CONTROLS

Heat sterilization is a good alternative where possible; bedbugs quickly die in temperatures of 113 degrees F, and die in 30-60 days at temperatures below 48 degrees F.

4. CHEMICAL CONTROLS

Apply approved residual chemicals labeled for bedbugs to cracks and crevices, behind baseboards, and in all known or suspected harborage areas. Dust formulations of diatomaceous earth with synergized pyrethrins are effective low-toxicity products with residual activity.

END OF CHAPTER TEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER ELEVEN - FABRIC PESTS

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

Fabric pests are represented by two kinds of clothes moths and an array of different, although similar-appearing, small, variously colored beetles, which are grouped here under the generic name of "carpet beetles." Carpet beetles are probably the most difficult of all insects to control. Except for fumigation, pesticides are rarely effective for very long. Regardless of the treatment used, the best controls for fabric pests are thorough and very careful inspections, good sanitation, and exclusion.

Textiles infested and damaged by pests are usually wool-based items such as clothing, carpets, and tapestries. However, both carpet beetles and clothes moths feed on a broader diet than just wool, including items containing hair, mohair, bristles, fur, feathers, and leather, as well as dead insects, pollen, silk, grains, seeds, and many stored foods. Inside, infestations frequently occur when fabric pests develop on dead animal carcasses (birds and rodents) or nests located in or adjacent to buildings, on dead insects (wasps and bees) and molted insect skins, or in spilled foods. Clothing that has food, sweat, or urine stains is especially attractive to clothes moths.

Female moths and carpet beetles lay soft white eggs on materials that will later serve as a larval food source (including lint and debris in concealed cracks). Larvae hatch and feed until mature, at which time they may move away from the food source into secluded spots where they pupate. Upon emerging as adults, they mate and fly around looking for egg-laying locations. Since larvae and adults often avoid light, finding a random larva, pupae, or adult fabric pest in a dwelling may be the only signal of an impending infestation.

2. CLOTHES MOTHS

Webbing clothes moths, *Tineola bissolliella* (Fig. 11-1), and casemaking moths, *Tinea pellionella* (Fig. 11-2), look very much alike. Adults are yellowish or golden colored, 1/2-inch long or less, with narrow wings of about a 1/2-inch span. Adults do not feed, but they fly to find food materials on which they lay 40 to 150 eggs, which hatch in seven to ten days. From two to four generations per year are possible in warm, heated areas. Larvae are white, about 1/3-inch long, with brown heads.

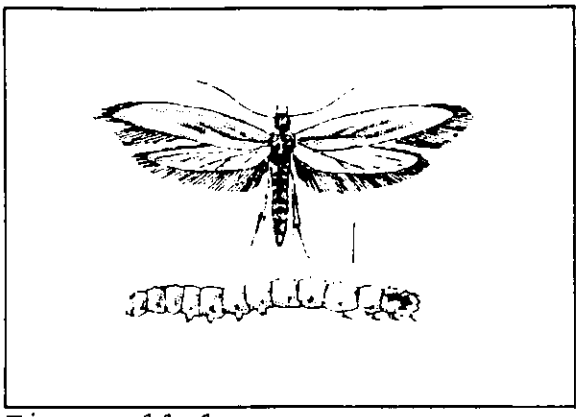


Figure 11-1

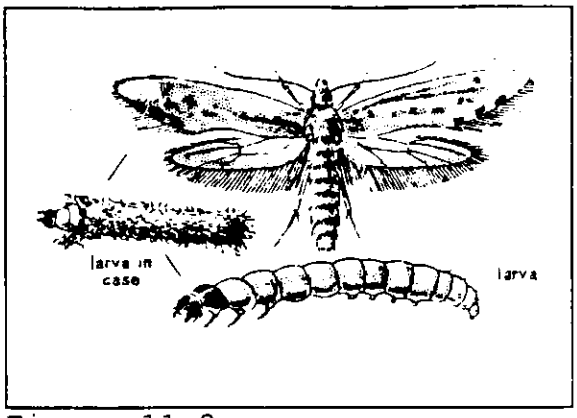


Figure 11-2

Casemaking moth larvae are easily identified by the slender, silken 1/4-inch case they carry around. Webbing clothes-moth larvae make similar silken cases or mats in fabrics but leave them to feed.

3. CARPET BEETLES

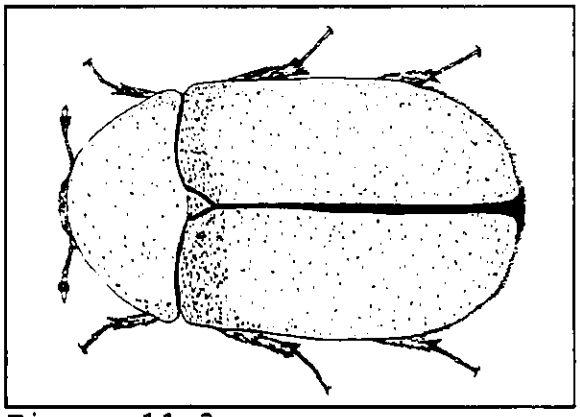


Figure 11-3

There are a many different kinds of carpet beetles (Fig. 11-3) in the United States, and all have greatly varying life cycles and habits. Therefore, it is best to request pest identification by an insect specialist before considering controls. In nature carpet beetles are scavengers that infest bird, mouse, rodent, tent caterpillar, old bee or wasp nests, and spider webs. In general, adult carpet beetles are broadly oval in shape, about 1/16 to 1/8-inch long, and calico, brown, or grayish in color. The round shape and mottled color distinguishes fabric beetles from such other stored-product pests as flour and grain beetles. Female carpet beetles lay up to 100 eggs, which hatch in about two weeks. Carpet-beetle larvae are brownish or yellowish, about 1/4- to 1/2-inch long, with slender bodies that taper towards a tail bearing tufts of hair on the upper surface. Larvae are generally found on products of animal origin. Adults are attracted to the light at windows.

SECTION B HAZARDS OF INFESTATION

Small hairs on larval carpet beetles, when ingested or inhaled, may cause dermatitis and irritations to nasal passages and sinuses. Food containing carpet-beetle larvae has sometimes been responsible for enteric irritation in infants who have eaten it.

Although fabric pests are not known to transmit diseases, feeding larvae do considerable damage to organic materials. Clothes moths damage clothing and rugs.

SECTION C INSPECTION AND MONITORING

1. INSPECTION

Since ordinarily inspection for and control of fabric pests would be carried out by residents themselves, HA staff members are likely only to be called on for assistance when the infestation is very serious or extensive. The information contained here may be passed on to a concerned resident by an HA staff member.

The first step in controlling carpet-beetle or clothes-moth infestations is to inspect the dwelling carefully to discover sources of infestation. Any occurrence of moths or carpet beetles (adults, eggs, larvae, or pupal cases) is ample reason to initiate controls. Prior to inspecting, determine whether soundproofing or insulating materials used in the building's construction are of plant or animal origin and supportive of fabric pests. Since fabric pests feed on a wide variety of items, inspection of the premises and subsequent control should be carefully and thoroughly performed in order to eliminate the problem. If infestation is found, inspect all spaces and destroy all adults and larvae. Populations can expand rapidly from only a few adults. Inspect the following:

- Stored woolen clothing and bedding;
- Down pillows and comforters;
- Silk, fur, mohair objects;
- Upholstered furniture, animal hides and trophies, stuffed animals;
- Light fixtures, washers and dryers;
- Dried-flower arrangements, stored foods, pet foods, dresser drawers and contents,
- Floor cracks, baseboards, and vents for lint, debris, and pet-hair accumulations;
- Eaves, attics, wall voids, and crawlspaces for wasp and bee nests, bird nests, bat roosts, and dead or live animals;
- Fireplaces, chimneys, and vents for dead animals;
- Likely locations for rodent infestations;
- Cereal, meal, and flour goods; seeds and pet foods;
- Wool carpets, rugs, and blankets.

To inspect carpets, pull back the edges from the tack strip and look under edges. Use sticky traps around walls and make careful visual observations. Insects do not infest the entire rug, only those parts not exposed to light and traffic. Closely examine compressed fibers under rugs and under furniture legs; this is an important area to spot-treat with pesticide. Also inspect carpet edges under

the quarter round trim.

Monitor for fabric-pest infestations at least twice a year, using a hand lens and flashlight to search for eggs, adults, larvae, granular feces, and cast larval skins. Check window sills, under windows, window runners, behind baseboards, in cracks, crevices, radiators, and air ducts.

Request help from residents by asking:

- Whether they noted rodents or birds in their homes;
- If animal carcasses or nests have been found and removed;
- If there have been bee, wasp, or ant nests in attic or wall voids;
- If there have been cluster-fly problems: dead insects in wall voids support fabric pest infestation.

2. MONITORING

Pheromone traps are available for several moths and beetles, and others are being developed for monitoring fabric pests. Pheromone traps are usually sticky traps with a lure, usually a sex attractant, for a specific species of insect.

SECTION D CONTROLS

1. MAJOR MISTAKES IN FABRIC-PEST CONTROL PROGRAMS

The following are some of the major mistakes made in fabric-pest control programs:

- Failing to find and control or remove sources of infestation;
- Allowing fabric-pest infestations from the outside through poor exclusion or importing by infested clothing, firewood, and contaminated foods;
- Failing to monitor for fabric pests and allowing infestations to become severe before initiating controls or prevention.

2. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

a. Sanitation

- Store all foods susceptible to fabric pests in glass or plastic jars with tight-fitting lids. Promptly dispose of infested food in outside garbage cans at some distance away from the dwelling. Freeze flour and pasta goods when first bringing them into the house. One commonly overlooked source of pests is infested pet food or bird seed cached by mice, rodents, or squirrels in inaccessible wall voids, under kitchen cabinets, under enclosed bath

tubs, and in attics.

- Periodically examine stored clothing to determine extent and location of damage.
- Illuminate closets; moths prefers darkness and search out dark folds in fabrics and other secluded places in which to hide and lay eggs.
- Regularly vacuum rugs, floors, windows; vacuum lint and dust from behind baseboards, under appliances, and heating units. Frequently vacuum organic debris from floor cracks, drawers, closets, radiators, air ducts, under and behind furniture and kitchen machines, where moths breed. Place vacuum bag in a sealed plastic bag and discard it outside to prevent spreading moths and larvae.
- Remove bird nests from window sills and eaves, rodent nests and dead rodents from attics and basements. Nests and carcasses provide food that supports moths and carpet beetles.
- Trap rodents rather than poisoning them; dead carcasses in wall voids become food sources for moths and insect pests and cause unpleasant odors.
- Moths normally only damage seldom-used clothing and blankets; frequently rotate or use woolen fabrics. Once or twice a month during summer, brush hidden areas (pockets, reverse cuffs, collars) on those garments which are infrequently worn and then shake, brush, comb, beat, and air them out in bright sun. Beating, brushing, and vacuuming dislodges and crushes eggs and young larvae. Sunning and dry-cleaning removes both moths and larvae.
- Comb fur skins with a fine-toothed comb close to the skin where larvae spin cocoons.

b. Exclusion

- Regularly and carefully inspect clothing for insects and evidence of damage; do not import insect eggs or larvae on unprotected or uncleaned articles. Inspect new articles for possible infestation and damage (especially antique upholstered furnishings) before mixing them with articles already in the house.
- Seal and screen all vents, cracks, crevices, holes, and chimneys through which fabric pests could enter the dwelling; install tight-fitting doors and windows; place filters over air ducts.
- Send valuable items out to be cleaned, treated, and stored by a commercial fumigator. Dry clean other fabrics and store them in tightly sealed plastic bags, to exclude moths. Moths cannot live on clean wool and feathers; remove unprotected or soiled woolens from the house or have them treated. Although professional dry-cleaning sterilizes fabrics, it can also uncover undetected damage; fabrics that were originally only held together by moth webbing may fall apart when cleaned.
- Maintain the lowest humidity and temperature conditions and as much illumination as possible.

3. OTHER CONTROLS

a. Biological Controls

Mites, insects, centipedes, scorpions, praying mantises, and spiders prey on fabric pests but cannot be relied upon to prevent infestation.

b. Humidity

Carpet-beetle eggs may be destroyed in highly humid conditions by fungi, but low humidity is the best preventive measure against clothes moths.

c. Sterilization

- Storing fabrics in atmospheres containing more than 50 percent carbon dioxide or inert gas suffocates insects.
- Freeze objects (18 degrees F) for several days to kill larvae and moths, warm them to 40 degrees F to encourage any eggs that survived to hatch, and then freeze again to kill any newly emerged larvae.
- Subject infested objects to a temperature of 120 degrees F or more in a microwave, in a plastic bag placed in the sun, or for an extended period of time in temperatures greater than 93 degrees F. Fabric pests have very low resistance to heat.

4. CHEMICAL CONTROLS

Some modern colorless chemicals used on woolens during manufacture provide permanent moth and carpet-beetle protection, and moth balls were once widely used to prevent moth and fabric-pest damage. Note that these may be dangerous substances.

Take the following precautions with chemical controls:

- Moth balls and naphthalene are very toxic chemicals and pose serious health risks. Moth-ball vapors damage leather goods, synthetic fabrics, plastic buttons, and pine pitch-covered artifacts. Babies can absorb gas from moth-ball treated clothing which may cause acute reactions; low solubility makes these chemicals hard to remove from fabrics. Moth balls can look like candy to youngsters, who can be poisoned by eating them.
- Various insecticides are labeled for fabric-pest control. Before applying any chemical, test fabrics for possible staining and damage. Apply general treatments over the entire carpet surface, as per label. If the nap is thick and moth larvae are deep in the pile, surface treatment will have only

limited effect, and the carpet undersides will need to be treated.

- If extensive damage is present, and moths have infested, or when adult moths are often seen, apply commercially labeled fog, aerosol, or spray treatment and nonresidual insecticide. Some new low-toxicity products may have good residual effects for six or more months in dark closets. Test articles for staining and damage before treating. Carefully follow product label instructions. Schedule any pesticide treatment to take place when moths are active (at night) since pesticide droplets suspended in the air do not easily penetrate cracks and crevices to reach hidden moths. Sensitive persons should dry clean and air treated garments, before wearing to prevent reactions.

END OF CHAPTER ELEVEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER TWELVE - WASPS AND BEES

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

There are thousands of kinds of wasps and bees in North America, most of which are small wasps that parasitize other insects and solitary burrowing bees. However, there are only 50 or so species of stinging wasps and bees that are troublesome to people. These are generally divided into two groups: the social wasps and bees (hornets and yellow jackets, umbrella wasps, and honey bees) and the solitary wasps and bees (mud dauber wasps, cicada killer wasps, and carpenter bees).

Social wasps and honeybees build nests in and around dwellings: beneath eaves, on porches, behind blinds, in trees, shrubbery, and vines, in stone walls, and even in the ground. Most of the social wasps prey on destructive insects (house flies, blow flies, caterpillars, and moths) that they feed to their young (larvae). From this standpoint, they are considered beneficial. Honey bees gather nectar from flowers and convert it into a thick viscous liquid we call honey, which is fed to both adults and larvae. Solitary wasps prey on insects they paralyze and place, along with eggs, into individual nests. After the eggs hatch, the larvae feed on those insects until they can emerge from the nest.

2. SOCIAL WASPS

Social wasps live in colonies that have a caste system (division of labor) with overlapping generations, and all offspring are produced by a single fertile reproductive female called the queen, by laying eggs. The other two adult forms in social-wasp colonies are the fertile males that mate with queens and the female workers, which are sterile. Their social colonies persist for many years, unlike other stinging wasps which start anew each year.

All social wasps develop in similar ways. In the autumn, queens and males leave the nest to mate. The males die after mating, but the queens hibernate over winter in some protected area such as a crack, under tree bark, in buildings, attics, and basements, or in a hole in the ground. Next spring, the queens come out of hibernation, find a suitable nest site, construct simple, small, paper-like nests made from masticated wood and plant fibers mixed with water, and lay 25 to 70 eggs. The queen will not lay more eggs until that first brood has matured. Larvae hatch in a few days and glue themselves into the cells. The queen will feed the larvae chewed up bits of insects over the next twelve to

eighteen days until larvae mature. When mature, larvae spin a silken cap to close the cell and pupate (undergo metamorphosis into an adult). Once the first brood emerges as adults, the queen resumes egg-laying. Subsequent larvae produced by the queen are fed by the first generation of workers who also expand the comb or nest. The queen and workers do not eat the insects they collect for larvae. They subsist entirely on flower nectar and a sweet liquid provided by larvae when fed. With the onset of cold weather, wasps abandon the nest, which disintegrate from actions of weather, birds, or squirrels. The only member of the colony that over-winters is the fertilized queen.

Although yellow jackets and umbrella wasps are closely related and have similar life histories, their nest-building habits differ.

a. Umbrella Wasps

The nest of the umbrella wasp (Fig. 12-1) best demonstrates a basic building pattern. Nests are made of paper-like material produced by the wasps, but appear as a flattened, circular-shaped comb of cells opening downward. These are initiated by the umbrella wasp queen, which starts the nest with a thick paper-like strand attached to an overhanging structure, then adds a small number of cells.

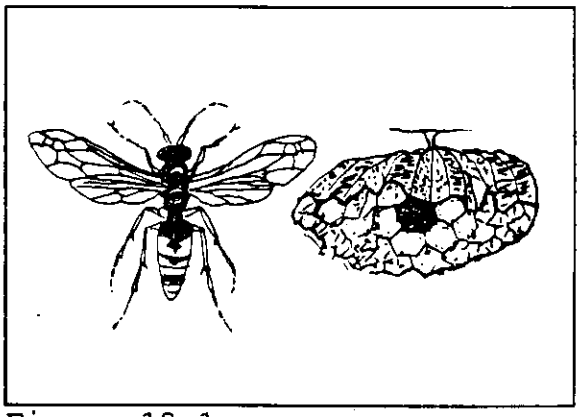


Figure 12-1

Umbrella wasps are slender and elongated, 3/4-inch to 1-inch long. They are black, brown, or red with a few yellow markings. An umbrella-wasp nest usually contains less than 250 individuals.

b. Hornets and Yellow Jackets

Aerial Nest Builders: Aerial nest builders (Fig. 12-2) include hornets and some yellow jackets, which build large football-shaped nests from paper materials similar to those of the umbrella wasp. These nests do not consist of a single, flat comb like that of the umbrella wasp, but contain from four to six wide circular combs, one hanging below the other, and all enclosed in an exterior multi-layer oval paper envelope which provides

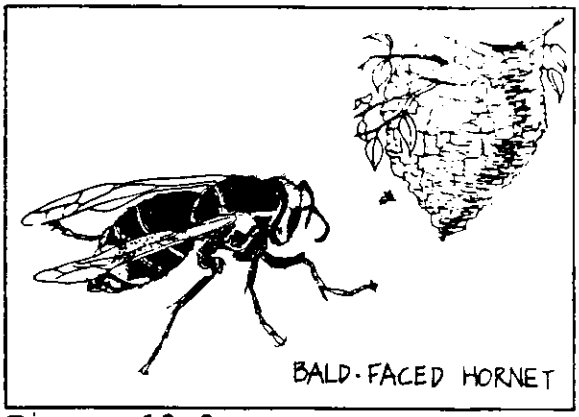


Figure 12-2

insulation. These nests are usually found on branches of trees, in shrubbery, and on gables. Hornet nests may only contain 500 to 600 workers, but yellow-jacket nests can support up to 10,000 individuals.

Underground Nest Builders: Underground nest builders (Fig. 12-3) include other yellow jackets that place a protected nest in a natural ground depression, rodent or animal burrows, or into building-wall voids, attics, hollow trees, and other enclosed spaces instead of in the ground. Once workers begin to care for the nest, they enlarge the entrance hole and try to expand the nest. Combs are placed in tiers, one above the other, and nests can become very large and contain up to 15,000 individuals.

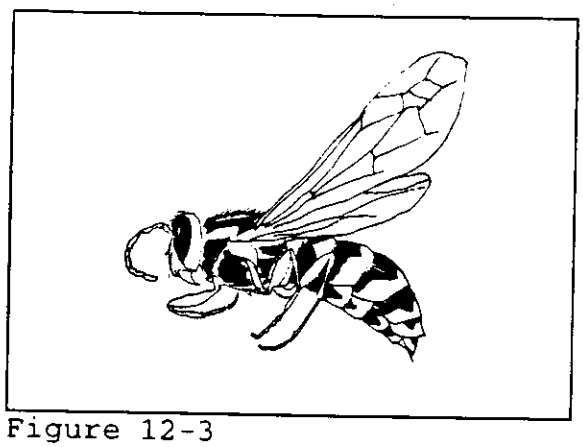


Figure 12-3

Hornets and yellow jackets are black and have yellow or white markings and are more compact in appearance than umbrella wasps. Hornet and yellow-jacket queens measure about 3/4-inch long. The males and workers are about 1/2-inch long. These wasps are feared because of their vicious sting. Populations are at a peak from late July to late September. Hornets and yellow jackets become more aggressive and easily irritated in the fall as the colony becomes old and there are fewer larvae to provide foraging adults their "sugar hit."

3. SOLITARY WASPS AND BEES

Solitary wasps and bees do not build large social nests; instead females dig a hole in the ground, or tunnel into wood, or build a nest out of mud. They then construct a cell or group of cells into which to deposit eggs, provide the eggs with a food source (pollen, or paralyzed insects), and abandon the nest, leaving the young to hatch and mature on their own.

a. Mud Daubers

Mud daubers (Fig. 12-4) are slender wasps, about 3/4-inch to 1-inch long. They are black and yellow, metallic blue, or shiny black, and do not sting unless held in the hand. Their nests are long clay cells placed in such protected places as electric-motor housings, stored machinery, sheds, outhouses, attics, on house siding under overhangs, and under porch ceilings. Occasionally wasps construct their nests on painted surfaces. Removal of these nests and repainting are an extra burden on the HA maintenance staff.

Mud daubers stock their clay nest tunnels with a paralyzed spider, caterpillar, or other insect. Inside a silken cocoon they deposit fertilized eggs on the prey and close the nest hole. When the eggs hatch, the larvae feed on the prey, and adults emerge in spring. In the fall and spring, abandoned nests often house carpet-beetle larvae that feed on residual organic debris in the open clay tunnel. Indoor carpet-beetle infestations have been traced to abandoned mud-dauber nests.

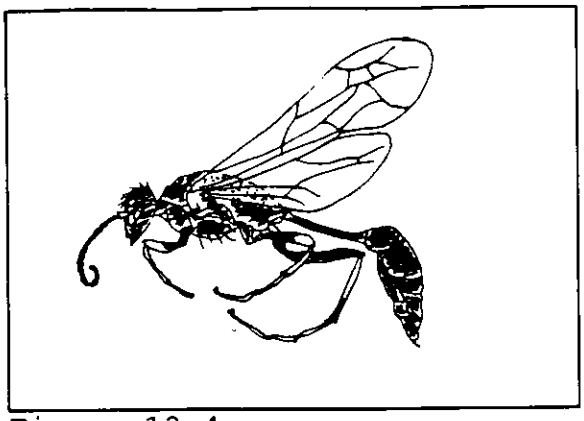


Figure 12-4

b. Cicada Killer Wasps

Cicada killer wasps (Fig. 12-5) are very large (1-1/8 to 1-5/8 inch long) solitary wasps with a black body; the first three abdominal segments are marked with yellow across the thorax, similar to smaller yellow jackets. Legs of the cicada killer wasp are yellowish and wings are brownish. Adult cicada killer wasps feed on nectar. In late summer, the female digs a conspicuous burrow (nest) in the ground (often in lawns or gardens) with a horseshoe-shaped mound of dirt at the entrance. Burrows may be 1-inch to 1-1/2 inches in diameter, two to ten inches under the surface of the ground, and up to eighteen inches long. The female constructs three to four cells at the end of the tunnel, which she stocks with a paralyzed cicada or two, and lays an egg in each cell. After eggs hatch, larvae feed on the cicada. Mature larvae hibernate over winter in the burrow, pupate in the spring, and emerge as adults from late July to August.

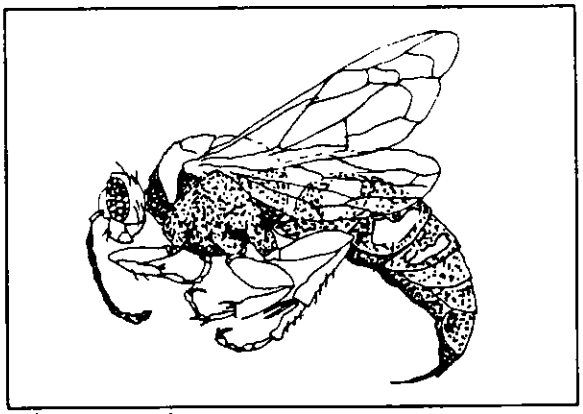


Figure 12-5

Although cicada killer wasps are helpful in reducing cicada populations, they frighten residents because of their large size and the numbers frequenting attractive egg-laying sites. Male cicada-killer wasps guard the burrows; although they may aggressively fly at an invader, they do not sting. Females rarely sting, usually when provoked.

c. **Carpenter Bees**

Carpenter bees (Fig. 12-6) are smooth and shiny solitary bees with a mostly black abdomen; they are not hairy as are bumble bees. They bore into wood to make a tunnel in which they lay eggs and supply developing young with pollen.

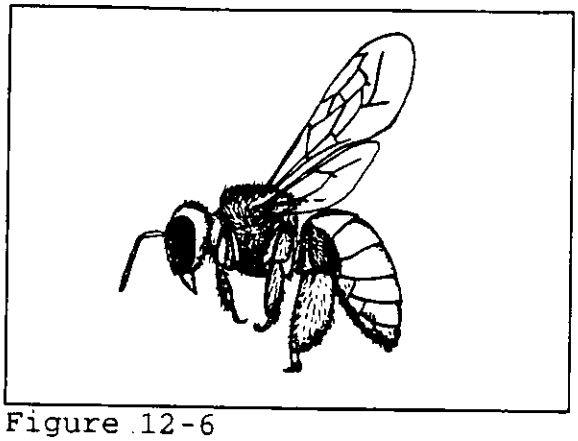


Figure 12-6

4. HONEY BEES

Honey bees (Fig. 12-7) make social colonies of up to 60,000 individuals that live through a number of seasons. Individuals survive the winter by clumping together into a tight group to conserve heat and feed on honey collected and stored during the preceding summer. The number of individuals in a honey-bee colony increase during the spring nectar flow (flower bloom) and develop a queen cell. Before the new queen hatches, the old queen and about half of the bees leave (swarm) the colony and establish a new one in a protected hollow tree, rock void, attic, or building void. Both the original and new colonies increase in number over summer, and swarm again the next spring. Africanized (an aggressive wild bee escaped and moving North into the U.S.) honey-bee colonies have the same life cycle as the European honey bee in the United States, except that Africanized honey bees produce less honey during summer and the colonies swarm much more frequently. Wild (colonies not housed in hives) honey-bee combs appear as long, hanging tiers of cells joined together at the top and made from wax that worker bees produce.

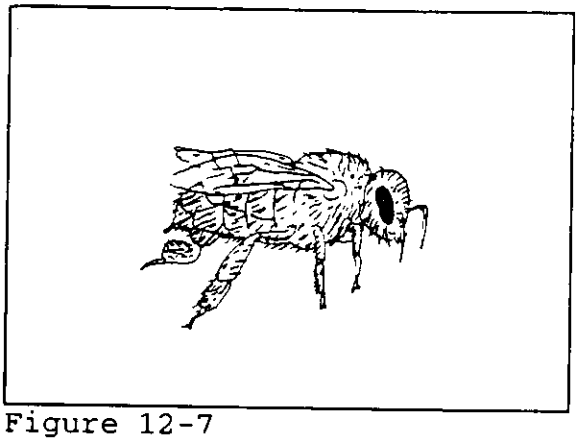


Figure 12-7

SECTION B HAZARDS OF INFESTATION

1. HAZARDS

Yellow jacket problems develop in August or later, when their populations and nest activities are the greatest. Yellow jackets are extremely aggressive wasps and, when stinging, release odors that further enrage the entire colony.

When disturbed, bees and wasps drive a needle-like stinger (modified egg laying organ) into a victim's

flesh and inject a venomous fluid. The venom causes painful swelling that may last several days. Stings may prove fatal to persons allergic to the venom who do not immediately use an anti-venin or consult a doctor.

2. TREATMENT FOR WASP AND BEE STINGS

If stung by a wasp or bee, apply an ice pack, then a paste made from bicarbonate of soda and water to the area around the sting. If stung by numerous wasps or bees, or if allergenic reactions appear, immediately contact a doctor for advice.

SECTION C INSPECTION AND MONITORING

Inspect areas above doorways, holes leading into structures, and hollow trees or rotten tree stumps for stinging-insect nests. Keep records of persons stung in a given area. Monitor garbage cans for the numbers of wasps or bees feeding there over a set period of time. Take control action when fifteen or more foraging wasps or bees visit an open garbage can in ten minutes. Sting incidents increase, based on sting records, when ten or more wasps arrive at a can in ten minutes. Good records should allow correlation of stings with numbers of foragers. This monitoring information can be used to predict when action may need to be taken to control these generally beneficial insects.

SECTION D CONTROLS

1. SANITATION

Good sanitation controls the amount of food available to wasps. Denying food forces worker wasps to find less abundant natural prey and limits the amount of nutrition which larvae receive during periods of exponential colony growth. This ultimately restricts the colony size. Following are sanitation measures which will reduce wasp and bee problems:

- Keep garbage cans tightly closed.
- Check cans often for gaps and holes; request frequent garbage pickup.
- Install garbage liners in cans; promptly clean up garbage spills.
- Spray the inside of garbage cans with household ammonia to repel wasps and hornets.
- Frequently clean both inside and outside of garbage cans with steam or soap and water.
- Move dumpsters and trash barrels away from doorways or other areas of human traffic.
- Prevent the accumulation of standing liquid waste from garbage or dumpster containers underneath the dumpster or in low-lying areas.
- During summer, yellow jackets are attracted to meat; keep food covered.

- Clean up all food or drink spills that attract bees and wasps; wipe outdoor food-preparation surfaces and picnic-table tops with diluted ammonia solutions.

2. EXCLUSION

Some methods of exclusion appropriate to a development are:

- Assure that all doors and windows close tightly and that screens are in good condition.
- Frequently and carefully inspect structural exteriors and seal up all possible wasp or bee entry spots.
- Seal up holes in hollow trees and remove rotten stumps.

3. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

Whenever working around wasps and bees, wear protective bee veils and coveralls. Do not allow bystanders and pets to remain nearby. Only approach honey-bee nests on warm and calm days. Bees are more aggressive on cloudy and windy days when foraging is not possible. Avoid walking through the flight paths of foraging wasps and bees leaving and returning to the colony. At night, avoid shining lights or casting shadows on the nests; use red lights when working on colonies at night. Walk softly near ground-nesting bees and wasps to avoid making vibrations that alert the bees. Carefully and slowly brush off a bee or wasp that lands on a person, or wait until it flies off. If stung, remove the stinger by scraping it from the side, apply cold water or ice in a wet cloth, lie down, lower injured arm or leg, and don't drink alcohol.

Inspect and remove all small wasp nests early in the spring, while nests are still small. Removal at this time of the year is easily done with a broom, vacuum cleaner, garden hose, or other mechanical means. Later, nests will be much larger and better guarded by workers. Watch for honey bee swarms in April and May when they begin to search for new nesting places: including holes leading into structural voids. (Honey bee swarms are easily collected by professional beekeepers from nearby trees and bushes before they find such holes.) Swarms can be discouraged from nest establishment in buildings by various mechanical means such as providing a hive box.

Nesting pests in wall voids can be detected by using a stethoscope. Yellow-jacket nests in wall voids do not necessarily require removal since they do not contain honey and are not reused in the following year. Abandoned nests, however, may attract fabric pests.

Do not seal up active nests before killing the insects. If wasps are sealed into wall voids without an exit, they will chew through the wall to exit somewhere else, even into the interior of the house. If honey bees are sealed into wall voids, melting honey will spoil, rot, and stain the wall. After destroying

nests, close up holes with copper gauze, caulk, duct tape, spackle, putty, or screening.

Use outdoor lights that are not attractive to insects. Remove stumps, dead limbs, hollow trees that can be used for nest sites. Remove plants that attract wasps and bees, including those that are vulnerable to scale or aphid attack, which produce honeydew food sources for wasps.

Sticky or jar traps may be used to capture wasps; however, traps reduce only a small number of foragers.

Keep a list of local beekeepers who may voluntarily remove honey-bee nests. Remove dead honey bee colonies and residue from walls so remaining organic debris and odor does not attract more insects.

Don't go barefoot; don't make unnecessary movements, and don't strike at individual wasps or bees flying nearby. In areas frequented by such insects, avoid wearing perfumes, scents, hair spray, suntan lotion, shaving lotions, talcum powder, cosmetics, and brightly colored or highly patterned clothing, which are attractive to bees and wasps. Examine wet towels before use to see if insects are taking moisture from them. Reduce honey bees on lawns by closely mowing clover and flower heads.

4. OTHER CONTROLS

a. Biological Controls

Biological controls show little promise; parasites, predators, and pathogens are mostly effective only on small, weakened colonies.

b. Heat

Wet or dry temperatures of 130 degrees F effectively kill wasps and bees. If an infested area is covered with a plastic tarp, the summer sun generates lethal heat to kill them.

c. Vacuum

Wasp and bee nests can be removed with an industrial vacuum cleaner. Wear protective clothing. Be sure the vacuum nozzle is placed over the only entrance hole before disturbing the nest. When the last of the colony is removed, plug the vacuum bag with cotton and heat it in the sun to kill the insects.

d. Soap

Cold soapy water effectively kills bees and wasps.

e. Other

- Carbon dioxide foam used for fighting fires is effective in stopping flight and suffocating bees and wasps.
- Spread a plastic sheet over areas where colonial, ground-nesting bees are located. A number of bees may temporarily remain around the plastic, but they will leave after a couple of days. Another alternative is to flood the nest areas with water containing a little soap to drown the adults and larvae.

5. CHEMICAL CONTROLS

a. Poison Baits

Several commercial pesticides are available which foraging wasps and bees carry into the nest; however, poison bait doesn't always work well for all types of wasps since different colonies of yellow jackets have different foraging habits and food preferences. Further, poison baits may kill valuable domestic honey-bee colonies. Poison baits should not be accessible to children and nontarget insects and animals.

b. Aerosol Sprays for Aerial Nests

Commercial aerosol preparations are available that quickly and safely destroy aerial wasp and bee nests. Follow label directions.

c. Insecticides for Subterranean Nests

After locating and sealing all entrances but one, properly labeled insecticides can be poured into subterranean colonies and the entrance plugged. Do not seal all entrances of nests located in building walls without killing the colony; wasps will chew through walls into interior spaces in an effort to escape.

d. Dusts and Aerosols for Wasp and Bee Nests in Wall Voids and Attics

There are residual pesticide dusts and aerosol formulations available to treat nests in building

walls and attics. Follow label directions. Having found the location of a nest (by listening for buzzing behind wallboard), drill a hole and inject aerosol or dust directly into the colony. Killing honey bees in walls with pesticides causes deterioration of honey and nest combs and attracts other bees and troublesome insects; melting honey and wax may stain walls unless the structure is opened up to remove the debris. Contact your local beekeeper association for assistance, if necessary, in removing honey bees by means other than pesticides.

END OF CHAPTER TWELVE

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER THIRTEEN - SPIDERS

SECTION A CHARACTERISTICS AND RECOGNITION

1. GENERAL

Only a few species of spiders live in structures; most are accidentally carried into dwellings on firewood, laundry, or flowers. Since they feed on insects, they are rarely problems in buildings without an insect food source. They are objectionable pests to people fearful of them, even though most are harmless. There are only two spiders considered dangerous to human beings in the United States: the black widow and the brown recluse. These generic names, however, represent several different species. The following discussion describes these two spiders, but generally applies to all spiders.

2. BLACK WIDOW SPIDER

Several kinds of black widow spiders are widely distributed over the eastern, southern, western, and northwestern states of this country. Black widow spiders are normally outdoor species; however, they sometimes move or are accidentally brought indoors. Young spiders may migrate inside on ground-floor levels. Outside, the black widow can be found in crawl spaces, bird nests, on low-growing plants, grape arbors, and under porches, garages, and sheds. But they are also found in stacked pots, baskets, boards, firewood piles, rodent burrows, water meters, and under bricks and stones.

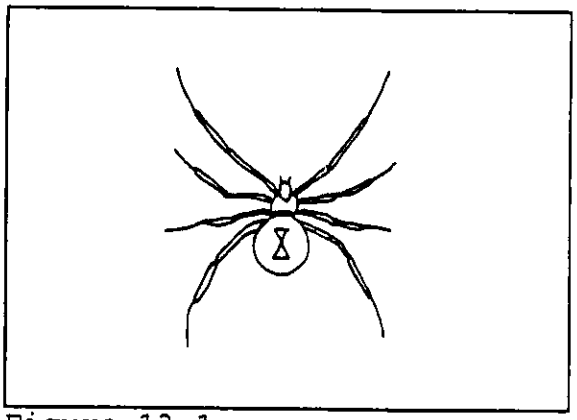


Figure 13-1

The female black widow has poison glands and fangs with which she kills insect prey. These spiders can go for as long as three to four months without eating at all. Although the female black widow rarely leaves the web, males are more adventurous, especially when seeking a mate. When they first hatch, males are slightly venomous, but the potency of venom is lost as they mature. Male black widow spiders are not dangerous to people.

The adult female black widow spider (Fig. 13-1) has a shiny black abdomen that usually carries on the

underside red or yellow-red markings resembling an hourglass, and visible when she hangs upside down in the web. The markings, which may be absent, vary in different individuals from that of a typical hourglass shape to a pattern of two or more triangles; occasionally, some spiders may only possess a long, irregularly colored area. Male black widow spiders are small, white, and streaked with red, white, or yellow. Although female black widows are about 1/2-inch long, males are only about half that size and have longer legs.

Adult female black widow spiders are primarily nocturnal. They weave tangled webs of coarse silk in dark locations, and in late summer begin to lay batches of eggs in units of 300 to 400 on the web. During a season, they can produce from four to nine batches of eggs, which are covered with a silken sac. The female guards the egg capsules and moves them as necessary when repairing the web. Females tend to be hungry and aggressive after egg-laying, during which time most human-related bites seem to occur. Eggs hatch in eight to ten days, and the young disperse by riding air currents on short strands of web. Black widows mature in about four months and only mate once. Although some believe the female kills the male after mating (hence, the name "widow"), others contend that the female rarely does so. The life span of a spider is from eighteen to twenty-four months.

3. BROWN RECLUSE SPIDER

About seven kinds of brown recluse spiders make up this group. These are dusky-tan or brown spiders that range over most of the United States, sometimes "hitch-hiking" into dwellings on luggage or household furnishings from other places.

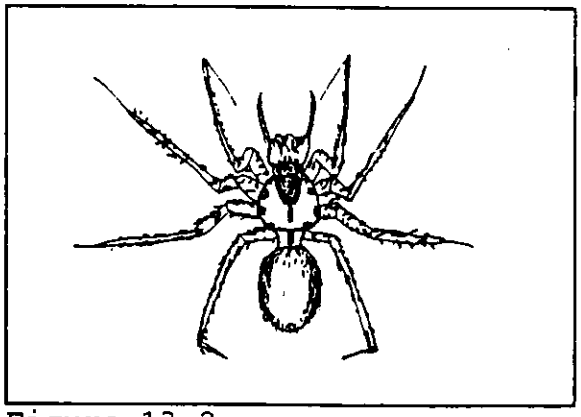


Figure 13-2

The brown recluse spider is an outdoor species that hunts at night. It doesn't use a web to capture prey, but runs fast to overtake it instead. In the south, the brown recluse lives under loose bark, in woodpiles, under sheds, and beneath debris. In the North, it has to live indoors, especially in the sleeves of clothing hung for long periods of time in closets. The brown recluse spider has a high moisture requirement, and is often found near water heaters. It may also be found behind or under furniture and boxes.

The brown recluse (Fig. 13-2) is a medium-sized spider (about 5/16 to 1/2-inch) and smaller than the black widow. Unlike the black widow, the brown recluse has an oval abdomen that is uniformly tan-to-brown and without markings. A dark "violin-shaped" fiddle back mark is obvious on the cephalothorax (combined head and thorax portions) on most species. The broad base of the fiddle

begins at the eyes and the narrow part of the fiddle neck ends just above the attachment of the abdomen. The brown recluse has six eyes placed in a semi-circular pattern. Its legs are long, the second pair longer than the first.

Although the brown recluse makes a fine, irregular web, it wanders around to hunt after maturing. During a lifetime, females produce one to five egg cases of 30 to 50 eggs each. Eggs are placed on the web in a loosely woven sac of wispy sheets of silk. Usually one or two young spiders per brood survive, because adults are cannibalistic (and also feed on black widow spiders). Recluse spiders mature in seven to twelve months, and they generally live one or two years.

SECTION B HAZARDS OF INFESTATION

1. BLACK WIDOW SPIDER BITES

Death results in less than four percent of persons bitten by black widow spiders. Strong, healthy adults rarely succumb to a bite, but young children are more vulnerable. Deaths among the elderly are usually the result of complications beyond the spider's bite.

Female black widow spiders are quite timid and usually make no effort to bite, even when provoked. Bites may occur when a spider is accidently squeezed against a person's body. Spiders make webs in the folds of clothing, shoes, or under objects in dark corners.

The severity of the black widow bite depends on the amount of venom injected, age and condition of both the victim and the spider, part of the body bitten, degree of immunity of the victim, and treatment given. A black widow spider bite is not always felt, and in most cases, only two tiny spots along with redness appear at the bite site. Pain begins to increase around the bite after half an hour or more, along with other symptoms such as headache, dizziness, shortness of breath, and abdominal and back pain. The pain lasts for 12 to 48 hours and is generally worst by the second or third hour. Muscles in the victim's abdomen become rigid, and the person may develop nausea and, in some case, convulsions.

a. How to Treat a Black Widow Bite

Anyone bitten by a black widow spider should be treated for shock by being kept quiet, preferably in bed and covered with a blanket. Get victims to a hospital as soon as possible. Antivenin is readily available to most physicians; if a doctor is not available, wash the skin around the bite but make sure any venom still remaining on the skin is flushed away from and not into the wound. Recommendations are to continually apply ice to the bite site, since cold delays absorption of the

poison and gives the body an opportunity to neutralize the venom. Never administer alcohol since it increases sensitivity to the venom. Give the patient plenty of water and sweet weak tea.

2. BROWN RECLUSE SPIDER BITES

Brown recluse spiders generally avoid areas of human activity, and are usually found only in unused rooms. Even though indoor infestations may be large, household residents are seldom bitten. The brown recluse is not aggressive but bites and causes severe wounds when squeezed against a person's skin, as in putting on shoes or clothing (most bites occur on arms and legs). Bites can be expected when previously unused rooms are occupied or when clothing stored for a long time in closets is brought out for use. Brown recluse bites sometimes produce a sharp sensation at first, which may be mistaken for a bee sting or insect bite. However, it may not be noticed at all. Victims may not realize the full extent of the trouble for eight to twelve hours, when pain becomes intense. A reddened area and accompanying painful swelling develop at the bite, and nausea, vomiting, fever, and a rash may appear. The site of the bite becomes dark and dry and after seven to fourteen days, tissues surrounding the bite become an open ulcerous wound. Without prompt medical attention and over a period of days, the ulcerous wound becomes a festering sore. Although scabs may form over the wound, they tend to fall off and the wound continually grows deeper and fails to heal for several months (up to a year). There is always the potential for gangrenous infection and skin grafts are sometimes required to close the wound. Death from bites is extremely rare, but bites are very debilitating and traumatic.

a. How to Treat a Brown Recluse Bite

Apply ice to a bite as soon as possible, elevate the limb, and take the victim to a physician. The brown recluse is a delicate spider and after a bite it can usually be found near where it was slapped by the victim. The spider should be killed (without destroying it, so it can be identified) and taken with the victim to the physician. Identification of the spider is important for proper treatment, because a few other biting arthropods produce similar injury.

3. OTHER HAZARDS

Some spider webs may clog vent pipes and trap fumes or odors inside structures.

SECTION C INSPECTION AND MONITORING

Move cautiously when inspecting or treating sites where there is potential spider harborage.

1. INSPECTING FOR RECLUSE SPIDERS

Wear long sleeves, long pants, socks, and gloves and use a flashlight during inspections along walls in little-used, cluttered storage areas such as closets and attics. Look for loose irregular webs, cast skins and silky egg cases (about 1/3 inch in diameter), but avoid placing hands in dark places. Spiders shed their skins in order to grow; these "cast" skins are fragile but retain a characteristic violin marking. Such skins indicate infestation.

Inspect behind and under furniture, in kitchen and bathroom cabinets, closets, ceiling light fixtures, stacks of fire wood, and water-heater closets. Other locations for inspection should include mattresses and bedding; walls and floors and stacked boxes, bags, papers in store rooms and sheds; behind picture frames; under stairs; and hanging clothing that has not been used for some time. Concentrate on areas outside daily traffic patterns. Outdoors, brown recluses are found between the soil and foundations, door stoops, and in window wells.

2. MONITORING BROWN RECLUSE SPIDERS

The presence of brown recluse spiders can be monitored in sticky traps. Tent-top or other sticky traps with covers seem the most effective.

SECTION D CONTROLS

Spiders should be conserved whenever possible; they are natural control agents for many pests.

1. MAJOR MISTAKES IN SPIDER CONTROL PROCEDURES

The following are mistakes made in spider control procedures:

- Spiders are re-introduced into structures by way of firewood, laundry, and flowers.
- Failure to eliminate the insect food source.
- Over-responding in control due to spider misidentification.
- Extensive pesticide application when only a few harmless spiders are present, which could be controlled by physical or mechanical means.

2. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

a. Sanitation

Habitat modification, good sanitation, and exclusion are absolutely necessary for long-term spider elimination. Inform residents of the need and the techniques.

- Frequently and thoroughly vacuum (with an industrial vacuum) all cracks and crevices, closets, behind furniture, and mop floors to destroy webs, egg sacks, and young spiders. Clean dark corners (using leather or rubber gloves). Concentrate efforts for brown recluse control in seldom-used rooms. Remove webs from exterior of building so that spiders leave.
- Remove lumber, scrap, rubbish, and debris from near and under buildings; frequently clean rain gutters. Stack firewood, brick, and stone piles away from buildings; inspect firewood for spiders and egg sacs. Keep grass mowed and cut very short next to buildings; establish an 18-inch swathe of gravel cleared of vegetation all around buildings. Keep trees and shrubs trimmed back at least twelve inches from structural walls. Pick up leaf litter and other debris in yard, especially next to buildings.
- Make residents aware that spiders are often introduced into dwellings on firewood, lawn furniture, garden implements, and children's toys. Remove the bark from firewood or be sure that it has been solidly frozen before bringing it inside; don't bring in any more wood than will be burned in an hour or two.
- Perform annual spring cleaning: turn mattresses, clean closets; dispose of unused items, rotate seldom-used items in garages, under beds, other areas; neatly stack items inside away from walls; remove and wash all bedding; remove and clean drawers from dressers, remove cobwebs. This is very important for brown recluse control because it interrupts the spider's reclusive habits. Re-inspect spaces disturbed by dusting, vacuuming, and mopping the same evening, and kill any moving spiders.
- Inspect winter clothing and other unused closets during spring and summer. Before returning clothing to storage, clean it and pack it in sealed plastic bags.
- Repair all water leaks and sources of condensation on pipes.
- Reduce the numbers of insects in and around the building. To avoid attracting spiders, arrange outside lighting so as not to attract insects, move lights onto poles and away from structures; trim weeds and remove debris around foundations, caulk entry holes, install tight-fitting screens and door sweeps. Spiders need a ready supply of insects to survive, and invade homes infested with insects.
- Regularly clean floors and baseboards and remove debris. Do not leave old clothing or bedding or boxes and piles of paper on floors.
- Thoroughly clean attached garages and basements, crawlspaces, and outbuildings.
- Dry out crawlspaces, or spider problems will recur.

b. Exclusion

Inspect doors and window casings to be sure screens function properly; caulk holes large enough to admit spiders, including openings around water pipes and electrical lines. Keep tubs, sinks, and drains stoppered at night. Install tight-fitting door sweeps to exclude spiders and crawling insects.

3. OTHER CONTROLS

a. Biological Controls

Mud dauber wasps, birds, rodents, and predatory insects prey on spiders.

b. Heat

Infested rooms can be treated by heating them to 120 degrees F for one-half hour.

c. Direct Controls

Step on individual spiders, kill them with a fly swatter, or remove them with a vacuum.

4. CHEMICAL CONTROLS

Chemical control, when used, should be combined with nonchemical controls. Although spiders are susceptible to most insecticides, chemicals are seldom used because of difficulties in getting spiders into contact with pesticides: they do not ingest pesticides during grooming and walk on hairs on their feet which prevents surface contact. Web-building spiders seldom leave their webs.

Pesticide dusts, however, are sometimes applied in attics and crawlspaces and residual sprays are used for perimeter treatment. If a good spider reduction is done in the fall, few problems should occur until early to late summer of the next year.

When using pesticides to treat dwellings for spiders, warn residents that spiders not killed will wander for a few days following treatment and residents should be cautious in rooms that were treated.

Carefully analyze the micro-habitat occupied by problem spiders and use appropriate nonchemical and chemical controls.

a. Indoors

If necessary, use crack-and-crevice application dust like boric acid or diatomaceous earth to treat the structure, including attic and crawlspace, window and door frames and casings, baseboards, cracks and crevices, room corners, beneath and behind furniture, closet bottoms, and garage, in order to reduce insects spiders feed on. Since web-building spiders recycle silk (eat and digest old webs), light dust applications on webs may be effective.

If spider populations are not reduced, spot-treat areas of infestation with residual chemicals by directing insecticide into voids, cracks, and crevices.

b. Outside

Using the above techniques and materials, treat around foundations, windows, doorways, pipe openings, wooden fences, weep holes in brick walls or veneers, and building perimeters. Dustings should be wide-spread to eliminate spiders before they enter the dwelling. There is no need to treat the lawn.

END OF CHAPTER THIRTEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER FOURTEEN - TICKS

SECTION A GENERAL

Ticks feed on the blood of only mammals, birds, reptiles, and amphibians. One way in which ticks differ from mites is that ticks are larger and have recurved teeth or ridges on the central mouthparts (called the holdfast organ). They also have, on each of the first pair of legs, a sensory pit which detects stimuli such as heat and carbon dioxide. Ticks also detect light and dark as well as shapes, shadows, and vibrations—all stimuli that help them find their hosts.

There are two types of ticks: soft and hard. Soft ticks feed on hosts that return periodically to a nest, shelter, cave, or coop. Hard ticks are found on pets, cattle, wildlife, and people. Campers, hikers, and hunters are sometimes hosts for hard ticks. Worldwide, there are over 650 species in this group.

Some ticks live their entire lives on one host, while others spend only their larval and nymphal stages on a single host, then drop off as an adult to find another host. Most ticks, however, have three hosts, one for each stage.

1. LIFE CYCLE

a. Seed Ticks

Normally, thousands of tiny larvae hatch from a batch of eggs and crawl randomly in the surrounding area; larvae (or seed ticks) have only three pair of legs. Some attach to a small mammal or lizard, and suck blood. Their feeding (or engorgement) time lasts for hours or a day or so, since they are small. The host may distribute them while wandering away from the site of the initial encounter. When the engorged seed ticks drop off, they are still usually in or near an animal run.

b. Nymph

After molting, engorged nymphs, now with four pair of legs, climb grass leaves or a plant stem. Ticks climb progressively higher as they develop, so that different stages reach different layers of vegetation. Because of this, developing ticks find larger hosts than they had during the previous stage. After several days of feeding, engorged nymphs drop off the host and molt.

c. Adult

Adults climbs vegetation, stretch their front pair of legs, and wait for vibrations or a shadow announcing a nearby host. Ticks sometimes wait for months or more for a suitable host. If heat or carbon dioxide is detected (for instance, from a feeding mouse), the tick will seek it out. As the host passes by, claws located at the tips of the tick's legs grab hold of the host, and the tick moves to a place where it can engorge.

2. ATTACHMENT AND FEEDING

Adult female hard ticks will feed from several days to more than a week. Ticks usually grasp human hosts from a point close to the ground and crawl upwards until they reach tight clothing or the head. On wild mammals or pets, they move until they reach the highest point on the host, the head or ears.

The tick's ability to creep undetected is matched only by its ability to attach for feeding without the notice of the host; stealth keeps ticks from being scratched off by the host before they can attach. The tick slides its pair of slender teeth painlessly into the host's skin, and feeding attachment begins. Female feeding may take a week or more, or in the case of human hosts, until the tick is discovered. When feeding is complete, the engorged female drops off of the host, lays eggs, then dies. Male ticks are on the host only to mate with the female. They do not enlarge greatly or feed much. They sometimes pierce and feed on engorged females. In one species, this is the only way males feed.

SECTION B TICK RECOGNITION

1. BROWN DOG TICK

The brown dog tick, *Rhipicephalus sanguineus* (Fig. 14-1), is the most urban of the pest ticks in the U.S. whose only host is dogs. It lives outdoors year round in the southern states, but in the rest of the country it cannot live outdoors in winter.

Adult ticks are about 1/8 inch long and dark red-brown, differing from the other pest ticks that have a red-and-black or white-and-brown color variation. The engorged female becomes a dark blue-gray because of her blood-stretched abdomen.

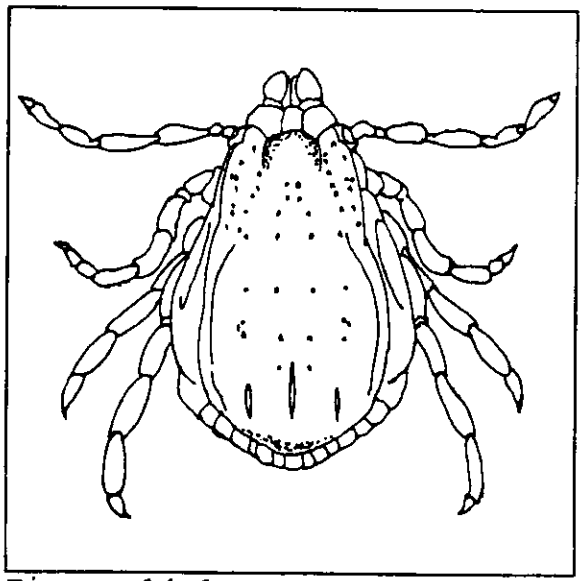


Figure 14-1

Up to 4,000 eggs can be deposited by the female. When the eggs hatch outdoors, larvae climb vegetation; inside they climb walls and furniture. The larvae, nymphs, and adults return to the dog to feed; they do not bite people. If they do not find a host, they can easily wait more than six months without feeding. After each engorgement, the tick drops and crawls to a crack where it molts. After a generation or two, ticks can be found at all stages, hiding, molting, or seeking a host. One to four generations can be produced each year, depending on the availability of hosts and temperature.

a. Infestation

Residences and yards can be infested by the visit of an infested dog that drops mated, engorged female ticks. Dogs can pick up ticks outdoors when taken to an infested kennel or home. Female ticks will drop off indoors, lay eggs, and their larvae will emerge in late fall. Tick infestations indoors are likely to be by brown dog ticks. Brown dog ticks usually drop off when the dog is sleeping, so its sleeping areas will most likely be infested.

2. AMERICAN DOG TICK

Larvae and nymphs of the American dog tick, *Dermacentor variabilis* (Fig. 14-2), prefer small rodents, especially *Microtus*, the short tailed voles, called meadow mice. The adults, which are slightly over 1/8 inch long, are found on dogs and people. The adult female is brown with a pearly light anterior dorsal shield. Males are brown-backed with pearly streaks. Both sexes have eyes, or unpigmented light-receiving areas, at the edges of the shield.

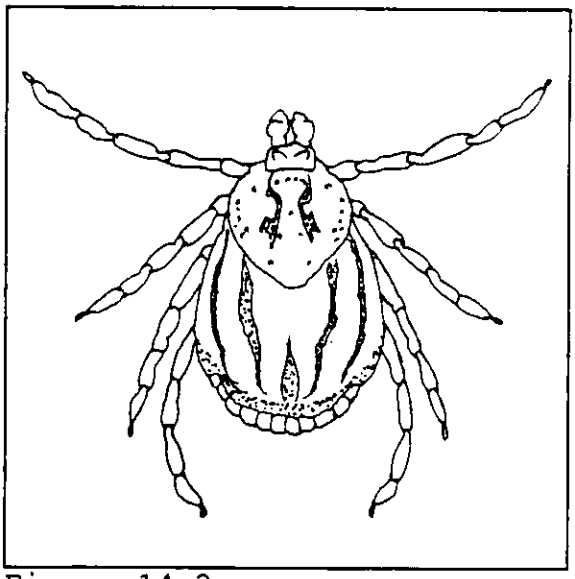


Figure 14-2

With a favorable food supply, American dog ticks can complete their life cycle in three months, with the female laying up to 6,500 eggs in late summer. Warm springs promote early adult and larval activity and egg-laying.

Adult ticks usually contact people on the lower extremities and crawl upwards until they are stopped by constricting clothing, such as belts or underclothing. Loose clothing allows ticks to proceed as far as the head. Because of possible communication of Rocky Mountain Spotted Fever (RMSF), any tick attachment should be noted and the victim observed for symptoms.

3. LONE STAR TICK

The Lone Star tick, *Amblyomma americanum* (Fig. 14-3), lives in the southeastern quarter of the United States, from Texas to Missouri and east to New Jersey. It attacks birds and wild and domestic mammals, as well as people.

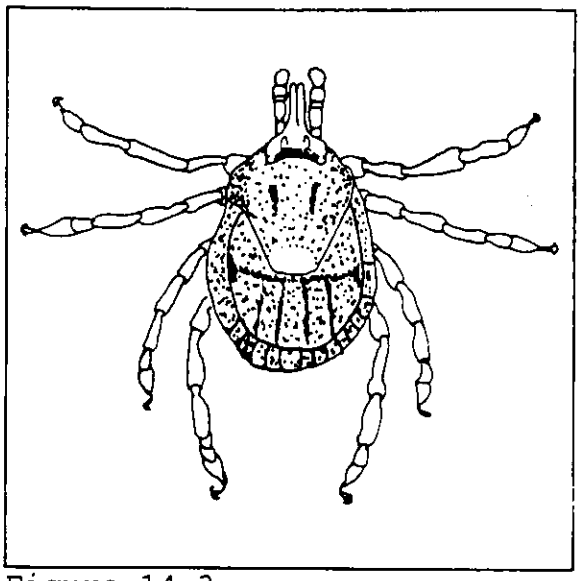


Figure 14-3

Females are brown with a white spot in their center (the Lone Star); males are mottled brown without a white spot. Both sexes have pigmented eyes at the front lateral edges of the scutum. Females often produce more than 6,000 eggs.

Although it is rare, people may be infested by all three stages of the Lone Star tick while inadvertently sitting or laying on an aggregation of larvae. However, the larvae do not attach, so they can be showered off. When found on people, the ticks should certainly be removed and noted in case RMSF symptoms develop.

4. DEER TICKS

Deer tick (*Ixodes*, Fig. 14-4) larvae are very small. Nymphs are close in size to the adult, a little less than 1/16th inch, or the size of the head of a pin. Adult deer ticks are the size of a sesame seed. Deer ticks have a two-year life cycle and utilize three different hosts.

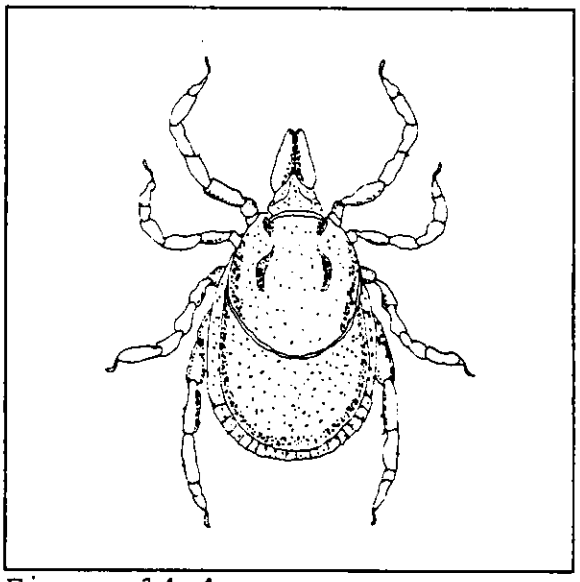


Figure 14-4

a. Eggs and Larvae

Eggs of the deer tick are laid in the spring by overwintering females. Tiny larvae hatch and feed on white-footed mice and other mice in the late summer. Larvae can feed on human beings, but will not transmit Lyme disease. After overwintering, larvae molt into the nymphal stage the following spring.

b. Nymphs

Nymphs are ready to feed in May and June. The body of the nymph is tan with black legs and a black shield (scutum) near its front. Nymphs climb vegetation and attach to passing animals such as dogs, cats, horses, cattle, raccoons, opossums, mice, migrating birds, and people.

Nymphs live in woodlands: bushy, low-shrub regions and grassy areas where they can infect animals and people. **Most human Lyme disease cases are the result of nymphal tick feeding.** The remainder is due to adult activity. Nymphs usually molt into the adult stage in late summer, although they sometimes overwinter and molt in the spring.

c. Adults

The body of the adult female is brick red with black legs; she has a black shield (scutum) in the front. The male is entirely dark and smaller than the female. Adults feed in late fall or spring, as well as on warm days in winter. Hosts of the western blacklegged tick are dogs, cats, sheep, horses, cattle, and deer.

SECTION C TICKS AND DISEASES

Several species of hard ticks are responsible for the spread and increase of Lyme disease and the persistence of Rocky Mountain Spotted Fever (RMSF). HA pest managers should be familiar with Lyme disease and the *Ixodes* ticks that transmit it.

The urban population in the U.S. is increasingly at risk from tick-borne diseases for the following reasons:

- Reversion of farmland to scrub vegetation;
- Continuous incorporation of rural land into urban population centers;
- Frequent travel to rural areas;
- Wildlife populations, hosts for tick-borne disease, are increasing in both rural and urban areas.

Ticks are successful parasites and transmitters of diseases because:

- They are persistent bloodsuckers; they attach and hold on.
- Long feeding periods give time for infection and extend the distribution time.
- Species have a wide host range. Initially ticks feed on small hosts, later on larger hosts; most can take three different hosts. They primarily feed on mammals, but also on birds and reptiles.
- They have a tremendous reproduction potential and lay several thousand eggs.
- Eggs of some disease-carrying ticks also carry the disease.
- They have few natural enemies. Only two species of wasps parasitize hard ticks.

1. LYME DISEASE

Lyme disease is caused by a spirochaete (spiral-shaped) bacteria. Symptoms vary and may resemble other diseases; many cases go undetected. The first indication of a potential infection may be the discovery of an attached tick. **Disease transmission does not occur for an estimated 10-12 hours after feeding begins; if the tick is located and removed within that time, no infection will occur.**

Usually, within seven days (from three to 32 days) after disease transmission, a rash appears which looks like a red, expanding ring with a clear spot at the center of the bite. It is not uncommon to find the rash, which is called erythema cronicum migrans (ECM), at multiple sites. It may burn or itch, but it disappears within three weeks, with the possibility of recurring.

Other skin symptoms may be hives, redness of cheeks under eyes, and swelling of eyelids with reddening of the whites of the eyes. Flu-like symptoms may accompany the skin symptoms—high fever, headache, stiff neck, fatigue, sore throat, and swollen glands.

A second set of symptoms occurs in untreated patients four to six weeks after transmission. Over half of untreated victims experience an arthritis of the large joints (primarily the knees, elbows, and wrists) intermittently or chronically.

A few experience neurological effects, including severe headache, stiff neck, facial paralysis, weakness, and possibly, pain in the chest or extremities; these symptoms may persist for weeks. In some cases, heart block may occur.

Dogs can also acquire Lyme disease, since they forage in tick habitat and become infected. Diagnosis of the disease in dogs in the area is a harbinger of human cases to follow. Symptoms in dogs include sluggishness and lameness.

a. Responses to Lyme Disease: Education

The seriousness of this disease warrants instruction of residents by HAs that there are no easy or effective control measures, and that the following risks should be taken seriously:

- Children are at the highest risk from encountering infected ticks at play grounds, parks, and other areas where mice live. Children are not as sensitive to finding ticks on themselves as are adults.
- The second risk group consists of adults, especially grounds and outdoor maintenance workers, whose occupations place them in tick habitat.

2. ROCKY MOUNTAIN SPOTTED FEVER (RMSF)

RMSF is caused by a rickettsia, a disease organism related to bacteria. It is an acute infectious disease characterized by pain in muscles and joints, fever, and spotty, red skin eruptions. **At least four to six hours elapse after the American dog tick begins feeding before disease transmission begins. If ticks are removed during this noninfective period, infection will not occur.**

Rash on wrists and ankles, the most characteristic and consistent symptom of RMSF, occurs on the second to fifth day after infection. Often aching in the lower back and headaches around the head and eyes will also occur. Victims feel very tired and can run fevers of 104-106 degrees F. Less obvious symptoms may not be noticed.

3. TICK PARALYSIS

All species may cause tick paralysis if they feed at the base of the victim's skull for extended periods. Symptoms include paralysis of the arms and legs, followed by a general paralysis which can cause death. The victim can recover completely in a few hours, after the tick is removed. Tick paralysis is mainly reported in the western United States, but may occur wherever ticks are found.

4. DISEASE-CARRYING TICKS

Deer ticks, or *Ixodes*, carry Lyme disease. This genus of ticks contains the greatest number of hard tick species which transmit diseases. The northern deer tick, *Ixodes dammini*, is the carrier (called a vector) of Lyme disease in the eastern United States. Its counterpart in the South is the blacklegged tick. In the West, the common vector is *I. pacificus*. There are many other *Ixodes* in the United States.

The American dog tick, *Dermacentor variabilis*, is the vector of Rocky Mountain Spotted Fever in the eastern and central United States, and the Pacific coast. The Rocky Mountain wood tick, *Dermacentor andersoni*, which closely resembles *D. variabilis*, is found in the Rocky Mountain states, Nevada, eastern California, Oregon, and Washington. This tick was the original vector of Rocky Mountain Spotted Fever.

The Lone Star tick, *Amblyomma americanum*, ranges in the southeastern quarter of the United States from Texas to northern Missouri and east to New Jersey. The Lone Star tick can transmit Rocky Mountain Spotted Fever, but it is not as important as the previous two species of *Dermacentor*.

SECTION D TICK PEST MANAGEMENT

Where pest-management services are provided to an HA development, it is important to know what kinds of ticks are present, where they are most numerous, what the disease potential in the area is, and what the host and reservoir populations are. Pest-management programs are critical for effective management of tick species that transmit Lyme disease or Rocky Mountain Spotted Fever.

1. INSPECTION AND MONITORING

a. Dragging

A commonly used method of off-host sampling involves dragging a white cloth over the ground or foliage where ticks are questing for passing hosts. Ticks cling to the cloth, and can be removed for counting and identification. An easily-constructed "drag" consists of a 3 x 4 foot sheet of white muslin or flannel, hemmed on all edges, weighted at one end, and attached to a wooden pole at the other. A rope attached to each end of the pole allows the apparatus to be dragged across the desired sampling site. Selection of the sites to be sampled may have great effects on the efficiency of collection. Lone Star ticks are likely to be found in shaded areas of high humidity, while American dog ticks are most often encountered along roadways and animal runs. Sample sites should represent favored tick habitats, and sampling should be done under conditions favoring tick presence (when vegetation is not wet, and when temperatures are above 50 degrees F). All stages of ticks will attach to the flannel. A University Extension Service office, located in each county, can assist in the identification when necessary.

b. Dry Ice (CO_2) Collection

This technique is nondestructive to small animals, requires no human "attractants," and appears to give more reproducible results than the drag technique. This simple technique involves placing a half-pound block of dry ice in the center of a 2 x 3 foot panel of white polyester cloth on the ground at the chosen sampling site for a predetermined period. Dry ice is available from most beverage and ice cream stores. The sampling sites should be selected in areas favoring ticks which are likely to receive heavy visitation. After one hour, ticks on the top side of the panel are collected and can be counted.

A conscientious monitoring program is the basis of effective IPM. Regular surveys should be conducted at all sites where ticks have been reported, and at other locations which appear to be favorable tick habitats. Records of sample sites and methods should be kept so that the progress of tick populations and the effect of control measures can be gauged. The records may be

supplemented by the following information:

- Local veterinarians are the first to see Lyme disease cases in an area. Positive disease diagnosis in dogs is a clear signal that human cases will follow.
- Inspect units, especially rooms where dogs sleep, under the edge of rugs, under furniture, in cracks around baseboards, window, and door frames.

2. HABITAT MODIFICATION

Advise residents to:

- Check pets regularly for ticks.
- Treat pets using pesticidal dips, washes, or dusts. Do not let small children play with dogs that have been recently treated.
- Wash dog bedding frequently.
- Keep in mind that the effectiveness of flea and tick collars is variable.
- Keep grass cut short around buildings and fences. Mow on both sides of fences.
- Keep stray dogs out of the yard.

a. Outdoor Areas

- Dense shrub or tree cover or tall grass provides harborage for animal hosts of ticks, and protects ticks from the loss of body fluids due to drying winds and direct sunlight. Removal of excess brush and shrubbery, and clearing of overstory trees so that approximately 50 percent of a development is exposed to direct sunlight are recommended. Grass should not be allowed to grow more than six inches high, to allow ventilation and illumination of soil. Chemical tick control is rarely needed when vegetation control is practiced.
- Inspection of the development should be performed regularly to determine when management techniques should be conducted.
- Basic principles of animal-tick management include isolation of susceptible animals from known tick populations.

b. Indoor Areas

Methods of nonchemical indoor tick management include regular inspection, elimination of animal harborage areas, food- and waste-handling procedures which eliminate possible animal harborage and entry, and animal-proofing of each building. The latter includes sealing of all holes in foundations and walls, and screening with heavy-gauge metal screen above-ground windows, vents, and other openings through which animals may enter.

Recommended practices also include frequent examination of clothing (preferably by another individual) and the body (after showering), and the destruction of collected ticks.

Periodic surveys of potential or known habitats can reveal the presence of low-level tick infestations, and the need for application of management procedures (such as habitat modification described in Section D-2) to prevent or retard further population increase. A recommended action threshold is based on the CO_2 (dry ice) sampling technique described in Section D-1 above. A count of two ticks per three hours of CO_2 exposure is considered the action threshold for tick management, although this value may not be applicable to every situation. Actions should be taken (such as habitat modification) to keep tick populations below the selected action threshold.

3. PESTICIDE APPLICATION

A new control measure using permethrin-treated cotton balls in cardboard cylinders has been reported to reduce tick populations. White-footed mice use the pesticide-treated cotton as nesting material, and although the pesticide does not harm them, it kills their tick parasites. This device, marketed as Damminix, should be placed within the reach of female mice, to catch larvae and nymphs in an early stage of their life cycle.

The HA's pest manager can utilize these techniques:

Inside:

- Use crack-and-crevice pesticide applications where ticks hide.
- Treat under the edge of rugs, under furniture, in cracks around baseboards, windows, door frames, and in dog boxes.
- **Do not allow pets or children in the treated area until it is dry.**
- Fogging for ticks is useless.

Outside:

- Spray or dust affected areas using pesticides labeled for that treatment.
- **Do not allow pets or children into the treated area until it is dry.**

Pesticide sprays are most effective when applied to the sides of paths.

- Spray low vegetation, including low shrubs, thoroughly.
- Mow around weedy fences that provide cover for rodents moving in from nearby woodland edges. Spray at their base.
- Use herbicides to control weeds where mowing is impossible. Broad application of pesticides to mowed grass does not reduce tick populations because white-footed mice do not infest lawns.
- Dust rodent runs or burrows in areas where human traffic cannot be controlled and where there is a danger of disease transmission.

To control ticks on pets:

- Use insecticidal dips, washes, or dusts, which may be obtained at pet counters or from veterinarians. Dogs should be protected if they roam in tick habitat.
- Advise that all uncontrolled or ownerless dogs be regulated.
- Use of flea and tick collars has variable results.
- Cats do not appear to be at risk from Lyme disease nor are they hosts for RMSF vectors.

a. Follow up

It is important that residents know that dogs should be protected even after treatment, since eggs can take thirty days to hatch. Advise residents that brown dog ticks do not bite humans and will therefore **not transmit a disease**. The fear of Lyme disease can drive a desire for overkill; explain that the brown dog tick does not spread Lyme disease.

Continued monitoring and record-keeping is important. Tick counts should be reviewed annually to evaluate and adjust the pest-management program. Educational programs and materials for at-risk groups are vital.

b. Precautions for At-Risk Group Members

- Wear long pants tucked into socks while working or hiking in tick habitat.
- Use insect repellents on clothes and skin. Do not use formulations with over 20-30 percent active ingredient on skin.
- Use permethrin formulations that are labeled for use as a repellent on clothes; they withstand washing and remain effective. Those sensitive to chemicals should not use this method.
- Schedule regular body inspections for ticks at noon and at bedtime.
- Nymphal deer ticks are small, but they can be seen with close inspection. Larval deer ticks cannot be spotted easily, but they are not disease carriers.
- Only adult American dog ticks infest people or dogs.

c. Tick Removal

Regular inspection, location, and early removal of ticks prevents disease transmission. To remove feeding ticks, dab them with alcohol. If feeding has just started, and mouthparts are not cemented in, ticks sometimes pull their mouthparts out. If they do not release in a few minutes, take tweezers, grasp the tick at the skin level, and pull steadily until the tick is removed. Grasping the tick by the back end, or heating it, can force disease organisms into the wound. Place the tick in alcohol or otherwise keep it for identification. If the mouthparts are left in the skin, they will not

transmit the disease, but the wound should be treated with an antiseptic to prevent secondary infection. Note the date of removal to calculate the time of symptoms onset.

If the tick is identified as a deer tick, see a physician. If it is a RMSF carrier, look for symptoms within a week after exposure; if they occur, notify a physician.

END OF CHAPTER FOURTEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER FIFTEEN - MISCELLANEOUS PESTS

SECTION A CHARACTERISTICS AND RECOGNITION

1. SCORPIONS

There are twenty to thirty kinds of scorpions in the United States that range in size from 1/2-inch to 7-1/4 inches long. Most species live in warm, dry areas of the Southwest, but a number are also found across the southern states from the Atlantic to the Pacific Ocean. All scorpions are nocturnal and prey on insects; most are found under loose bark of large trees and logs, under objects lying on the ground, in woodpiles, and in crumbling stone and brick foundations. Although scorpions can live six months without food or water, free water attracts them, and they are often found near air conditioners, bathrooms, kitchens, and utility rooms. After eating, scorpions may hide for two or three months. Scorpions shun temperatures above 90 to 100 degrees F, and will often move into cooler living spaces from attics during summer. Heavy rains force scorpions to higher ground from dry river beds, and this is when many move into cool hiding places in homes—in crawlspaces, attics, and closets. The female bears between fourteen and more than 100 living young in mid-summer, and the young climb to ride on her back for up to two weeks, until their first molt. It takes one to four years for scorpions to mature; and their span of life is two to seven years. The sting of two kinds of scorpions from extreme southern Arizona, California, New Mexico, and Texas can cause human fatalities.

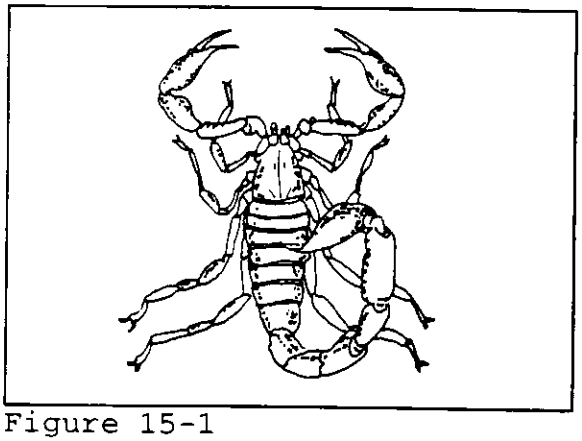


Figure 15-1

The most widely distributed scorpion in the southern states (from South Carolina to New Mexico) is the striped scorpion (Fig. 15-1). This small scorpion is about 1-1/2 inches long, tan-colored, with two dark strips running lengthwise down the body, and is found under rocks, generally on south-facing hillsides.

2. CENTIPEDES

Centipedes are many-segmented arthropods with elongated antennae and one pair of legs attached to each body segment. Most adults are over one-inch long and run in an almost fluid manner on their numerous, long legs. Centipedes kill their insect prey with venom that is injected by means of fangs located on the front claws. Except for one group (house centipedes), these arachnids are accidental invaders of dwellings, and normally live outside under stones and debris. Extended periods of dry weather force them to wander, and they may enter structures. People are often bitten when putting on sweaty or damp clothing that had been on the floor and to which a centipede was attracted because of the moisture it contained.

a. The House Centipede

The house centipede (Fig. 15-2), common throughout the United States, usually lives its entire life indoors in dark, moist areas such as bathrooms, basements, and damp closets. This centipede is one to 1-1/2 inch long, has long slender antennae, and fifteen pair of legs unusually long for its body size. It has three stripes running the length of a grayish-yellow body, and its legs are banded in white. The house centipede usually infests basements and other rooms not continually occupied in buildings where it preys on spiders and insects.

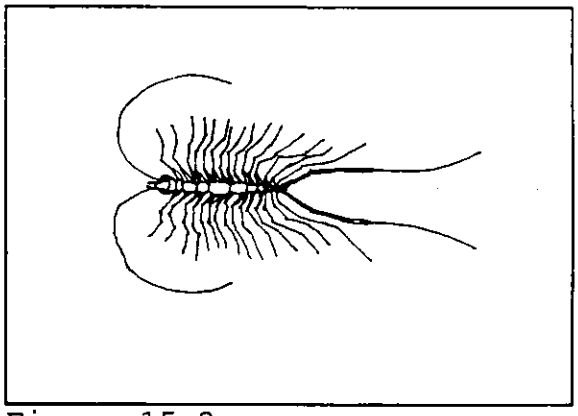


Figure 15-2

3. MILLIPEDES

There are about 1,000 different kinds of millipedes in the United States. These are slow-moving vegetarians that feed on damp and decaying organic matter and tender roots and green leaves. Millipedes require high moisture levels and are found in leaf litter, mulch beds, firewood piles, compost heaps, and loose flower-bed soil. They overwinter in the soil. Some millipedes are about six inches long, but species found in residences are usually one to 1-1/2 inches long.

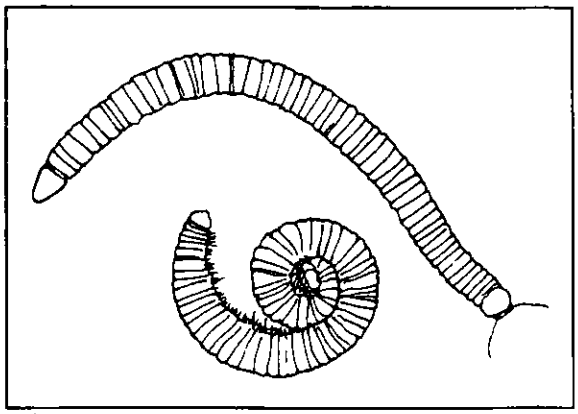


Figure 15-3

Millipedes (Fig. 15-3) are cylindrically-shaped, brown or black, many-segmented arthropods with short

antennae and two pair of legs attached to each body segment. Outside, they may become numerous and, in dry weather, migrate into basements, ground floors, and window wells. During migrations millipedes crawl over anything in their path, including dwellings. They are mostly a problem in residences located near woodlands. Females lay clusters of up to 300 eggs in moist soil. These hatch into small larvae with only three pair of legs and seven body segments. Most require two years to reach maturity.

4. CRICKETS

There are three kinds of crickets common throughout the United States that often become pests in structures: house crickets, field crickets, and camel crickets.

a. House Cricket

House cricket adults (Fig. 15-4) are 3/4-inch to one-inch long and have a light-colored head marked with three dark cross bands, yellowish-brown to straw-colored body, long and thin antennae, and heavy mandibles. House crickets fly but also have large rear jumping legs like a grasshopper. These are nocturnal insects that enter dwellings in spring or before winter, attracted to shelter, light, moisture, and warmth. House crickets are mainly attracted to warm areas around stoves, fireplaces, and furnaces, but they can also be found throughout the residence. Incessant nocturnal chirping by the male makes this a nuisance pest. Outside, house crickets live in compost piles, debris, and garbage dumps. Usually there is one generation per year. Eggs laid in sandy soil during fall hatch in late spring; young often enter dwellings under doors or through cracks and voids and complete their life cycle indoors, where they develop all year and lay eggs in cracks. Nymphs mature in mid- to late-summer.

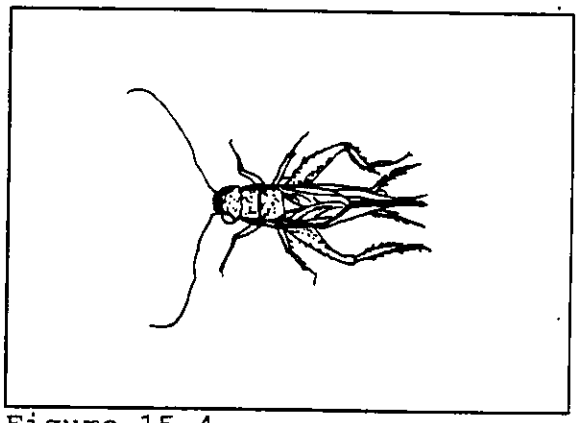


Figure 15-4

Outside, house crickets feed on plants and other insects. Inside, their diet is more diverse: they feed in early evening on bread crumbs, fruits, vegetables, liquids, paper (such as soiled newsprint), clothing, rubber, silk, wool, linen, rayon, fur, feathers, meat and meat products, dead insects, and leather. House crickets contaminate foods by walking over it.

b. Field Crickets

Field crickets (Fig. 15-5) are common pests attracted indoors by light; however, once inside, they die before early winter because they cannot adapt to indoor conditions. Adults are 1/2-inch to 1-inch long and look very similar to house crickets, except that field crickets are usually black to dark brown in color, have brown wings, a shiny head, and antennae much longer than the body. Males have two spear-like appendages at the tip of the abdomen. Females have three similar appendages. The field cricket also flies and jumps.

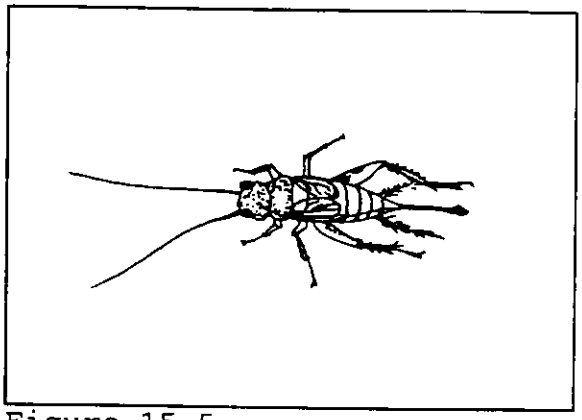


Figure 15-5

In northern parts of the United States, eggs deposited in the ground are the overwintering stage for most field crickets. The small remainder pass the winter as half-grown nymphs under leaves, trash, and debris. There is only one generation per year. In the South, where field crickets can feed outdoors on soft plants year-round, there may be three generations per year with the nymphs overwintering in the soil. Females lay 150 to 400 eggs about 1/4-inch to 1-inch deep in the soil in late August to September. Eggs hatch in May to June and nymphs develop in nine to fifteen weeks. Adults are only found outside from late July until the first hard freeze. Field crickets migrate into structures during fall, when populations are large, or as vegetation dries up. Indoors, field crickets are attracted to such warm, dark areas as water-heater closets and large appliances; they are usually found in basements and ground-floor levels where they feed on human food, debris, and clothing.

c. Cave or Camel Cricket

Cave or camel cricket (Fig. 15-6) populations build up indoors during fall, when large numbers of these insects move under doors and through cracks seeking dark, cool, damp areas in crawl-spaces, basements, utility rooms, garages, and outdoor sheds (especially those with partial dirt floors); they are rarely found in living spaces. Their natural habitat is outside, where camel crickets live under stones and logs or in animal burrows. Camel

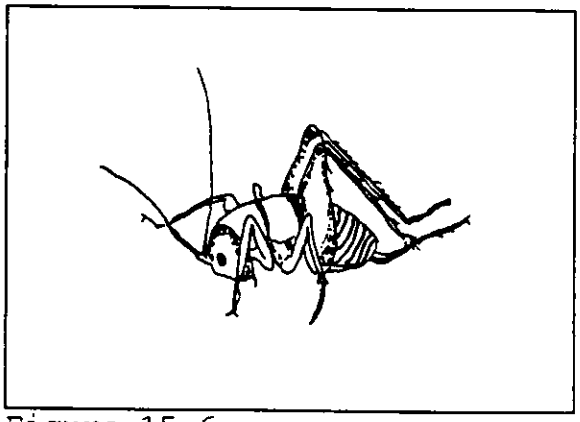


Figure 15-6

crickets have a rounded, hump-backed appearance with a head bent downwards. They are light brown in color with darker brown bands and markings. Camel crickets are easily identified by their long antennae and long and large jumping hind legs. They are wingless, don't chirp, and are not attracted to light. Most importantly, camel crickets serve as a warning or indicator of excessive moisture problems.

5. EARWIGS

Earwigs (Fig. 15-7) are 1/2 to 3/4 inch long, conspicuous and easily recognized. They are nocturnal insects with a flattened shape and forceps or pinchers at the tail end. At first glance, earwigs appear to be wingless, but they will fly to lights at night. Earwigs feed on other insects and often scavenge in garbage and moist plant material. They are dependent on high-moisture conditions and serve as a warning or indicator species for moisture problems. Earwig females place 50 to 90 eggs in moist depressions or holes and tend them until hatching; after eggs hatch, earwig mothers continue to guard and groom the young nymphal stages. Earwigs often enter on ground floors and then make their way into other parts of the house. Some species of earwigs produce a noxious odor when crushed.

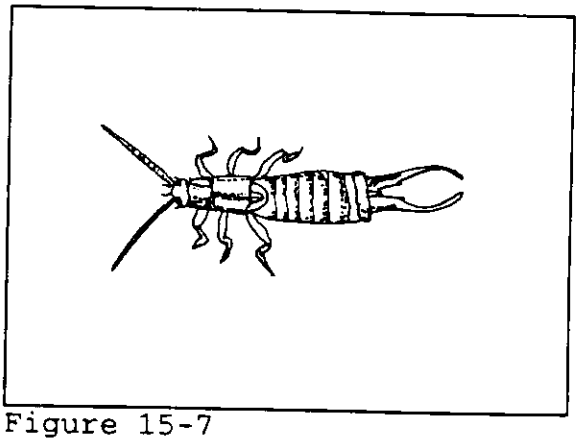


Figure 15-7

6. SILVERFISH AND FIREBRATS

Silverfish (Fig. 15-8) are wingless, flat and carrot-shaped insects, about 1/2-inch long, and covered with a sheen of silvery scales. They possess three long, slender antennae-like appendages that project rearward from the abdomen. Silverfish prefer temperatures between 70 and 80 degrees F, and high humidity. Adults may live from two to three and up to eight years, and can survive as long as a year without food. Silverfish feed on starches like flour, starch, glue, paste, and textile and paper sizings, but they can also digest cellulose. Silverfish build up around materials upon which they feed, such as spilled flour in cupboards, corrugated cardboard boxes in damp basements, and on insulation, glue, and stored books in unventilated attics. Their feeding leaves irregular, yellow-

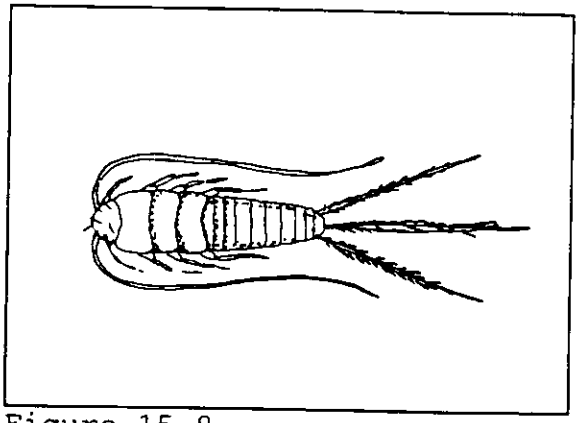


Figure 15-8

stained holes in textiles and paper, damaged surfaces on corrugated cardboard, and irregular chewed areas on cloth-bound books. Damaged materials often have dark fungus growing on them supported by humidity and insect fecal pellets. Large populations of silverfish spread into other humid areas within the building from basements and wall voids penetrated by pipes, and are often trapped in wash basins and bath tubs.

Firebrats are similar insects but not silver-colored, rather mottled dark-gray and dull-yellow. Their size, shape, and appendages very much resemble silverfish, but firebrats prefer decidedly higher temperatures and surroundings, to 90 degrees F or above. Firebrats are commonly found in furnace rooms, steam-pipe tunnels, hot apartment bathrooms, and partition walls of water-heater rooms.

SECTION B HAZARDS OF INFESTATION

1. SCORPIONS AND CENTIPEDES

Scorpions and centipedes sting or bite when accidentally crushed or contacted, but most are relatively nonvenomous. The venom is no more poisonous than that of a bee or wasp. Although beneficial, these pests frighten people.

a. Precautions

Use a stick to turn over objects on the ground, or carefully inspect their undersides, before picking them up. Be careful or wear gloves when placing hands into dark, damp areas or holes in the ground. Shake out and inspect shoes and clothing before putting them on in the morning.

Move beds away from walls and be sure that the bedspread does not touch the floor. Since scorpions and centipedes can't climb clean glass, place crib or table legs in wide-mouth glass jars at night, where warranted. Further, use a flashlight and do not walk around barefoot at night where such pests are suspected.

2. MILLIPEDES

Many millipedes roll into a ball when disturbed, but other species expel caustic, noxious, pungent secretions that may be irritating to human skin and smell unpleasant or leave temporary stains. Some species forcibly eject the spray secretion.

3. CRICKETS

a. House Crickets

House crickets feed on, damage, or contaminate human foods and possessions.

b. Field Crickets

Field crickets damage garden and field crops when feeding on flowers and young seeds. Large unsightly and unsanitary swarms of crickets are attracted to windows and street lights. Cats feeding exclusively on cricket swarms become emaciated and subject to fits. When inside, field crickets feed on and contaminate foods.

4. EARWIGS

Earwigs may be destructive to chrysanthemum and dahlia flowers, often causing complete seedling losses. Earwigs eat holes in various parts of other plants and destroy buds. The bite of an earwig is uncomfortable, but is not serious to humans. Earwigs contaminate food when walking over it.

5. SILVERFISH AND FIREBRATS

Silverfish and firebrats are destructive to books, paper, fabrics, and may contaminate foods. They are often found in libraries, used book stores, and areas where old books and papers are stored.

SECTION C INSPECTION AND MONITORING

1. OUTSIDE

- Conduct a flashlight inspection under bark, boards, and stones near the dwelling's foundation (be careful if scorpions or centipedes may be present).
- Inspect for open cracks around foundations and door stoops.
- Inspect for pests behind bird houses, tree-trunk wrappings, and under plant mulch. Carefully examine crawlspaces and attics.

2. INSIDE

- Inspect kitchen sink cabinets and bathroom areas, open cracks and pipe chases that lead into wall voids, or crawlspaces for the presence of pests.

- Check food packages, starch-based materials, and stored textiles for pest infestation and damage.
- Inspect water-heater closets, utility rooms, and attics, especially areas of high humidity or temperature.

SECTION D CONTROLS

1. PHYSICAL, MECHANICAL, AND CULTURAL CONTROLS

Control or elimination of miscellaneous pests in structures requires careful inspection to find established populations and correct conditions that support pests. General physical, mechanical, and cultural control methods which apply to all miscellaneous structural pests include the following:

a. Outside

Tighten up and caulk all possible points of entry. Most pests find easy entry into dwellings beneath doors. Seal foundation cracks, floor entries, windows, cracks between door stoops and patios, and building foundations near ground level. Be sure weatherstripping and sweeps on doors and windows fit tightly.

Raise garbage cans off the ground to dry out soils, and tightly close their lids to prevent pests from entering cans. Use yellow "bug lights" or high-pressure sodium bulbs. Provide all vents with metal screens. Remove lumber, firewood, trash piles, stones, boards, leaves, grass, compost piles, or other materials which provide pest harborage and are stacked near buildings.

Reduce moisture both outside and inside; repair plumbing leaks and dry out wet areas. Eliminate standing water and change the grade so that water drains away from structures. Trim hedges and plants away from foundations, and trees away from the roof. Prune shrubbery back from buildings and foundations; keep lawns mowed and landscape weeded. Replace mulch near doors and window wells with plastic ground cover, then cover plastic with 2-inches of gravel. Clean leaves and debris from roof gutters. Control insects on plants that attract predatory pests.

b. Inside

Check all floor-level doors (see if outside light comes in under door sweeps) and window openings for tight closure. Repair leaking pipes or pipes that accumulate condensation. Caulk loose-fitting baseboards and holes around electrical and plumbing utility lines and seal cracks.

Clean up cellars and basements. Keep trash covered and remove garbage every night; keep

trash receptacles clean. To prevent access from sewer lines, plug or screen sink and floor drains (especially at night); cap or keep liquid in drain traps.

Reduce the numbers of insects that predators (centipedes, scorpions, earwigs) feed on. Move outside lights away from doors to prevent attracting insects to doorways. Many moisture-loving pests can be trapped during dry weather under damp burlap bags or newspapers.

Use dry heat (120 to 140°F) to control many insects that favor cool locations or high moisture. A heat treatment using forced air heat may be provided by a licensed pest-control company.

2. CHEMICAL CONTROLS

Chemical controls do not correct situations that foster pest populations, and will only provide relief for short periods of time. Pesticides, used alone, will not control pests satisfactorily without also performing habitat alteration. Long-term control requires correcting the conditions that support pests.

Aerosol, spray, dust, and bait pesticides are available for insect and spider control; however, their effectiveness can be enhanced if:

- Pesticides are properly applied with narrow extension tubes deep into cracks, crevices, and voids where household pests hide and where greatest effects are obtained.
- Regular and follow-up inspections are conducted. Determine whether the eggs of a pest have hatched or if pests have emerged from deep recesses in the structure, where they hide for a couple months after feeding or during bad weather.
- Exclusion by closing cracks and crevices is used to prevent entry of outdoor pests (such as field crickets) that cannot become established indoors but which may enter the house through open cracks and crevices.
- Pesticides with residual action when applied on alkaline (gypsum or concrete) or on porous surfaces (such as unpainted wood) are used.
- Toxic baits used are attractive to pests and transferred to reproductive members of the pest population.
- Pests have not developed resistance to pesticides used.

END OF CHAPTER FIFTEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT AND RODENT CONTROL

CHAPTER SIXTEEN - RATS

SECTION A INTRODUCTION

Human beings, dogs, snakes, and birds, all of which have spinal columns, are vertebrates, while insects, worms, jellyfish, and snails are not. A few vertebrates, such as rats and mice, are common pests in urban sites. Others may occasionally become pests when their presence conflicts with human use of a space.

Public concern for animal welfare and the potential risk from vertebrate poisons to people, pets, and other nontargets have made rules governing vertebrate pest control particularly strict. Laws and regulations at state and local levels may be more restrictive than federal regulations. The HA's pest manager should ensure that the applicable regulations are satisfied.

SECTION B CHARACTERISTICS AND RECOGNITION

Rats have caused more human suffering and economic damage than any other vertebrate pest. It is estimated that rats destroy twenty percent of the world's food supply every year, by feeding on or contaminating it. Rats have adapted to nearly all human environments. They live in granaries, fields, city sewers, attics, basements, on roofs and street trees.

Rats can leap three feet straight up and four feet horizontally. They can scramble up the outside of a pipe three inches in diameter, climb inside pipes of one-and-a-half to four inches in diameter, and pass between buildings on telephone or power lines. Rats can swim through a half mile of open water, tread water for up to three days, swim against a strong current in a sewer line, and dive through a sewer trap to pop up inside a toilet. They can fall more than 50 feet and survive.

Rats gnaw constantly, and their teeth are extremely hard. They commonly chew through building materials such as concrete block, aluminum siding, sun-dried adobe brick, wall board, wooden cabinets, lead sheathing, and plastic or lead pipes. After gnawing a hole, an adult rat can compress its body and squeeze through a half-inch opening.

Rats are very wary. Hundreds may be nesting in a city block, in underground burrows, in sewers, on roofs, and inside buildings, and few people in the area will realize it, even though their populations may be excessive.

Successful long-term rat control is not simple. The key is to control the environment of rat populations, not individual rats. Rat control requires an integrated approach that includes nonlethal tools such as careful inspection, upgraded sanitation, and rat-proofing structures to exclude rat entry. Lethal control may combine the use of selected rodenticides with low-risk control measures such as snap traps or glue boards.

SECTION C HAZARDS OF INFESTATION

1. RATS AS DISEASE CARRIERS

Rats are responsible for the spread of many diseases. Sometimes they transmit the disease directly, by contaminating food with their urine or feces. At other times they transmit disease indirectly; for example, fleas may first bite an infected rat, then a person. Following are some typical diseases associated with rats.

a. Plague

The "Great Plague" of London killed half of the city's population. The "Black Death" of Europe lasted 50 years in the 14th Century and killed 25 million people. In the first quarter of this century, an estimated eleven million people died in Asia from plague. The disease is transmitted to human beings primarily by the oriental rat flea. The flea bites an infected rat and then, while feeding on people, inoculates them with the bacteria that cause disease.

Although no major urban outbreak of plague has occurred since 1924, this is not a disease of the past. A reservoir of plague exists in some populations of wild rodents in several Western states, and human beings contacting these rodents could contract the disease. As suburbia expands into undeveloped areas, wild rodents can transmit the disease to urban rats. There is concern that an outbreak of urban plague could occur in the United States.

b. Murine Typhus Fever

Murine typhus, which occurs in California and in the southeastern and Gulf Coast states, is a relatively mild disease. Murine typhus is transmitted from rats to people by rat fleas, with the disease organism entering the bloodstream when feces of infected fleas are scratched into a flea-bite wound.

c. Rat-Bite Fever

Rats bite thousands of people each year, and most bites occur in inner cities. In some cases victims, particularly infants and bed-confined elderly persons, are bitten in the face while sleeping. Those who are bitten may develop rat-bite fever from the bacteria carried on the teeth and gums of rats. Although the disease is similar to flu, it can be fatal, and is of particular risk to infants.

d. Salmonella Food Poisoning

Rats frequent sewers, rotting garbage, cesspools, and similar sites where Salmonella bacteria thrive. Such rats can infest stored food, leave bacteria on dishes, silverware, or food-preparation surfaces, and thus transmit Salmonella food poisoning to people.

e. Leptospirosis or Weil's disease

This disease is seldom fatal to people. The disease organisms are spread from rat urine to water or food, and affect people through mucous membranes, minute cuts, and abrasions of the skin.

f. Trichinosis

Trichinosis results from a nematode (a tiny roundworm) that invades intestines and muscle tissue. Both people and rats get the disease from eating raw or undercooked pork infected with the nematode. Rats help spread trichinosis when hogs eat food or garbage contaminated with infested rat droppings.

SECTION D KINDS OF RATS

In the United States, the two typical species of rats are the Norway rat (*Rattus norvegicus*, see Fig. 16-1) and the roof rat (*Rattus*, see Fig. 16-2). The Norway rat is also called the brown rat, house rat, sewer rat, and wharf rat. The Norway rat is considered the most common in the U.S. and is found in every state. The roof rat, also called the black rat, ship rat, and Alexandrine rat, is found primarily in coastal areas including California, Washington, and Oregon, the Southeast and Middle Atlantic States, and the Gulf States.

Figure 16-1

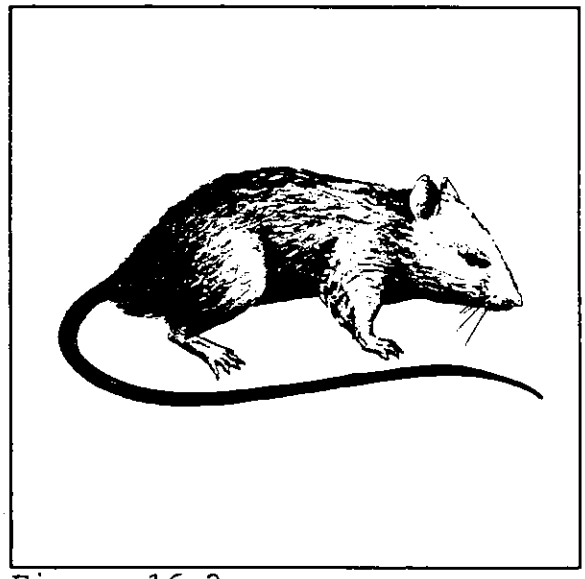


Figure 16-2

The two species look similar, but there are noticeable differences. In general:

- A Norway rat looks sturdier than the roof rat; the roof rat is sleeker.
- A mature Norway rat is 25 percent longer than a roof rat, and weighs twice as much.
- A Norway rat's tail is shorter than the length of its head and body combined; a roof rat's tail is longer than its head and body.
- A Norway rat's ears are small and covered with short hairs; a roof rat's ears are large and nearly hairless.
- A Norway rat's snout is blunt; the roof rat's snout is pointed.

SECTION E HABITS OF RATS

Knowledge of the life history, habitat, food requirements, patterns of behavior, range, and other factors is essential to the control of rat infestations. Since Norway and roof rats have similar habits, most of these discussions apply to either species.

1. LIFE CYCLE

A mature female rat can give birth to about twenty young in a year (four to six at a time), if she lives that long. The average life span of a rat in the field is less than one year, although females live longer than males.

The young are born in a nest. They are hairless, and their eyes and ears are closed. Within two weeks their eyes and ears open, they become furry and rat-like, and they begin exploring the nest area. In the third week they begin to eat solid food, and imitate their mother in foraging, escaping, and watching for danger.

If the mother rat has become wary of rodenticides or traps, many of her young will learn to avoid them. This learning experience can make control difficult in sites where long-term rodent-baiting programs have been unsuccessful in the past.

The young are totally weaned at four or five weeks old, when they weigh about 1-1/2 ounces, and at the age of three months, they are independent of their mother. They will mate and continue the cycle in the same location, or will migrate to a new area.

2. SOCIAL BEHAVIOR

Rats live in colonies with well-defined territories that they mark with urine and glandular secretions. The colony has a complex social hierarchy with a dominant male leader and a "pecking order" of subordinate males and ranking females. The strongest and most dominant animals occupy the best nest and resting sites, and feed at their leisure. Weaker, subordinate rats are pushed out to less favorable sites, or forced out of the territory completely. Rats are aggressive, and social conflicts are most common at feeding sites, prime resting areas, and territorial boundaries. Females fiercely defend their nest and young from other rats.

3. RAT SENSES

a. Vision, Touch, Taste, Balance

Rats have poor vision; they are nearly color blind, and react to shapes and movement rather than identifying objects by sight. Thirty to forty-five feet is the limit of their vision, and their eyes are adapted to dim light. Other senses, however, compensate for poor vision. They use their sensitive noses to locate food, follow pathways, tell whether another rat is friend or foe, and identify new objects in their territory. They use long whiskers and guard hairs to "touch" their way through dark burrows, pipe chases, wall voids, and other runways. Their ears detect faint sounds that signal danger. Rats can taste certain chemicals at a parts-per-million concentration. (This explains why rats often reject baits or avoid traps that have been contaminated with insecticides.) Finally, rats have an excellent sense of balance which allows them to walk on wires and always land on their feet in a fall.

b. Fear of New Objects (Neophobia)

Rats are wary of anything new that appears in their territory. A bait station, a trap, a block of wood will be avoided for a few days until the rats become familiar with the new object; even then, they approach cautiously. This fear of new objects can make baiting and trapping difficult. Rats will avoid poison bait when it is first placed. Later, they may nibble warily. If the poison bait makes them ill, but doesn't kill them, they will subsequently avoid similar baits or stations.

4. FOOD AND WATER

Rats need about one ounce of food daily. Norway and roof rats prefer different types of food. Norway rats prefer protein-based foods such as meat, fish, insects, pet food, nuts, and grain. Household garbage is ideal food for Norway rats. Roof rats prefer plant materials such as fruits, nuts, seeds, berries, vegetables, and tree bark. They occasionally feed on garbage and meats. Both rat species will feed on nonpreferred food if nothing else is available.

Rats may hide or hoard food in hidden areas. This food may or may not be eaten when other food supplies run short. Hoarding food is important for three reasons. First, rats may be moving toxic bait into areas where perhaps the label does not permit its use. Second, rats may be hoarding poison bait while feeding on their regular food. In this case, a baiting program becomes ineffective. Third, hidden food may become a focal point for insect infestations.

Rats need water every day. The amount varies, depending on the moisture content of their food, but is usually around one-half to one fluid ounce. Rats prefer to nest where water is available.

5. RANGE

Rats usually begin foraging after dark. Most of their food gathering occurs between dusk and midnight, but short bursts of restlessness and activity can occur anytime, day or night. Rats commonly travel 100 to 150 feet from their nest looking for food and water and patrolling their territory. It is not unusual for a colony that nests outdoors to forage inside a building 100 feet away.

6. NESTS

Outdoors, Norway rats usually nest in burrows dug into the ground. The burrows are shallow (less than eighteen inches) and usually short (less than three feet), with a central nest. Extra "bolt holes" are used for emergency escapes. They are hidden under grass or boards or lightly plugged with dirt. Burrow openings are two to four inches in diameter. Indoors, Norway rats nest inside walls, in the space between floors and ceilings, underneath equipment, between and under pallets, and in crawlspaces, storage rooms, and any cluttered area that is normally unoccupied. Norways prefer to nest in the lower floors of a building.

Roof rats commonly nest above ground, in trees, particularly untrimmed palm trees, and in piles of wood or debris, vine-covered fences, and stacked lumber. Overgrown landscaping is also a prime nesting area. Roof rats will sometimes nest in burrows if above-ground sites are limited and Norway rats are not nesting in the area. Indoors, roof rats prefer the upper levels of a building, in the attic and ceiling and attic voids, near the roof line. But at times, they will nest in the lower levels of a building.

Both species also nest in sewers and storm drains, and highly unusual nest sites, and can have several "hotel" nest sites in an area. A rat may spend a week in its home base and then move for a day or two into a secondary "hotel" nest site. Norway rats have been shown, on occasion, to have a home range of up to twenty acres when these secondary nest sites were included in calculations.

SECTION F INSPECTION AND MONITORING

There are many signs of a rat-infested area which assist the Inspector in identifying where rats are feeding and nesting, their patterns of movement, the size of population, and the extent of infestation. This helps the HA decide what control measures to use, where and how to use them, and how much effort is needed to control the infestation.

1. SIGNS OF RATS

An inspection using a powerful flashlight after dark is the best way to see live rats. Dead rats are signs of either a current or past infestation. Dried carcasses and skeletons may indicate an old infestation. Fresh carcasses may indicate a recent poison baiting. If rats are seen during the day, the rat population is probably high.

2. SOUNDS

Squeaks and fighting noises in a building, clawing, scrambling, or gnawing sounds in walls may indicate the presence of rats. Use a stethoscope or electronic listening device to help pinpoint such noises.

3. DROPPINGS

A rat may produce 50 droppings daily. Roof-rat droppings are generally smaller (a half-inch) than the Norway rat's (three-quarter inch). The highest number of droppings will be found in locations where rats rest or feed. Determine if a rat population is active by sweeping up old droppings, then reinspect a few days to a week later for new droppings.

Look at the appearance of droppings to determine if rats are present. Fresh rat droppings are black, glisten and look wet, and have the consistency of putty. After a few days the droppings become dry, hard, and appear dull. After a few weeks, droppings become gray, dusty, and crumble easily. Note that sometimes old droppings moistened by rain may look like new droppings; however, if crushed, they will crumble.

4. URINE

Both wet and dry urine stains will glow blue-white under an ultraviolet light (blacklight). Use portable ultraviolet light, as used in the food industry, to identify rat urine on food and other items. Other substances besides rat urine also glow, which can be confusing, so proper use of this inspection method takes practice.

5. GREASE MARKS

Oil and dirt rub off of a rat's coat as it runs along walls. Grease-mark build-up in frequented runways is noticeable. Look for grease marks along wall and floor junctions, at pipes, ceiling joists, and sill

plates, where rats swing around obstacles. Grease marks are also found at regularly used openings in walls, floors, and ceilings.

6. RUNWAYS

Outdoors, rats constantly travel the same route; their runways appear as beaten paths on the ground. Look for such paths next to walls, along fences, and under bushes and buildings. Indoor runways of rats may appear as well-polished trails which are free of dust.

7. TRACKS

A rat's footprint is about 3/4-inch long, and may show four or five toes. Rats may also leave a "tail drag" line in the middle of their tracks. Look in dust or soft moist soil. Place a tracking patch in suspected rat areas to show footprints. A tracking patch is a light dusting of an inert material such as clay, talc (unscented baby powder), or powdered limestone. Don't use flour, which may attract insect pests. A good patch size is 12x4 inches. Apply patches in suspected runways and near grease marks. When inspecting tracking patches, shine a flashlight at an angle that causes the tracks to cast a distinct shadow. Note that a tracking patch is not the same as tracking powder. Tracking powders are diluted rodenticides in dust form. Tracking patches use nontoxic dust. Do not use a tracking powder to make a tracking patch.

8. GNAWING DAMAGE

A rat's incisor teeth grow at a rate of about five inches per year. Rats keep their teeth worn down by continuously working them against each other and by gnawing on hard surfaces. Look for gnawing damage on floor joists, ceiling joists, door corners, kitchen cabinets, and around pipes in floors and walls as evidence of rat infestation. Gnawed holes may be two inches or more in diameter.

9. NEST SITES

Roof rats often nest or store food in the attics of buildings. Their nests may also be found in trimmed dense vegetation.

10. BURROWS

Outdoors, rat burrows may be found singly or in groups along foundation walls, under slabs and dumpster pads, in overgrown weedy areas, beneath debris, and in embankments. Look for a burrow

opening that is free of dirt, leaves, and debris; however, the openings may be covered with smooth, hard-packed soil. Look for rub marks at the opening, and soil pushed out in a fan-shaped pattern.

Fill the opening with a small amount of wadded-up newspaper or a few leaves and cover it with loose soil. Or, just kick in the open entrance to close it. If the rats are still using the burrow, they will reopen and clear the hole overnight.

11. PET EXCITEMENT

Cats and dogs may excitedly probe an area of floor or wall where rats are present, especially if the rats have recently invaded.

12. ODOR

Heavy infestations have a distinctive odor which can be identified with practice. The odor of rats can be distinguished from the odor of mice.

13. ESTIMATING RAT NUMBERS

It's not easy to tell how many rats are infesting a site. Rat signs, however, may categorize the population as low, medium, or high. In rat-free or low infestation conditions, no signs are seen. In the case of medium infestation, old droppings and gnawing can be observed and one or more rats are seen at night. No rats are seen during the day. When there is a high infestation, fresh droppings, tracks, and gnawings are common. Three or more rats are seen at night, and rats may be seen in the daytime as well.

SECTION G CONTROLS

Most successful rat-control programs use a combination of tools and procedures to reduce and control a rat population. The methods combine habitat alteration and population reduction. Some of the tools, such as trapping, are lethal to the rat. Some tools are not. Rat-proofing by making building repairs or increasing the frequency of garbage pickup are examples of nonlethal methods.

1. SANITATION

Rats may ignore bait since it can't compete with the rats' regular food. Reducing rats' normal food supply encourages them to move to some other territory. This can be accomplished by closing or

repairing open or damaged dumpsters and garbage containers, cleaning up food spills promptly, and not allowing food to be left out overnight.

2. ELIMINATE HIDING PLACES

Outdoors, remove plant ground covers such as ivy near buildings. Remove high grass, weeds, wood piles, and construction debris that permits rats to live and hide adjacent to a building. Indoors, eliminate clutter in dwelling units and rarely used rooms, basements, storage rooms, equipment rooms. Organize storage areas.

3. RAT-PROOFING (EXCLUSION)

The most successful long-term form of rat control is to build them out, called rat-proofing, a technique that makes it impossible for rats to get into a building in the first place.

a. Building Exterior

Seal cracks and holes in building foundations and exterior walls. Block openings around water and sewer pipes, electric lines, air vents, and telephone wires. Install 1/4-inch steel wire screen or hardware cloth on ventilation openings. Caulk and seal doors to ensure a tight fit, especially between door and floor threshold. Fit windows and screens tightly. Caulk and close openings on upper floors and the roof; inspect under siding and repair damaged soffits. Repair breaks in the foundation below ground level.

b. Building Interior

Seal spaces inside hollow block voids or behind wallboard. Repair broken blocks and holes around pipes. Repair gnaw holes or stuff them with copper wool. Equip floor drains with sturdy metal grates secured firmly in place.

4. TRAPPING

Trapping is an art that has been almost forgotten. The usefulness and great versatility of snap or guillotine traps where toxicants cannot or should not be used is rarely recognized. The snap trap is an effective method of killing rats when used correctly, and is advised for use inside structures. It has several advantages: there is less nontarget risk than from a toxicant bait, the pest manager knows instantly whether or not the trap has been successful, and it allows disposal of the carcass so that

there are no odor problems. Carcass disposal also eliminates the possibility of secondary infestation by blowflies and dermestid beetles that would feed on it. Traps should be strategically placed in sufficient number, otherwise rats will pass them by.

a. Physical Condition of Traps

A trap physically incapable of holding a rodent should never be set out. Staples holding the spring should be firm; the trap jaw should be square and fit inside the trap base. The trigger mechanism should operate smoothly at the slightest touch. Use properly sized traps for the species to be controlled: mousetraps for mice; rat traps for roof and Norway rats. The trap base should not be warped or the trap will rock when stepped on. If necessary, working parts should be lightly oiled with mineral or other inorganic oil, not machine oil. Traps should be kept away from pesticides or other strong odors that might be repellent to the rodents. Don't clean a trap bloodied by a catch, since the odors enhance its acceptance. A shiny new trap increases the possibility of rejection in response to the "new object avoidance" instinct. For some situations, the best traps are those with enlarged bait pans (triggers) set for a light touch.

b. Enlarged Bait Pans

Traps should have enlarged bait pans. Commercial traps with expanded bait pans are available, but the old style traps can easily be adapted with wire screen or light metal cut from beer cans. The enlarged bait pan should be trimmed so that it is 1/4-inch smaller than the trap jaw wire and securely fastened to the standard bait pan.

c. Placement of Traps

Traps with enlarged bait pans, if properly placed in runways, do not need to be baited, but baiting adds to their effectiveness. Smear peanut butter in the center of the bait pan; sprinkle oats lightly across the pan; or tie a nutmeat or dried fruit piece to the center of the pan. Meat such as sausage or bacon, or peanut butter, is attractive to Norway rats, while fresh or dried fruit will draw roof rats. Cotton balls also are attractive to females of both rat species. Traps must be placed in the rodents' regular active runways, as indicated by the presence of feces, smears, or tracks.

Place light tracking patches of talc, powdered limestone, or other odorless, innocuous fine-particled material to find where the rodents are most active, and place traps there. All traps should be set perpendicular to and across the runway so that the bait pan is in the runway, and against the wall or other vertical surface. Make narrow runways to force the animals to cross over

the trap pan. Put traps in concealed places where rodents are more apt to be found rather than in places the trapper can easily reach. Trap the area heavily, every ten to twelve feet. Map the locations so traps can be more easily recovered later or by someone else if necessary. Move traps to other areas after two weeks (the first area can be retrapped after a lapse of several weeks).

Adhere to good public relations practices, and pick up trapped animals as soon as possible (at least daily). In areas used frequently by the public, use trap stations to cover trapped animals instead of snap traps. This also protects the traps from accidental tripping by maintenance personnel. Don't place traps above food or food-handling areas or in areas where pets or children can reach, since rat traps can break their small bones.

Leaving the traps unset for a few days may increase the catch by reducing the chance that wary rats will trip the traps without capture. Set traps with bait, if food for rats is in short supply, and without bait if they have enough.

When runways are located on rafters and pipes, set expanded trigger traps directly across them, fastening them securely to pipes with wire or hose clamps, and to rafters with nails (Fig. 16-3). Use enough traps. Set five or ten traps in an active corner of a space. Set three traps in a row so that a rat, leaping over the first, will be caught in the second or third. If unsure about sites of activity, set traps along possible runways spaced ten to twelve feet apart.

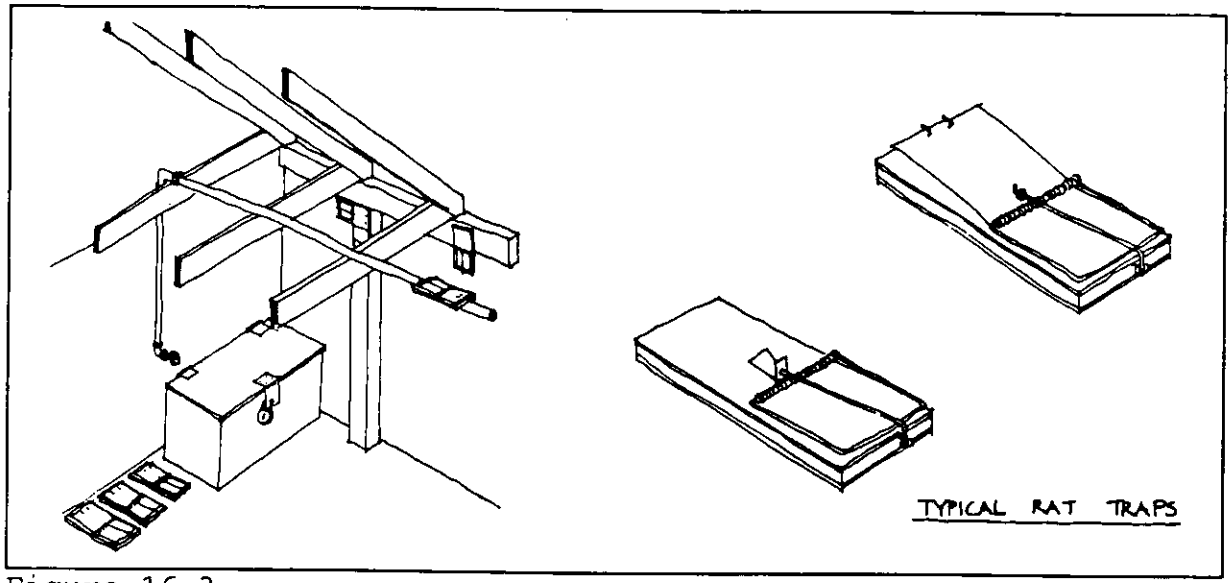


Figure 16-3

Camouflage traps when only a few rats remain and are difficult to capture. Set traps in a shallow pan of meal, sawdust, or grain. In stubborn cases, expose food in shallow pans until the rats

readily feed on it. Then add a buried trap. Inspect traps frequently to remove dead rodents and change old bait.

d. Glue Boards

Rats can also be trapped with sticky glue boards. Although most often used against mice, glue boards are also effective against rats. In the latter case, larger glue boards should be used, designed to trap an animal the size of a rat. There are, however, some drawbacks to glue boards. They are messy and expensive, and cannot be reused. This device catches all four feet of rodents on its sticky surface, and the trapped animal dies quickly, when its nostrils get plugged with glue.

The glue boards should be placed in the same location as snap traps; lengthwise and flush along the wall, box, or other object that edges a runway. Overhead runways along pipes, beams, rafters, and ledges are also good sites for placing glue boards. Adding a dab of bait to the center of the glue board may improve its effectiveness.

Don't place glue boards directly over food or food-preparation areas. Secure the glue board with a nail or wire so a rat can't drag it away. Install glue boards in covered stations if people might be upset to observe a struggling rat, where children or pets could come in contact with the glue, or in areas with excessive dust or moisture. Check glue boards frequently and dispose of rodents.

5. RODENTICIDES

A rodenticide is a pesticide designed to kill rodents. There are three major formulations of rodenticides used to control rats: food baits, water baits, and tracking powders. Toxic baits may be used outdoors under some controlled circumstances. The disadvantage of toxic baits or tracking powders is that it is difficult or impossible to recover the carcass, and there is a risk of secondary poisoning of nontarget animals such as cats and dogs, or of having to control secondary insect infestations such as blowflies or dermestid beetles that feed on the carcass.

a. Food Baits

Rat baits combine a poison effective against rats with a food bait attractive to them. Baits can be purchased ready-made and packaged as extruded pellets, in a dry meal, or molded into paraffin blocks for wet sites. Baits may be obtained in all sizes—from 45-pound bulk tubs to place-packs containing less than one ounce of bait.

Some baits kill rats after a single feeding, some require multiple feedings. Some are anticoagulants (which cause rats to bleed to death), some affect respiration, and others have totally different modes of action. Some baits are only slightly toxic to people or pets, others are moderately or very toxic. Unfortunately, old poisons that killed rodents by affecting the stomach were also toxic to human beings.

Another rodenticide, called warfarin, was developed in the 1940s; it interferes with the blood's clotting mechanism. Others are coumafuryl, chlorophacinone, diphacinone, pindone and valone. While these anticoagulants are effective and do not cause bait shyness, they could be lethal to people as well as pets. Consumption of rodenticides in quantities over several days results in fatalities. Vitamin K is an antidote to these anticoagulants.

The resistance of rodents to anticoagulants and a desire for quicker results led to the development of single-dose anticoagulants including brodifacoum and bromadiolone. In recent years, rodenticides with different modes of action, such as bromethalin or cholecalciferol, have also been proven effective. Zinc phosphide, used as a single-dose nonanticoagulent, is somewhat poisonous to all vertebrates. It is often used as a tracking powder meant to be licked from the fur when rodents groom themselves, and is also incorporated into dry baits. Zinc phosphide should never be applied without wearing gloves.

Rodenticides must be used very carefully because they are dangerous to people and pets. Several general guidelines should be followed when using a poison bait:

- All rodenticides should be kept in their original containers bearing labels warning that the bait is poison and that it should not be placed in locations accessible to children, pets, wildlife, and domestic animals.
- Rodenticides should be kept in tamper-proof containers. Decisions about what are safe, inaccessible areas for placement of rodenticides is determined on a case by case basis. Ask questions like these:
    - Is it possible for a child to reach a place-pack hidden underneath construction materials?
    - Could a guard dog find and eat the bait blocks?
    - Could a squirrel or cat enter the bait box and feed?

    If so, change the placement or put the bait inside a tamper-proof bait box. **Toxic baits should not be used inside inhabited structures.**

b. Bait boxes

A tamper-proof bait box is designed so that a child or pet cannot get to the bait inside, but the rat can. (Bait trays and flimsy plastic or cardboard stations are not tamper-proof bait boxes.) Tamper-proof boxes differ in the type and quality of construction. They are usually metal or heavy plastic. Rat-bait stations are larger than those used for mice. Most designs are not considered to be truly tamper-proof unless they can be secured to the floor, wall, or ground.

Ensure that bait boxes are clearly labeled with a precautionary statement. Check stations or boxes periodically to ensure that rats are taking the bait and that the bait is fresh. Rats will rarely feed on bait that has spoiled. Bait boxes should be placed wherever the rats are most active, as determined by droppings and other signs (near burrows, along outside walls, and at other travel sites). When rat populations have been eliminated, remove bait boxes, but continue to monitor for new signs of rodent activity.

Put place-packs in burrows and similar protected sites. If a site is damp, use paraffin bait blocks or other water-resistant formulations. Roof rats often need to be baited in areas above ground such as trees, and roofs. Put out enough bait and check it often. Incomplete baiting can lead to bait shyness and make control difficult.

Be sure to limit or eliminate the rats' normal food supply, otherwise the baits may be avoided. Remember that rats fear new objects at first so that baits may not be eaten for a few days or a week. Once bait is taken, leave the box in place for some time. Rats now consider it to be part of their normal surroundings. Good bait placements can be effective even when placed fifteen to 50 feet apart. Bait placed outdoors can kill rats moving in from nearby areas.

c. Water baits

Rats drink water daily if they can. When water supplies are short, water baits, formulated rodenticides mixed with water, can be effective. Several types of liquid dispensers are available. The best are custom-designed for toxic water baits, but plastic chick-founts can also be used in protected sites. Use water baits only where no other animals or children can get to them.

d. Tracking Powders

Rats groom themselves by licking their fur. Toxic tracking powder can be used to take advantage of this behavior. This formulation is a rodenticide carried on a talc or powdery clay which is

applied to areas where rats live and travel. The powder sticks to the rats' feet and fur, and is swallowed when rats groom themselves. The major advantage to tracking powders is that it can kill rats even when food and water is plentiful, or if rats have become bait- or trap-shy.

Apply tracking powders more heavily than an insecticide dust (but never deeper than 1/8-inch.) Best application sites are inside dry burrows (when permitted by label). Apply with a hand bulb or bellows duster.

Do not use tracking powders inside buildings occupied by people, or around air ventilators. The powder can become airborne and drift into nontarget areas. The rodenticide in tracking powders is generally five to 40 times more concentrated than that in baits. Tracking powders are formulated with acute poisons or slower-acting poisons.

END OF CHAPTER SIXTEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER SEVENTEEN - HOUSE MICE

SECTION A INTRODUCTION

The house mouse (*Mus musculus*) easily adapts to living near people. It thrives in a wide range of climatic conditions in a great variety of habitats, feeding on most human food, and reproducing at a remarkable rate. House mice live throughout the United States, and are found in most areas of human habitation. They are a common problem in residences and structures. Not only do house mice destroy food and cause damage to structures and personal possessions, they also have the potential to transmit diseases and parasites to people and domestic animals.

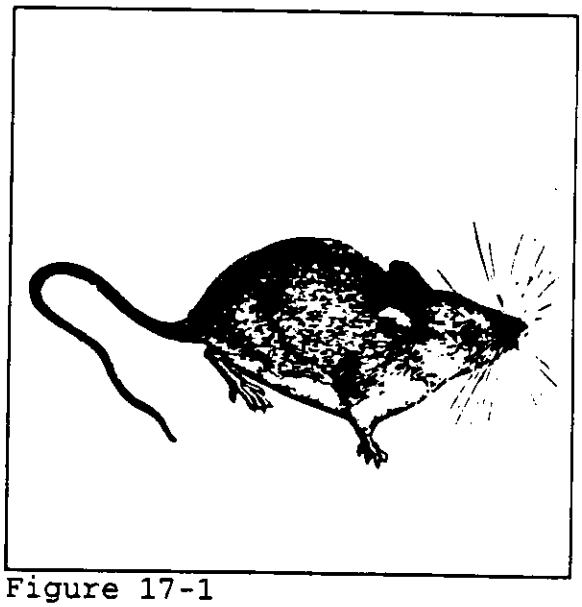


Figure 17-1

House mice are also found living in the wild. They are common inhabitants of grassy fields and cultivated grain crops. They have also been captured in open tundra in Alaska, miles away from human settlements.

Control of house mice requires understanding mouse biology and habits, and particularly the major differences between mice and rats. During the past few decades, control of Norway and roof rats has improved, while problems with house mice have increased. Baiting programs often are more successful in controlling rats than mice.

SECTION B CHARACTERISTICS AND RECOGNITION

1. APPEARANCE

The house mouse is a delicate, agile little rodent. Although adult weights vary by region and may be linked to the suitability of habitat, they usually range from half to one ounce. The color of adult house mice ranges from light brown to dark gray, but most often is a dusky gray or medium brown over most of their bodies, except the belly, which may be a lighter shade of their general color, but never white.

The mouse has moderately large ears for its body size. The tail is nearly hairless and about as long

as the body and head combined (2-1/2 to 4 inches). The feet are small in proportion to its body, and the eyes are also relatively small.

Our native deer (white-footed) mice (*Peromyscus* sp.), which often invade buildings adjacent to fields and woodlands, are about the same size as or slightly larger than house mice. Deer mice have a distinct, bicolored tail; the upper portion is brown or gray and the underside is distinctly white, with a well-defined line where the two colors meet.

Meadow mice or voles (*Microtus* sp.) sometimes invade homes; they are less agile, have larger, chunky bodies and weigh at least twice as much as house mice. They also have much shorter tails and small ears and eyes.

2. HABITS OF HOUSE MICE

a. Life Cycle

Under optimum conditions, house mice breed year round. Out-of-doors, house mice may tend toward seasonal breeding, peaking in the spring and fall. Environmental conditions, such as the availability and quality of food, can influence the frequency of pregnancy, litter size, and survival. Under ideal conditions, females may produce as many as ten litters of five young in a year. At very high densities, however, reproduction may nearly cease, despite the presence of excess food and cover.

New-born mice are quite undeveloped, weighing between 0.02 and 0.03 ounce, and are nearly hairless. Their eyes and ears are closed, but within two weeks the body is covered with hair and the eyes and ears are open. At about three weeks, the young begin short trips away from the nest and begin taking solid food.

b. Social Behavior

While mice are active primarily at night, some day-time activity occurs. Movements of house mice are largely determined by temperature, food, and hiding places. Home ranges of mice tend to be smallest where living conditions are good. Mice tend to travel over their entire territory daily, investigating each change or new object that may be placed there. They are very aggressive. Unlike rats, they show no fear of new objects. They dart from place to place, covering the same route over and over again. This behavior can be used to advantage in control programs. Disturbing the environment at the beginning of a control program by moving boxes, shelves, pallets, and other objects can improve the effectiveness of traps, glue boards, and bait. Mice will

investigate the changed territory thoroughly.

c. Senses of Mice

Like rats, mice have relatively poor vision, and are also color blind. They rely heavily on smell, taste, touch, and hearing. Mice use their keen sense of smell to locate food and to recognize other individuals, especially those of the opposite sex. Taste perception in mice is also good. Mice use their acute hearing to detect and escape danger.

An important sensory factor for mice is touch. Like rats, mice use long, sensitive whiskers near the nose and guard hairs on the body as tactile sensors to enable them to travel in the dark, pressing against walls and boxes, scurrying through burrows.

Mice also have an excellent sense of balance. A mouse's ability to carry out actions or movements quickly is increased by constant practice of sequences of muscular movements (sometimes referred to as the kinesthetic sense): a subconscious recording of the series of movements necessary to go from point A to point B. This is the result of stimulation of sensory nerve endings in muscles, tendons, and joints, and allows mice to quickly escape danger.

d. Curiosity

As mentioned above, mice do not fear new objects as do rats, and they quickly detect and investigate new objects in their territories. They will immediately enter bait stations and sample a new food (although they may only nibble on a small amount). They will also investigate traps and glue boards. Control programs against mice often have early success, just the opposite of rat programs.

e. Physical Attributes

It is difficult to mouse-proof a building or control mice without understanding their physical capabilities:

- For their size they are excellent jumpers. Some of the more agile individuals jump twelve inches high from the floor onto an elevated flat surface.
- They can jump against a wall or other vertical surface, using it as a spring board to gain additional height.
- They can run up almost any vertical surface, from wood and brick walls to metal girders, pipes, weathered sheet metal, wire mesh, and cables without difficulty, if the surface is rough.
- They can run horizontally along insulated electrical wires, small ropes, and the like, with ease.

- They can squeeze through openings slightly more that 1/4 inch high.
- They can easily travel for some distance hanging upside down from 1/4-inch hardware mesh.
- They are capable swimmers, although they generally do not take to water as well as do rats, and tend not to dive below the surface.
- They can walk or run along ledges too narrow for rats.
- They can jump from a height of eight feet to the floor.
- They can survive at a constant 24 degrees F (-4 degrees C) temperature for ten generations.
- They have been reported 1,800 feet below the ground in a coal mine.
- They are quick to explore any physical change in their environment.

f. Food and Water

House mice prefer cereals over other items, although they feed on a wide variety of foods. Mice sometimes search for foods high in fat and protein, such as lard, butter, nuts, bacon, and meat. Sweets, including chocolate, are taken at times. Mice satisfy much of their water need with moisture in their food, but they drink if water is readily available.

Mice have two main feeding periods, at dusk and just before dawn, and they are nibblers, feeding twenty or more times during evening rounds. In any territory there will be one or two feeding sites, dark and protected, where mice eat more than at other places. Mice tend to hold grain kernels, such as oats or wheat, nibbling on it like corn on the cob. They often drop portions of kernels as they get smaller.

g. Range

Mice are territorial and seldom travel more than thirty feet from their nest. Their range is much smaller than the rats' range of 100 to 150 feet. When food is nearby, mice may restrict their activity to a few feet. Males average slightly larger ranges than do the females. This phenomenon can be related to trapping strategies. Placing traps closer together will get a higher percentage of females.

h. Nests

House mice may nest in any dark, sheltered location, in nests approximately four inches in diameter and constructed of fibrous, shredded materials such as paper, cloth, burlap, insulation, or cotton, which generally look like a loosely woven ball. Outdoors, house mice sometimes dig and nest in small burrows.

The small range of mice, the way they feed, and their food preferences are the characteristics that set house mice apart from rats. Keep these in mind when controlling mice.

SECTION C HAZARDS OF INFESTATION

1. LOSSES DUE TO MICE

When mice infest stored food, the greatest loss is not what they eat, but what is thrown out because of real or suspected contamination. In six months, one pair of mice can eat about four pounds of food and deposit about 18,000 droppings. The amount of food contaminated by the mice is estimated to be about ten times greater than what is eaten.

Losses are not limited to food. Mice also damage personal property and installations by gnawing, including electrical wiring in buildings. House mice frequently take up residence in electrical appliances and end up chewing into the power supply.

2. MICE AS DISEASE CARRIERS

Excluding the spread of food poisoning, house mice are not as dangerous as rats as carriers of disease and parasites. Yet their potential cannot be neglected. House mice and their parasites are implicated in the transmission of a number of diseases.

a. Salmonellosis

Bacterial food poisoning, salmonellosis, can be spread when some foods are contaminated with infected rodent feces. Mice are probably more responsible than rats for the spread of this disease.

b. Rickettsial Pox

Rickettsia akari is the causal agent of rickettsial pox, a disease causing a rash of the chickenpox type. Rickettsial pox is transmitted from mouse to mouse, then to people by the bite of the house-mouse mite.

c. Meningitis

Lymphocytic choriomeningitis is a viral infection of house mice that may be transmitted to people (mainly to children) through contaminated food or dust.

d. Leptospirosis (Weil's Disease)

The mouse can be a major carrier of Leptospirosis (Weil's disease), although human cases are more commonly caused by rats.

e. Rat-bite Fever, Ray Fungus, and Ringworm

Rat-bite fever can be transmitted by house mice, as can ray fungus, *Actinomyces muris*. Certain tapeworms are spread in house-mouse droppings, and ringworm, a skin fungus disease, can be carried to human beings by mice or contracted indirectly from mice through cats. Tularemia has also been linked to house mice.

f. Dermatitis

Dermatitis caused by the bite of a mite has been associated with house-mouse infestation. The uncomfortable skin irritation and itching can affect both children and adults. Mites may spread through a mouse-infested house or apartment during particular times of the year; however dermatitis is frequently blamed on other causes (heat rash, allergies, fleas, and the like).

SECTION D INSPECTION AND MONITORING

1. INSPECTION

a. Sounds

Sounds are common at night where large numbers of mice are present. Listen for squeaks, scrambling, and sounds of gnawing.

b. Droppings

A house mouse produces about 70 droppings per day. Fresh droppings are not usually as soft in texture as rat droppings, and in a few days become quite hard. Mouse droppings are frequently the first evidence that mice are infesting. Large cockroaches, bats, and other species of mice such as deer mice (*Peromyscus* sp.) and meadow mice (*Microtus* sp.), may produce droppings similar to those of house mice. Look along runways, by food, near shelters, and in other places mice may frequent.

c. Urine

House mice occasionally make small mounds known as "urinating pillars." These consist of a combination of grease, urine, and dirt, and may become quite conspicuous. Look for many small drops of urine using a blacklight, since urine stains will fluoresce under ultraviolet light.

d. Grease marks

Like rats, mice produce greasy smears where dirt and oil from their fur mark pipes and beams. However, house mouse spots are not as easy to detect; expect markings to cover a smaller area than those made by rats.

e. Runways

Most house-mouse runways are indistinct trails free of dust but not readily detectable.

f. Tracks

Look for footprints or tail marks on dusty surfaces or on mud. Use a nontoxic tracking patch to help to determine the presence of house mice within buildings.

g. Gnawing Damage

Recent gnawings on wood are light in color, turning darker with age. Look for enlarged cracks beneath doors and small tooth marks. Such evidence frequently helps to distinguish between mice and rats. Look for wood chips with the consistency of coarse sawdust around baseboards, doors, basement windows and frames, and kitchen cabinets.

h. Visual Sightings

Since mice are often active in daylight, this may not indicate a high population as it does with rats. Use a powerful flashlight or spotlight at night in storage spaces to confirm the presence of house mice.

i. Nest Sites

Look in garages, attics, basements, closets, and other storage places. Be alert to fine shredded paper or other fibrous materials, which are common nest-building materials.

j. Pet Excitement

Follow up when cats and dogs paw excitedly at a kitchen-cabinet door, the floor at the base of a refrigerator, or at the base of a wall, especially if mice have invaded the premisses only recently.

k. Mouse Odors

Check for the characteristic musky odor produced by mice, which is easily differentiated from that of rats.

2. ESTIMATING NUMBERS OF MICE

Estimating the number of mice is more difficult to do than for rats. Unlike rats (which may travel widely within a building leaving tracks on many patches of dust), house mice do not range widely. Read natural signs such as droppings, urine stains, tracks, and damage.

Make nontoxic tracking patches of talc at twenty- to thirty-foot intervals throughout a building. The more tracks seen in each patch, and the more patches showing tracks, the larger the population. The percentage of patches showing tracks will reflect the extent of infestation. Tracking patches are also an excellent means to evaluate a control operation. Compare the number of tracks or patches with mouse tracks before and after a control program.

SECTION E CONTROLS

Control and prevention of house mice is a three-part process: sanitation, mouse-proofing, and population reduction indoors with traps. The first two are useful preventive measures. When a mouse population already exists, some kind of lethal control is necessary. Otherwise, the reproductive capability of the mice, and their remarkable ability to find food in almost any habitat, will keep their populations up or increase them. House mouse control is different from rat control. Pest managers who do not take these differences into account will experience failures. The following tips may contribute to success:

- Sealing mice out of a building is difficult because they are so small.
- The range of mice movement is small. Identify each infested site in order to target control procedures appropriately.
- Mice can often produce offspring faster than control methods can work.

Nevertheless, some of the techniques to control and manage rats also apply to mice. In the sections below the differences in procedures for rats and mice are emphasized.

1. SANITATION

Good sanitation makes it easier to detect signs of mouse infestation since it also increases the effectiveness of baits and traps, which represent the only food supply. However, not even the best sanitation eliminates house mice, since they require very little space to get into the house and small amounts of food to flourish.

Store bulk foods in mouse-proof containers or rooms. In storage, stack packaged foods in orderly rows on pallets so that they can be inspected easily. A family of mice can live in a pallet of food without ever having to leave the immediate area.

Keep stored materials away from walls and off the floor. A twelve to eighteen-inch yellow or white band painted on the floor next to the wall in commercial storage areas permits easier detection of mouse droppings. This band and the areas around pallets should be swept often so that new droppings can be detected quickly.

2. MOUSE-PROOFING

It isn't easy to completely mouse-proof a building, since mice are able to squeeze through an opening as little as 1/4-inch. Seal all holes to limit the movement of mice into and through a building. Plug holes in foundation walls with steel wool or copper mesh. Caulk and fit doors and windows tightly. Seal holes around pipes, utility lines, and vents, to make it difficult for mice to move in and out of wall and ceiling voids. This confines mice to a smaller area and may make snap traps more effective.

3. TRAPPING

See Chapter Sixteen—Rats for illustrations of appropriate traps and glue boards.

a. Snap Traps

If used correctly, snap traps are very effective in controlling mice. They must be set in the right places, in high numbers, and in the right position, or mice will miss them entirely. Here are some factors to keep in mind when trapping mice.

- The territory of mice rarely extends further than 30 feet from the nest, and more often is about ten feet. If mice are sighted throughout a building it means that there are numerous locations where you will have to set traps.
- Place snap traps not only wherever you see obvious signs of mice, but also in good trap locations in a three-dimensional sphere about ten feet in diameter around those signs.

- Use traps every three to six feet in prime mouse habitat.
- Mice can be living above their main food supply in suspended ceilings, attics, inside vertical pipe runs, and on top of walk-in coolers. Or they can be below, in floor voids or crawlspaces.
- The best sites are those with large numbers of droppings, since that indicates that mice are spending a lot of time there. Other good sites are along walls, behind objects, and in dark corners, particularly where runways narrow down, funneling mice into a limited area.
- Good mouse baits increase the effectiveness of traps. Peanut butter, bacon, cereal, and nuts are traditional, but one of the best baits is a cotton ball, which the female mice like to use for nest material. It should be tied securely to the trigger. Food baits should be fresh to be effective.
- Mice are attracted to sweet baits, so a gumdrop tied to the bait pan may be effective.
- Probably the biggest mistake made in mouse trapping is not using enough traps. Use enough to make the trapping campaign short and productive.

b. Multiple-Catch Traps

Multi-catch traps (for example, TIN CAT® and KETCH-ALL®) are widely used for mouse control. These mouse traps catch up to fifteen mice without requiring reset. Some brands are called "wind-up" traps; the wind-up mechanism kicks mice into the trap. Others use a treadle door. Since mice like to investigate new things, they enter the small entrance hole without hesitation. Odor plays a role too; traps that smell "mousy" catch more mice. Place a small dab of peanut butter inside the tunnel entrance to improve the catch.

Mice should be humanely killed. Check traps frequently (at least daily). Although mice are captured alive, they may die in a day or two. Some traps have a clear plastic end plate or lid so you can see if any have been captured. Place the traps directly against a wall or object with the opening parallel to the runway, or point the tunnel hole towards the wall, leaving one or two inches of space between the trap and the wall. If mice are active, place many traps six to ten feet apart. For maintenance trapping, place the traps in high-risk areas and also at potential mouse entry points such as loading docks, near utility lines, and at doorways.

c. Glue Boards

Glue boards are very effective against mice. As with traps, placement is the key. Locations that are good trap sites are also good sites for glue boards. Do not put glue boards directly above food or in food-preparation areas. Set glue boards lengthwise and flush against a wall, box, or other object that edges a runway. Move objects around; create new, narrow runways six inches wide to increase the effectiveness of glue boards. Put peanut butter or a cotton ball in the center

of the board, and place the glue boards five to ten feet apart in infested areas (closer if the population is large). If no mice are captured in three days, move the boards to new locations. If a trapped mouse is alive, kill it before disposal. Replace the boards if they fill up with insects.

4. CHEMICALS

a. Rodenticides

Toxic mouse baits may not be as effective in controlling a mouse population as toxic rat baits are for rats. Mice are nibblers and may not get a large enough dose to achieve a kill. This leads to bait shyness. Mice that are killed usually die in hidden areas that may be inaccessible. Dead mice will have a bad odor for a while, another disadvantage to toxic baits. Dead mice that are not removed immediately become attractive to blowflies and dermestid beetles which feed upon the carcass. These insects then may become the source of insect infestations in other areas of buildings. The use of toxic baits and tracking powders is discouraged in occupied dwelling units.

b. Food Baits

Observe the same safety guidelines for toxic mouse baits as discussed in Chapter Sixteen's section on rat baits. In addition, follow these guidelines:

- Children, pets, wildlife, and domestic animals should be protected by putting the bait in inaccessible locations or inside tamper-proof bait boxes. Do not use food baits for mice inside residential buildings.
- Apply many small bait placements outdoors rather than a few large placements.
- Only use baits labeled for mouse control.
- Place the baits in favorite feeding and resting sites, as determined by large numbers of droppings.
- Place the baits between hiding places and food, up against a fence or object to intercept the mice.
- Bait in three dimensions.
- Make bait placements ten feet apart or closer in infested outdoor areas.
- If bait is not taken, try switching to a different type, and replace the baits often.
- Use small bait stations, which are more attractive to mice.
- Make sure that sanitation is good so that other food is not competing with the baits.
- Place secured tamper-proof bait boxes in safe locations near doors in late summer to intercept mice before they enter structures from the wild.

c. Liquid Baits

Although mice get most of their water from their food, they will also drink from a water container. Liquid baits labeled for mouse control can be effective in sites that do not have a ready supply of water. As with food baits, many outdoor water stations will be necessary to put the bait into the territory of all mice infesting an area.

d. Tracking Powders

Toxic tracking powders are especially effective against mice, since they groom themselves more often than rats, and they investigate enclosed areas which can be dusted with tracking powder.

Outdoors, use a secured bait station, PVC tube, cardboard tube, or any small, dark shelter that a mouse could enter in cases where tracking powder can be applied. Apply the tracking powder in a layer less than 1/16-inch deep. Do not allow tracking powder to drift into nontarget areas.

END OF CHAPTER SEVENTEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER EIGHTEEN - BIRDS

SECTION A INTRODUCTION

Birds provide enjoyment and recreation, enhancing the quality of life for those who view, enjoy, study, photograph, or hunt them. Bird-watching as a sport and recreational activity involves over 10 million people. For this reason, birds are protected by laws, regulations, and public opinion. However, birds can become pests when they feed on crops, create health hazards, roost in large numbers on buildings, contaminate food, or create a nuisance. Pigeons, for example, can cause human health problems when roosting in large numbers, and their droppings can foul buildings and sidewalks, and damage automobile paint. But no particular species can be flatly categorized as good or bad; whether birds are seen as beneficial or harmful depends on time, location, and activity.

SECTION B CHARACTERISTICS AND RECOGNITION

1. PIGEONS

The domestic pigeon, *Columba livia* (Fig. 18-1), developed from the rock doves of Europe and Asia, was introduced into the U.S. as a domestic bird. Rock doves originally nested in caves, holes, and under overhanging rocks on cliffs, so they comfortably adapt to window ledges, roofs, eaves, steeples, and other components of man-made structures.

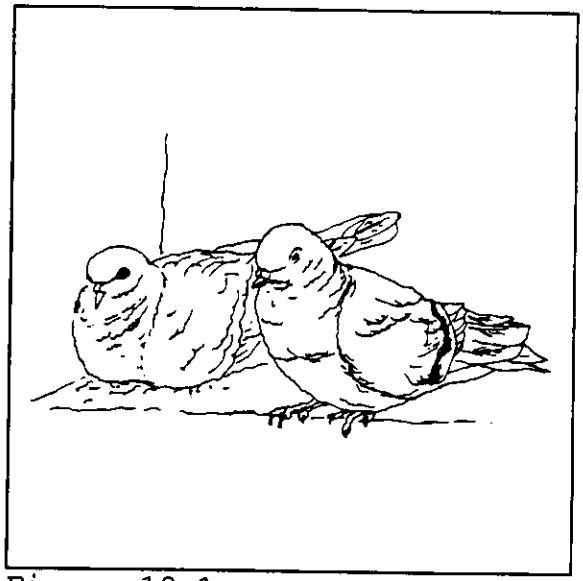


Figure 18-1

Along with house sparrows, pigeons may be the only "friendly" wildlife observed by many people living in an inner city. Park visitors have adopted pigeons that they feed every day.

But pigeons have also become a serious pest bird. Although primarily seed or grain eaters, in urban areas pigeons feed on garbage, spilled grains, insects, and food left out by outdoor diners and provided by bird lovers.

a. Habits of Pigeons

Pigeons commonly feed, roost, and loaf in each other's company whenever possible. Feeding, roosting, and loafing sites are usually separate. Roosting sites are used for nesting, congregating at night, and shelter in bad weather. Loafing sites will be nearby the roosting sites to be used by inactive birds during the day. Feeding sites may be several miles away. When pigeons are not feeding or mating, most of their day is spent cooing, preening, and sun bathing. Sun bathing is most common in the morning of cool days.

Pigeons prefer flat and smooth surfaces on which to rest and feed. Unlike most birds, they will feed from rooftops, regardless of height, because they like open feeding areas that permit a speedy get-away. They also feed on open ground and occasionally on ledges.

Male pigeons are sexually mature at three to four months of age, females at six months. After pairing and mating, nest construction begins. Pigeons nest on a frail platform of small twigs, straw, and debris in which they make a slight depression. Nests are usually located in protected openings in or on buildings. The male usually selects the nest site, but both adults actually build the nest, with the male often bringing nest materials to the female.

One or two creamy white eggs are laid eight to twelve days after mating. (Three or more eggs are sometimes found in a single nest, but this occurs when two or more hens share one nest.) The eggs are incubated by both parents for roughly eighteen days, by the male from mid-morning through afternoon, and the female the rest of the day and night.

Young pigeons are born naked, and are fed "pigeon milk," a milky-white fatty substance regurgitated from the parents' crops. After five days, the parents begin mixing grain and other foods with the pigeon milk, and after ten they switch completely to whole grains. During the first week or so, young pigeons double in size daily, and are full-grown in less than a month. They are fledged at 37 days, and are capable of an average flight speed of three to six miles per hour.

Adult birds can mate again while the young are still in the nest. Pigeons nest during all seasons when conditions permit. City pigeons generally remain in one area year-round and produce ten young per year. Nests that are continually used become solid with droppings, feathers, debris, and sometimes, dead birds. Life span is highly variable, ranging from three to fifteen years in urban roosts. They have lived for 30 years in captivity.

2. STARLINGS

European starlings (Fig. 18-2) were introduced into the United States in 1890, when 60 were brought to New York City. They rapidly expanded into new areas, and today 140 million starlings range throughout North America.

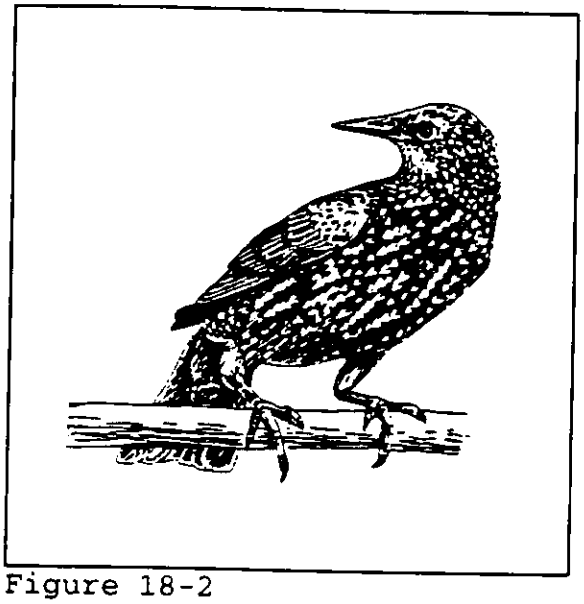


Figure 18-2

Starlings are robin-sized birds weighing about three ounces. Adults are dark with light speckles on their feathers in winter; the feathers turn glossy purplish-black and green in summer. The bill of both sexes is yellow from January to June, and dark at other times. Young birds are grayish.

Starlings have relatively short tails and appear somewhat chunky and humpbacked. The wings have a triangular shape when stretched in flight. Starling flight is direct and swift, not rising and falling like that of many blackbirds.

a. Habits of Starlings

Starlings nest in holes or cavities in trees or rocks; in urban areas they nest on buildings, in birdhouses, on power stations and water towers, and other structures. Starlings average two broods a year with four to seven young per brood. Both parents build the nest, incubate the eggs, and feed the young. The young birds leave the nest at about three weeks old.

In some parts of the country, starlings migrate, forming larger flocks as cold weather begins in the fall. Their major sources of food shift from insects and fruits to grains, seeds, livestock rations, and garbage. Roosting areas may shift as well—from rural and suburban sites into cities and towns. Each day they may fly up to 30 miles to their feeding sites. Each starling eats about one ounce of food each day.

Leaving their evening roost at sunrise, they travel to feeding sites over well-established flight routes. Rather than fly straight into their roosts just before sundown, they "stage" on high perches such as trees, power lines, bridges, and towers. They are social at these times, and remain on pre-roost sites until after sunset, singing and calling to each other.

Starlings are considered pests because thousands or tens of thousands can roost at one site.

Droppings at the roost site damage car finishes, tarnish buildings, drop onto people below, and build up to such levels that they become a health hazard; starlings have been responsible for outbreaks of a number of diseases.

3. HOUSE SPARROWS

The house sparrow, *Passer domesticus* (Fig. 18-3), also called the English sparrow, was introduced into the United States in the 1850s. Populations now flourish all over the continental United States, except in heavy forests, mountains, and deserts. It seems to prefer human-altered habitats in cities and around farm buildings and houses. In fact, while still one of the most common birds, its numbers have fallen drastically since the 1920s when food and waste from horses furnished unlimited food. House sparrows feed preferentially on grain, though they will also feed on fruits, seeds, and garbage.

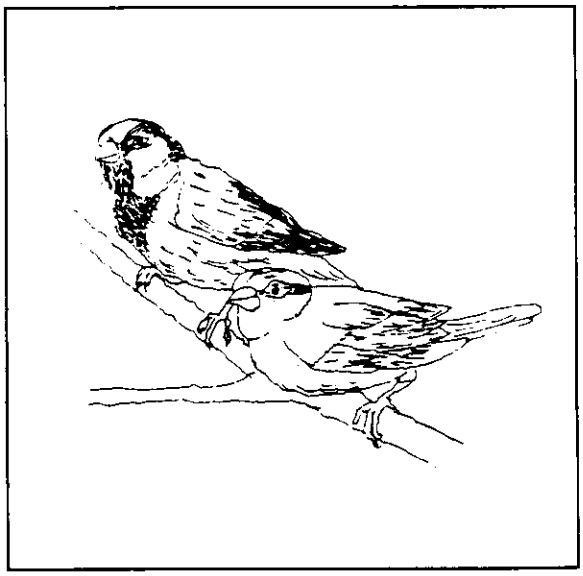


Figure 18-3

The house sparrow is a brown, chunky bird five to six inches long. The male has a distinctive black bib, white cheeks, a chestnut mantle around a gray crown, and chestnut upper wing covers. The female and young birds have a gray breast, buffy eye stripe, and a streaked back.

a. Habits of House Sparrows

House sparrows average three broods per season with four to seven eggs per brood. Breeding can occur in any month; through much of the country, it is most common from March through August. Eggs are incubated about two weeks, and the young stay in the nest another two weeks. The male usually selects the nest site. Nests are bulky and roofed over, and located in trees and shrubs, on building ledges, in signs, on light fixtures, and under bridges. Nests often plug rain gutters or jam power transformers.

Sparrows are aggressive, social birds, often out-competing native species. They have no recognized migration patterns, and will stay in an area as long as food and nest sites are available. Young birds, however, move out of an area to establish new territories. Flocks of juvenile birds and nonbreeding adults may sometimes travel four or five miles from nest sites to feeding areas. Sparrows are tolerant of human activity, and will not hesitate to set up

housekeeping in high traffic areas.

House sparrows can be pests in many situations. Their droppings contaminate stored grain and bulk food. Droppings and feathers make unsanitary, and smelly wastes. Sparrows can also become pests when they nest inside a structure. The birds cause damage by pecking at rigid foam insulation in buildings. Their nesting in transformers creates fire hazards. Sparrows are a factor in the transmission of a number of diseases, internal parasites, and ectoparasites. They are thought to be a major reservoir of St. Louis encephalitis.

4. OTHER BIRDS

Other birds, from hawks to swallows, may occasionally become pests. When blackbirds and crows roost in suburban areas they become pests. Woodpeckers can "hammer" into house siding looking for insects. Some of these birds are protected by laws. Special permits may be required to trap them or to control them by lethal means. The best protection is exclusion or modification of buildings.

SECTION C HAZARDS OF INFESTATION

Health risks from large populations of roosting birds may present risks of disease to people nearby. The most serious health risks are from disease organisms growing in accumulations of bird droppings, feathers, and debris under a roost. If conditions are right, particularly if roosts have been active for years, disease organisms can grow in these rich nutrients. Food may be contaminated by birds. When parasite-infested birds leave roosts or nests, their parasites may invade buildings and can bite, irritate, or infest people.

1. HISTOPLASMOSIS

This systemic fungal disease (mold) is transmitted to humans by airborne spores from soil contaminated by pigeon and starling droppings (as well as from the droppings of other birds and bats). The soil under a roost usually has to have been enriched by droppings for three years or more for the disease organism (*Histoplasma capsulatum*) to increase to significant levels. Although almost always associated with soil, the fungus, in rare instances, has been found in droppings alone, such as in an attic. Infection is by inhalation of the spores, which can be carried by wind, particularly after a roost has been disturbed.

Most infections are mild and produce either no symptoms or a minor flu-like illness. The disease can, on occasion, lead to high fever, blood abnormalities, pneumonia, and even death. The National Eye Institute (NEI) at National Institutes of Health has reported a potentially blinding eye condition, called ocular histoplasmosis syndrome (OHS), that results from infection by the *Histoplasma capsulatum.*

In this condition, the central part of the retina (the macula, used in straight-ahead vision) becomes inflamed and is damaged as blood vessels grow inside the affected area.

2. CRYPTOCOCCOSIS

Pigeon droppings appear to be the most important source of the disease fungus, *Cryptococcus neoformans*, in the environment. The fungus is typically found in accumulations of droppings in attics, ledges, and other roosting and nesting sites on buildings.

The disease is acquired by inhaling the yeast-like vegetative cells (two to three microns) of the organism. There are two forms of cryptococcosis found in humans. The cutaneous form is characterized by acne-like skin eruptions or ulcers with nodules just under the skin. The generalized form begins with a lung infection, and spreads to other areas of the body, particularly the central nervous system. It can be fatal. Like histoplasmosis, outbreaks of this disease often occur after building renovation, roost clean-up, or other actions that disturb the old droppings.

Other diseases carried or transmitted by birds affect people to a lesser degree. Psittacosis, pigeon ornithosis, and toxoplasmosis are normally mild in human beings; however, serious illness or death can occur in rare cases. Pigeons and sparrows have also been implicated (along with many other species of birds) in outbreaks of encephalitis.

3. ECTOPARASITES

Pigeons, starlings, and house sparrows harbor ectoparasites that can invade buildings. Some of these parasites can bite and irritate. A long list of mites infests pigeons, but the northern fowl mite and chicken mite are usually the main ones invading buildings from nesting and roosting sites. Other pigeon ectoparasites that may cause problems inside buildings are the pigeon nest bug (a type of bed bug), various species of biting lice, the pigeon tick, and the pigeon fly.

Droppings, feathers, food, and dead birds under a roosting or loafing area can also breed flies, carpet beetles, and other insects that may become major problems in the immediate area. These pests may fly or walk into windows, ventilators, and cracks and crevices, and enter buildings.

4. DEFACEMENT AND DAMAGE TO STRUCTURES AND EQUIPMENT

Bird droppings under window sills, "whitewashing" down a building face, or accumulating on sidewalks and steps, are the most obvious problem associated with large roosts. Clean-up can be labor-intensive and expensive, particularly on high-rise buildings. Bird droppings are corrosive and will

damage automobile finishes, metal trim, electrical equipment, and machinery. Downspouts and vents on buildings also become blocked by droppings, nest materials, and feathers. This debris can attract insect pests such as carpet beetles and other dermestids, spider beetles, and mealworms.

5. LEGAL CONSIDERATIONS

With very few exceptions, birds are protected by one or more federal laws and regulations. Although pigeons, starlings, and house sparrows are not directly protected at the federal level, toxicants or repellents should be applied according to the product label and under the restrictions of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).

Nontarget birds in the treatment area are protected, and any actions that kill or damage protected birds or their habitats would be a violation of various federal and state regulations. State and local regulations may require permits or restrict the actions taken against these three pest birds. When in doubt, contact the state Natural Resources Agency or the local United States Fish and Wildlife Service District office for further information.

SECTION D INSPECTION AND MONITORING

The first step in controlling birds is to conduct a detailed and accurate bird survey. Surveys should be conducted early in the morning, midday, and again in the evening to correspond to the different activity periods of birds. The survey should not be limited to information about pest birds; nontarget bird activity is just as important in order to minimize risk to these birds. The survey should investigate:

- What birds are present;
- How many there are;
- Whether they are residents, migrants, adults, or juveniles;
- Their activities—nesting, feeding, roosting, loafing;
- Where they eat and drink;
- What is attracting them to the various sites;
- Whether they are causing a health risk;
- Whether they are causing physical damage;
- If dispersed, where they would go;
- If poisoned, where they would die;
- Whether there is a risk to nontargets;
- The legal considerations;
- Whether the control method would provoke public relations problems;
- Whether exclusion or habitat modification would be practical.

SECTION E CONTROLS

1. HABITAT MODIFICATION

Habitat modification for birds means limiting a bird's food, water, or shelter. Attempting to limit the food or water of pigeons, starlings, and house sparrows is not practical. These birds will have a number of feeding and watering sites, often far from roosting and loafing sites. Where people are feeding birds in parks or lunch areas, education can help reduce this source of food; however, in some cases, people will pay little attention to requests to stop feeding the birds.

The most successful kind of habitat modification is to exclude the birds from their roosting and loafing sites (addressed in the section on exclusion). Other methods of habitat modification include the following:

- Pigeons may be induced to move from an infested site by the persistent destruction of nests and eggs. However, nest destruction is ineffective against sparrows and starlings.
- High-pressure streams of water spray is the most cost-effective method of nest destruction. It destroys the nest, eliminates ectoparasites, cleans droppings and feathers from the nest site, and harasses the roosting birds. Use high-pressure sprays only where the water will not damage buildings or equipment. Remove all droppings and nest materials from the area.
- When spraying is not safe, use a hook fastened to a long pole to remove the nests. (When the nests are within 20 feet of occupied sites, treat the immediate nest area with an insecticide/acaracide to eliminate ectoparasites.)
- Destroy nests every two weeks during the spring and summer months until the birds move to other nest sites.

2. EXCLUSION

Some building designs and conditions lend themselves to bird infestation. Flat ledges, openings in water towers and vents, unscreened windows, and other attributes make a building an attractive location for roosting, nesting, and loafing. Modification or repair can exclude birds. Typical solutions include replacing broken windows, adding screens, repairing damaged eaves or ventilation screens, eliminating large crevices, blocking openings into vents, cooling towers, and roof-top equipment with hardware cloth or similar material.

Exclusion methods also includes the use of netting, custom-designed sheet-metal or plastic covers, porcupine wire (Nixalite, for example), electrified wires, and sticky repellents to keep birds from roosting on ledges, roof edges, window sills, building signs, and other surfaces favored by pest birds. Two advantages are that the birds are not killed and the control is comparatively long-lasting.

a. Netting

Netting is used to block access of birds to large roosting areas in structures. Netting is especially useful around mechanical-equipment areas where aesthetics are of minor consideration. It has been used successfully on cooling towers. Metal and fiber nets have been replaced by plastic nets, normally extruded black polypropylene made with an ultraviolet inhibitor to reduce UV degradation. Knotted nets are also available. Nets will last from two to five years, depending on exposure to sunlight.

b. Covers or Ramps

Custom-designed covers for ledges, window air-conditioning units, and roof edges are the best technical solution to keep birds from infesting these sites. However, the high cost of this method may deter HAs from exercising this option on large buildings with extensive roosting sites. But covers are valid options where limited applications will keep birds off selected sites, and where aesthetics are an important consideration. The covers usually consist of sheet metal installed at a 45 degree angle to prevent the birds from landing. Sometimes plastic inserts are custom-fit into the indentations in order to block off ledges.

c. Spikes

Porcupine wire, sharp metal spikes, or any similar "bed of nails" can stop birds from roosting on ledges. Where they can be used, they usually work fairly well. If aesthetics are important, these devices are usually limited to areas where they cannot be easily seen. If pigeons are likely to drop nest material and other debris on top of the newly installed spikes in an attempt to create a new roosting surface, install metal spikes on potential landing sites above the installation. Check metal spikes every six months for accumulated debris or nest material, and regularly remove leaves and other matter that can cover the spikes and reduce their effectiveness. Ensure that no tree branches hang over protected ledges.

d. Sticky Repellents

Sticky repellents are tacky gels or liquids. The products are designed to be sticky enough to make a bird uncomfortable, but not so sticky that the birds are trapped. After a few attempts, the birds stop trying to land on treated surfaces. The active ingredient is polybutene or isopolybutene (the same substances used in some adhesive bandages) or petroleum naphthenic oils.

Before applying sticky repellents, clean ledges covered by bird droppings, feathers, and nest

material with a wire brush, paint scraper, high-pressure hoses, or by steam cleaning. Ensure that surfaces are clean and dry. Seal concrete, unpainted wood, or brownstone with silicone or other sealant, paint, or shellac before applying repellent. Sticky repellents will be absorbed into porous materials.

Use a caulking gun to apply repellent. The depth of the bead necessary to repel different species of pest birds is roughly as follows: crows and sea gulls, 3/8 inch; pigeons, 1/4 inch; starlings, 1/8 inch; sparrows, 1/16 inch. The pattern of application will depend on the site and the applicator's preference. The caulking gun should be held at an angle of 30-45 degrees. Apply a straight bead on ledges and roof edges, 1/2 inch from the outer edge, with another bead three inches in from the first, or they can be applied in a zig-zag or "s" curve. Place breaks in the bead every few feet to avoid trapping rainwater against the building. For easy removal and replacement, apply waterproof sticky repellent tape on ledge and roof edges.

Apply bulk gels with a paint roller, putty knife, or bulk caulking gun. Apply liquids with a roller, brush, or compressed-air sprayer to girders, rods, sign supports, and rooftops. They can also be used to treat the upper surface of branches in trees and bushes. The repellent should be 1/16 to 1/8 inch thick. Liquid application is not recommended for sites where the appearance of the sticky repellent would be undesirable. Do not place sticky repellent material where it will become unsightly over time.

Environmental conditions, particularly dust, make a big difference in the effective life of sticky repellents. In an area with no dust, applications should be expected to remain effective for a year or more. Some sticky repellents come with a liquid coating that is sprayed onto the repellent immediately after application. The liquid dries to a brittle film that protects the material from dust and may allow it to remain effective for as long as two to five years.

Precautions should be followed when sticky repellents are used. Be sure migratory or other nontarget birds are not harmed.

Under some conditions, sticky repellents stain the surfaces to which they are applied. Some products melt and run when exposed to direct sun and high temperatures. Review labels and the manufacturers' technical information on the effective temperature ranges of different products. Compare the stability of different products by running a test on a sunny roof or window ledge.

Birds occasionally get stuck in sticky repellents. When this happens, their feathers will get gummed up, and they'll be unable to fly. If a bird becomes gummed up with repellent, it can sometimes be rescued by cleaning the flight feathers with a small amount of mineral spirits

followed by mineral oil. In most cases, cartridge applications (as described earlier) will repel the birds with little risk of entanglement.

e. Remove Nests

Check state and local regulations which may prohibit destroying or disturbing nests containing eggs or young.

f. Ultrasonic Devices

Tests by university, government, and private independent researchers have failed to demonstrate any efficacy against birds by any of the ultrasonic devices tested. These devices do not work against birds.

3. TRAPPING

In many instances, trapping can be an effective supplemental control measure, especially against pigeons. Where a group of birds roosts or feeds in a confined and isolated area, trapping should be considered the primary control tactic.

The best time to trap pigeons is in the winter, when their food is at a minimum. There are many pigeon traps to choose from, and the best type and size to use is debatable. Most pigeon-trapping programs use large walk-in traps four to six feet high and designed to be disassembled and moved. Another common type is a low-profile bob-trap that is about eight inches to two feet high. The door or entrance through which pigeons are lured is the principle feature of a trap.

Set traps in inconspicuous places where pigeons commonly roost or feed, and where they are not likely to be vandalized (a major risk in trapping programs). Trap placement is important, so moving an inactive trap just ten to fifteen feet may significantly improve catches.

Feeding areas are the best trap sites, but are rarely on the same property as the roosting sites. Roof tops that have water from cooling towers or air-conditioning units are often good trapping sites in summer. The most difficult part of trapping is motivating birds to feed in a nonfeeding area so that they will follow the bait into the trap. Whole corn or sorghum are generally the best baits, but wheat, milo, oat groats, millet, popcorn, sunflower seeds, peas, greens, bread, or peanuts can be very effective if the birds are feeding on similar food. Once a few birds have been trapped, putting different foods in for the birds can show which bait they prefer.

In the first few weeks of a program, scatter small quantities of bait throughout the area to start the birds feeding and determine the best trap sites. Some specialists leave traps propped open for the first few days to allow the birds to get used to them. When they calmly enter the trap, set it. Put water (a "chick font" is ideal) and bait inside and just a handful or so outside. Leave one or two "decoy" birds in the trap to draw in other birds. Light-colored birds make better decoys than drab ones.

Remove trapped birds regularly (except for decoys), otherwise other pigeons will be frightened by fluttering trapped pigeons in the trap. Since pigeons can fly great distances and find their way home, trap and release is not normally effective. Trapped birds should be humanely destroyed. Some experts recommend gassing with calcium cyanide, but many feel it is simpler and more humane to kill the bird by breaking its neck.

Sometimes indoor roosting sites can be used as a giant trap. Pigeons often use attics, rooftop elevator houses, or empty floors of poorly maintained structures as nest and roost sites. By screening all but one or two entrances, such areas can be made into a giant trap. Late in the evening, after a two-week acclimation period, these last entrances can be closed after the pigeons have settled down for the night. The trapped birds can be captured by hand or with butterfly nets.

Sparrow traps come in various sizes and shapes. The sparrow funnel trap is a double funnel that prevents escape after the birds have travelled through two funnels in pursuit of a food bait. Fine cracked corn, millet, wheat, or bread crumbs make good bait. Trap sites should be baited for a few days before trapping is begun. Sparrow traps are usually more effective when placed on the ground. Nest-box traps attract a sparrow with a potential nest site. Once inside, the bird trips the mechanism, and is dumped into a collecting bag. This trap also works against starlings, as does the center-drop trap. Attracted by food, the birds drop through an opening and cannot escape. However, starlings are not usually good candidates for trapping programs.

4. CHEMICAL

a. Avitrol

Avitrol is a poison bait with flock-alarming properties used to control different kinds of birds. There are different Avitrol baits for each pest bird species: whole corn for pigeons, smaller grains for sparrows and other birds. Within fifteen minutes of eating a toxic dose of Avitrol, birds flutter erratically and go into convulsions. They may fly away from the baiting site, into windows, or "dive bomb" into the ground.

Affected birds convulse for an hour or more. Most die within a few hours, but some last for as

long as fifteen hours. Only a small percentage of the flock (usually from five percent to fifteen percent) needs to be affected for an Avitrol program to be successful. The flock becomes frightened by the convulsions and distress of the poisoned birds, and anywhere from 65 percent to 85 percent of the flock will leave the area. Avitrol should only be used by a professional who specializes in vertebrate animal-control measures.

b. Toxic Perches

A toxic perch is a metal container with a wick surface that holds a liquid contact poison that birds absorb through their feet when they stand on the perch. The toxicant (fenthion) is hazardous to all birds and animals **including human beings**. Toxic perches should only be used by a professional who specializes in vertebrate animal-control measures.

c. Ornitrol

Ornitrol is a chemosterilant, often called the "birth control pill" for pigeons, since it inhibits ovulation in the female and sperm production in the male. The effects of treatment last for six months in the female and three months in the male. When applied as directed on the label, it will not kill birds, but populations will slowly decline over the years from the natural mortality in an aging pigeon population.

The manufacturer recommends applications for ten days twice a year: in the early spring (March) and late summer or early fall. For each 100 pigeons, seven and a half pounds of Ornitrol corn are scattered daily for ten days. Prebaiting with whole corn for a week will usually be necessary to achieve bait acceptance. Most birds eating Ornitrol would be temporarily sterilized, so care must be taken to avoid feeding nontarget species. Research data indicated little or no activity in mammals. There is no secondary poisoning hazard.

5. SHOOTING

A possible alternative or supplemental method for eliminating birds is shooting with air-powered pellet guns. Shoot at night or first thing in the morning in roosting areas. Use a high-powered pellet gun because it is relatively accurate, quiet, short-ranged, and will not cause structural damage. Many models are available. Some specialists use .22-caliber smooth-bore rifle loaded with Number 12 or Number 9 bird shot or sand shot. However, these are noisy and too powerful for urban sites.

Errant shots can be dangerous. Most urban jurisdictions have regulations on the use of firearms or pellet guns for bird control. Check with local authorities.

a. Risks to Nontargets

Most lethal tactics in bird control pose some risk to nontarget birds, as well as other animals. All migratory and game birds are considered nontargets, and are protected by various federal, state, and local regulations, as well as by public opinion. Care must be taken to minimize the threat to nontargets or to use tactics that pose the least risk:

- Identify any nontarget birds or animals in the area;
- Use tactics that are least risky;
- Modify tactics to minimize risk;
- Monitor operations to be sure that no nontargets are being adversely affected.

b. Public Relations

People often react more negatively to one dying bird than to accumulated pigeon droppings on sidewalks or potential risks of parasites and disease from bird roosts. Pigeons and sparrows can be seen as pets rather than pests. The public's perception of bird-management operations needs to be considered. All bird-management programs should put some effort into avoiding "people problems," particularly when using Avitrol or other toxic control techniques.

SECTION F BIRD DROPPINGS REMOVAL AND CLEAN-UP

Workers removing large quantities of bird droppings should follow these precautions to minimize risk from disease organisms in the droppings:

- Wear a respirator that is labeled to filter particles down to 0.3 microns.
- Wear disposable protective gloves, hat, coveralls, and boots.
- Wet down the droppings to keep disease spores from becoming airborne, and avoid drying them out.
- Put droppings into sealed plastic garbage bags and wet down the outside of bags.
- When finished, and while still wearing the respirator, remove the protective clothing and place it in a plastic bag.
- Dispose of trash bags. Disposal should be permissible through standard trash pick-up.
- Wash up or shower.

END OF CHAPTER EIGHTEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL

CHAPTER NINETEEN - OTHER VERTEBRATE PESTS

SECTION A INTRODUCTION

Although rats, mice, and birds are the vertebrate pests most commonly encountered in the urban environment, other vertebrates sometimes become pests too. Some of these animals become pests when they wander into residential areas from nearby wild areas or parks—for example, skunks, raccoons, and possums. A skunk in the woods is beneficial; a skunk nesting in the crawlspace of a home is an entirely different matter. Other vertebrate pests, such as bats and squirrels, have taken to living with people—next to or sometimes inside buildings.

Whatever the pest, it should be managed. However, game animals or others which are considered pests may be protected. Many people feel a strong attachment to vertebrates that they do not feel towards other organisms. Children in particular may love and cherish them. Some people are involved emotionally in protecting the "welfare" of animals, particularly vertebrates. Control of vertebrates other than rats and mice is more of a public-relations problem than a pest problem. Killing may be the control method of choice.

1. BATS

a. Characteristics and Recognition

Bats (Fig. 19-1) are unique in the animal kingdom as the only true flying mammals. A thin membrane of skin stretches from their long front legs to the back legs and then to the tail. Bones in their "fingers" are elongated and support the wings.

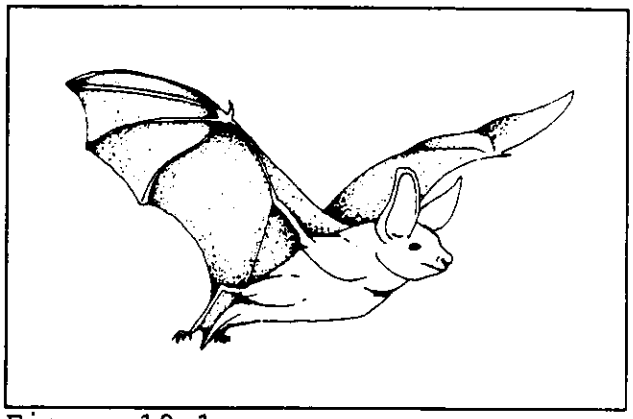


Figure 19-1

Bats are usually beneficial, since they feed on insects. They can consume up to half of their body weight in insects in one feeding. Occasionally, however, bats may become a nuisance when they move into buildings and pose a public-health problem.

They become a problem when they live in colonies or groups. Some of the bat species are: little

brown bats, big brown bats, Mexican free-tailed bats, and big-eared bats. These species sometimes hibernate or roost inside buildings in attics, wall and ceiling voids, belfries, chimneys, and unused furnaces. Bat droppings and urine can cause a foul odor and stains in walls and ceilings. Their squeaking and scrambling noises can be intolerable to residents.

b. Habits of Bats

During warm weather, bats feed on flying insects in late afternoon, evening, and early morning. They are not active in bright daylight. If you see a bat at this time, it has either been disturbed from its resting place or is sick. When not in flight, they rest in dark places (caves, buildings, hollow trees). Bats are able to enter these places of refuge through holes as small as 3/8-inch.

Bats capture flying insects by "echo-location." They emit high-frequency sound, inaudible to human beings, similar to sonar. They also make audible squeaking sounds for communication. In much of the country, bats migrate or hibernate when the weather turns cold, sometimes in hanging clusters inside buildings. Depending on the species and geographic location, they breed from late spring to midsummer. Young bats grow rapidly and can fly in three to seven weeks.

2. TREE SQUIRRELS

a. Characteristics and Recognition

Tree squirrels (Fig. 19-2) are mainly found in forest areas throughout most of the United States. Some species have adapted well to suburban and city life. Occasionally they enter buildings and cause damage or disturbance. The most common species that become pests are the gray squirrel, red squirrel, flying squirrel, and fox squirrel.

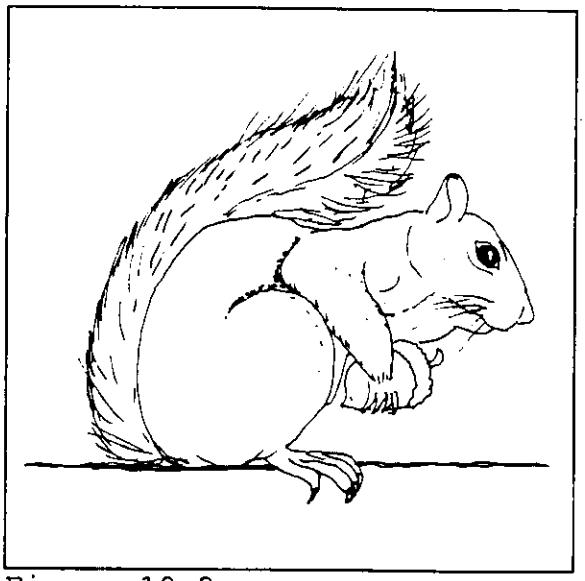


Figure 19-2

Tree squirrels usually build their nests in trees, but may also find shelter and store food in attics and garages. They can become pests by scrambling and scratching inside attics and in wall voids, and by short-circuiting transformers. They also like to gnaw on wires. The legal status of squirrels varies with geographic area and species. Many are classified as game animals. Some are protected. Be sure to check with local game conservation officers before beginning any kind of lethal control or trapping program.

3. GROUND SQUIRRELS AND CHIPMUNKS

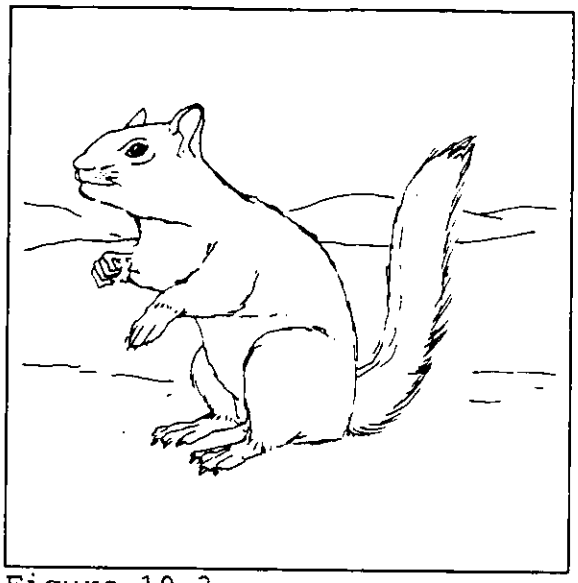


Figure 19-3

A number of species of squirrels and chipmunks occasionally become pests in and around buildings. The major concern is their burrowing around foundations, in lawns, and in gardens. Ground squirrels (Figure 19-3) can have extensive burrows with large mounds, especially along roads and ditch banks. On occasion, burrows beneath buildings can cause structural damage. Ground squirrels can also transmit diseases such as tularemia and plague.

Both ground squirrels and chipmunks are active during the day and are easily seen when foraging. But they spend much of their time in their burrows. During winter months, most ground squirrels and chipmunks go underground and stay inactive. In some areas, ground squirrels will go into a summer hibernation when the temperature is high.

Ground squirrels are primarily vegetarians, feeding on grass. When vegetation dries up, they switch to seeds, grains, and nuts. Chipmunks eat both plant and animal material, including seeds, nuts, insects, worms, songbirds, and frogs.

4. MOLES

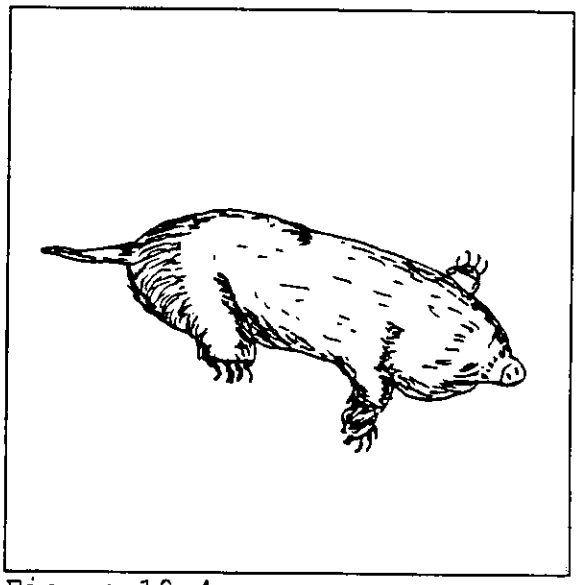


Figure 19-4

Moles (Fig. 19-4) are not rodents like mice and gophers, but are relatives of insectivores (insect eaters) like shrews and hedgehogs. Moles burrow in lawns, meadows, stream banks, and open woodlots while searching for food. They feed on earthworms and insect larvae (grubs), and are rarely seen above ground. Moles are four to nine inches long, including the tail, with long dark gray or brown fur. Their eyes are tiny, like a pinhead, and the tail and feet are usually pink. They have no visible ears. There are seven species in the United States.

Moles may damage plants and disfigure lawns with

mounds and ridges. As they tunnel just below the surface, moles raise the sod up with their front digging feet while searching for food or new tunneling sites. They can push up surface tunnels at the rate of a foot per minute if the soil is loose. They prefer loose, moist soil shaded by vegetation.

5. SNAKES

Most snakes are nonpoisonous, harmless, and beneficial. As a general guideline, poisonous snakes usually have a large triangular head, a pit between their eyes and nostrils, and vertical and elliptical pupils. They may also have rattles on their tail, noticeable fangs, and a single row of scales between their vent and tip of the tail. When unsure, assume that the snake may be poisonous and protect accordingly.

Snakes are predators. Depending on the species, their diet may include insects, rodents, frogs, birds, worms, or toads. Some snakes hibernate in dens during the winter, sometimes under houses. At certain times of the year, they may enter buildings for warmth, shade, or moisture.

6. SKUNKS, RACCOONS, AND POSSUMS

These three vertebrates are considered together because they are similar pests with similar management and control recommendations. Management of these animals almost always involves exclusion and live trapping.

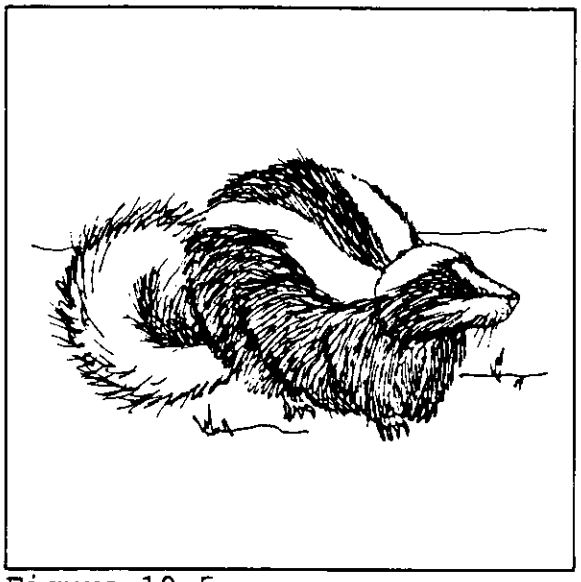


Figure 19-5

a. Characteristics and Recognition

Skunks: Two kinds of skunks may become pests, the striped skunk (Fig. 19-5) and the spotted skunk. The striped skunk is about the size of a large house cat, with two broad white stripes running from the back of its head to the large bushy tail. Spotted skunks are about half that size, with four irregular stripes beginning behind their eyes and below the ears.

Skunks are nocturnal. They do not hibernate, but may sleep through cold-weather periods. They usually live in underground burrows, hollow logs, or rock piles, or under houses, sheds, cabins, or storage buildings. The main problem with skunks is their stink. They become "pests" when they change their dietary selections from rodents, insects, and wild fruit, to garden crops, garbage,

and lawn insects, and locate their habitat closer to people. A major problem, in some areas of the country, is the transmission of rabies.

Raccoons: Raccoons are common throughout North America. They are easy to recognize with their black face mask and black, brown, and white-ringed bushy tail. They have long thick fur with a thin muzzle and pointed ears. Their feet are well adapted to climbing. They are large animals, weighing between ten and twenty-five pounds.

Their hearing, sight, and touch are well developed, while taste and smell are not. They are commonly found near streams, lakes, and swamps, and often do quite well in suburban areas and even in city parks. Raccoons den inside hollow trees or logs, rock crevices, deserted buildings, culverts, chimneys, attics, and crawlspaces. They may use more than one den. Mostly active at night, raccoons may be seen at dawn or dusk and sometimes even in the middle of the day. Winter months are spent in the den, but they do not hibernate. They may become active during warm spells.

Raccoons feed on animals and plants. In the spring and summer, they feed on crayfish, mussels, frogs, and fish. In the fall, they switch to fruits, seeds, nuts, and grains. They also eat mice, squirrels, and birds, and are quite happy knocking over a garbage can. Raccoons, too, can transmit rabies.

Opossum: Related to kangaroos, opossums are the only marsupial (a mammal whose young are carried for months after birth in an external pouch on the abdomen) in North America. The opossum is a whitish or grayish animal the size of a house cat. Its face is long and pointed with rounded, hairless ears. It grows up to 40 inches long. It will weigh up to fourteen pounds; the average is six to seven pounds for males and four pounds for females. Their tracks look like they were made by little human or monkey hands.

Opossums prefer to live near streams or swamps. They den in the burrows of other large animals, in tree cavities, brush piles, and under sheds and buildings. Occasionally, they move into attics and garages. They eat nearly everything, from insects to carrion, fruits to grains, garbage to pet food. Opossums are active at night. Their mating season is January to July, and they may raise two to three litters per year. Most young die in their first year, but those that survive may live up to seven years.

Opossums move slowly. Their top speed is about seven miles per hour. When threatened, opossums climb trees or go down into burrows. If cornered, they may growl, hiss, bite, screech, and exude a smelly green fluid from their rear ends. If these defenses aren't successful, they may

play dead. They have the reputation of being stupid, but scientists consider them to be smarter than domestic dogs.

As a pest, the main complaint against opossums is that they get into garbage, bird feeders, or pet food left outside, and carry large populations of cat fleas.

SECTION B HAZARDS OF INFESTATION

1. BATS AND DISEASE

Bats are associated with a few diseases that affect people. Rabies and histoplasmosis are the most serious. Rabies is a dangerous disease, fatal if not treated in time. However, the bat's role in transmission has been greatly exaggerated. Although bats are confirmed carriers of the disease, only a few human fatalities have been attributed to bat bites. Nevertheless, use care when handling bats. Bat bites should be considered to be potential rabies exposure. Because most bats will try to bite when handled, they should be picked up with heavy gloves, forceps, or a stick. If a bat has bitten someone, it should be captured without crushing its head. Refrigerate it (don't freeze it). Then take it to the local Health Department for rabies testing.

The incidence of Histoplasmosis (discussed in detail in Chapter Eighteen—Birds) transmission from bat droppings to humans is not thought to be high. However, when working in a bat-roost site with lots of accumulated droppings, wear a respirator and protective clothing and follow the safety procedures outlined in Chapter Eighteen.

SECTION C INSPECTION AND MONITORING

1. INSPECTION FOR BATS

Look for two things: entry and exit points of bats, and the location of the roost.

a. Entry and exit points

A building in poor repair will have seemingly unlimited entry points. Look for loose flashing, vents, shingles, or siding that bats can squeeze through. Look for damage and openings under eaves and soffits, at cornices, louvers, and doors, by chimneys and windows, and anywhere pipes or wiring enter. Notice droppings under openings, smudges around holes, and odors.

Bats can be observed at twilight as they leave the building to feed. The best time to observe the bats and pinpoint major exit and entry points is usually from just before to an hour after sunset. Station one or more observers at different sides of the building, looking up towards the roof. Listen for squeaking at the exits just prior to the flight. If the night is chilly or rainy, the bats may not come out.

b. Location of Roost

Locate the roost in the following way:

- Look inside attics and unused rooms during daylight;
- Check inside the chimney and vents;
- Bang on the walls and listen for squeaks and scratches as roosting bats are disturbed;
- Check behind shutters;
- Look for bat droppings. They will be found below roosting bats. Their droppings differ from mouse droppings, which they look like, because bat droppings contain wings, legs, and other body parts of insects. Bat droppings often accumulate to a depth of several inches or more.
- In large roosts, smell for bats. They have a very pungent and penetrating odor, musky and sweet, that comes from rotting droppings and bat urine.

SECTION D CONTROLS

1. CONTROL AND MANAGEMENT OF BATS

Chemical control is no longer an option for eliminating bats. No pesticides are currently registered for bat control by the EPA. The best way of getting rid of bats roosting in a building is through "bat-proofing."

a. Exclusion

Bat-proofing: Making a building "bat-proof" means sealing or screening all of the openings used by the bats to enter a building. It can be a difficult job because, in many cases, all upper openings 3/8 inch and larger must be sealed, but this is the only permanent method of ridding a building of bats. Bats should not be entombed when the building is sealed. Otherwise, trapped bats can be a problem.

June and July are the peak months for bat complaints in much of the country. Unfortunately, this is the worst time for control, since bats are rearing young in their colonies, and young bats cannot fly. Bat-proofing during this period would trap the young bats, and they would die, rot, and

become an odor problem. Bats may also crawl and flutter into living areas.

The best time of year to bat-proof a building is either in late fall, after bats have left for hibernation, or in late winter and early spring before the bats return. If bat-proofing must be done in summer, it should be done after mid-August.

Bat-proofing should be carried out as follows: seal all but one or two principal openings. Allow three to four days for the bats to adjust to using the remaining openings, then seal those openings some evening just after the bats have left for their nightly feeding. "Bat valves" can also be used. These are placed over the remaining openings and allow the bats to leave but not to return.

Standard bat-proofing materials include 1/4-inch hardware cloth, screening, sheet metal, caulking, expanding polyurethane foam, steel wool, duct tape—the same materials used for rodent-proofing. When old deteriorated buildings have many openings, and can't be sealed economically, large plastic bird nets can be draped over the roofs to keep out bats.

Bat repellents: If bat-proofing is not possible, or bats need to be forced out of a building before it is bat-proofed, they can be repelled by naphthalene crystals or flakes spread on attic floors or placed in voids. The crystals are most effective in confined spaces. While naphthalene may repel bats, it vaporizes and disappears in a few weeks, after which bats often return. Some people dislike the smell of naphthalene and are even sensitive to it. Such people should avoid all contact with this chemical.

Bright lights have been used with some success in repelling bats. Flood lights can be aimed at the bats' entry points to keep them from entering. However, the bright lights may attract insects too, which is the bats' food.) Attics can be illuminated with four or more bulbs; ensure that all corners of the attic are illuminated.

Drafts of cool air from fans and air conditioners may keep bats from roosting in a poorly sealed attic. Ultrasonic devices do not repel bats.

A single bat: When a single bat finds its way into a dwelling, it will usually find its way out again. When it does not find its way out, capture the bat with an insect net, a coffee can, or even with a gloved hand. The bat can then be released or destroyed.

2. CONTROL AND MANAGEMENT OF SQUIRRELS

Depending on state laws, ground squirrels and chipmunks may or may not be protected. Check with local officials before initiating any control plan.

a. Exclusion

Squirrel-proofing: The first step in eliminating a squirrel problem in a building is to find out where the squirrels are entering. Remember that squirrels will be coming and going each day. Common points of entry include damaged attic louvers, ventilators, soffits, joints of siding, knot holes, openings where utility wires or pipes enter, chimneys, and flashing. Squirrels may gnaw directly through siding and shingles too. Use heavy-gauge 1/2-inch hardware cloth or sheet metal to seal openings. Make other suitable repairs as for rat-proofing.

Squirrels can be stopped from travelling on telephone wires by installing two-foot sections of two to three-inch diameter plastic pipe. Split the pipe lengthwise, spread the opening apart, and place it over the wire. The pipe will rotate on the wire, sending the squirrel tumbling off. Be careful near high-voltage wires. Do not attempt to place plastic pipe on electrical wires. Call the company that supplies the electricity.

Squirrels often use overhanging branches as highways to rooftops. Tree branches should be trimmed back ten feet from the building. If the branches can't be trimmed, a two-foot wide band of metal fastened around a tree, six to eight feet off the ground, keeps squirrels from climbing up the tree and jumping to the building.

b. Mechanical .

Trapping: Live trapping with box or wire traps can be used to remove one or a few squirrels from a building. Traps should be left open and unset for a few days, surrounded by bait, so that the squirrels get used to them. Good baits include peanuts, nut meats, peanut butter, whole corn, sunflower seeds, or rolled oats. Good trap locations include the roof, the base of nearby trees, or attic spaces. Squirrels are nasty biters. Handle them carefully. Experts differ as to whether squirrels should be released or killed. If they are released, do so at least five miles away so that they do not return.

Where lethal control is permitted, rat snap traps can be used to kill squirrels in attics. The bait should be tied to the trigger and the trap nailed or wired to a beam.

c. Chemical

Repellents: Naphthalene has been used (in the same way as for bats) to keep squirrels out of attics and other unoccupied spaces. There is at least one sticky repellent product labeled for squirrels, similar to the sticky repellents used in bird control. Apply it to ledges, gutters, window sills, and the like, to keep squirrels off.

3. CONTROL OF GROUND SQUIRRELS AND CHIPMUNKS

a. Ground Squirrels

Control is usually required in severe infestations. Several important steps must be taken if a control or management program is to succeed:

- Correctly identify the species causing the problem.
- Alter the habitat, if possible, to make the area less attractive to the squirrels.
- Use the most appropriate control method.
- Establish an inspection or monitoring program to detect reinfestation.

Ground squirrels are generally found in open areas. However, they usually need some kind of cover to survive. Removing brush piles and debris will make the area less attractive, and will facilitate detection of burrows and improve access during the control program. Ground squirrels can be controlled with traps, rodenticides, and fumigants.

Trapping: Trapping is a practical means of controlling ground squirrels in limited areas where numbers are small. Live traps are effective, but present the problem of disposal of a live squirrel. Because squirrels can carry disease, many states will not permit the animals to be released at some new location, so they must be killed.

For the smaller species, rat snap traps can be effective. Place traps near burrow entrances or runs, baited with nuts, oats, barley, or melon rind. Place traps under a box if any nontargets might be killed in the trap.

Rodenticides: Rodenticides are the most cost effective way of controlling large populations of ground squirrels, and a number of products are registered for this use. Grain baits are most effective when squirrels are feeding on grains and seeds. Place rodenticides in burrows or in protected bait stations, according to the label directions.

Fumigation: Ground squirrels can also be killed by gassing their burrows. Aluminum phosphide

tablets or smoke cartridges are most commonly used. Fumigation is most effective when soil moisture is high, since moisture helps seal the tiny cracks in the burrow walls. Fumigation is not effective during periods of hibernation because the squirrels plug their burrows. Spring is normally considered to be the best time for burrow fumigation. Fumigation is not a good choice adjacent to buildings because of the risk that the fumigant gas could find its way into dwelling units.

b. Chipmunks

Chipmunks rarely become a serious pest problem. In most cases, lethal control is unnecessary. Altering the habitat may cause chipmunks to move. "Chipmunk-proof" the building to prevent entrance. Remove objects such as logs, stones, and debris close to a structure that may provide an attractive denning environment.

Trapping: Where permitted, live trapping and relocating chipmunks is a humane method of control. Effective baits include peanut butter, nuts, sunflowers, seeds, oats, bacon, and apple slices. Relocation should be done in remote forest areas at least five miles from the trap site.

Rat snap traps can also be used effectively. Traps should be placed at den entrances and baited with an apple slice, perhaps with some peanut butter. Seeds and nuts should not be used because they will attract ground-dwelling birds.

Poison baits labeled for chipmunk control can be used as described for ground squirrels. However, because chipmunk burrows are long, difficult to find, and often near buildings, burrow fumigation is not a recommended control tactic.

4. CONTROL AND MANAGEMENT OF MOLES

Although time consuming, the most effective method of control is the use of traps. Killing moles with fumigants or poison baits is not effective. Since there is no easy way to know which parts of the surface tunnels are active and which are abandoned, mole tunnels should be tamped down in several places over the yard. Mark tamped down sections with a peg or wire flag. If the tunnel has been pushed back up the next day or so, a trap should be set in that place.

Two types of traps are in general use: harpoon traps and chokers. A harpoon trap consists of two prongs that straddle the tunnel and a set of spring-driven spikes. The spikes are raised above the tunnel and catch in the trigger release. When the mole triggers the trap, the prongs are released and driven through the sod, impaling and killing the mole. A choker trap consists of a cast-metal frame with two spring-retractable loops. Two slits are cut in the tunnel and loops placed inside. When the

mole triggers the trap, it is immediately crushed.

When using traps, place a plastic pail with a warning sign over each trap. An average set will require three to five traps per acre. Check the trap every couple days, and if there are no results for three to four days, move the traps to new locations.

5. CONTROL AND MANAGEMENT OF SNAKES

If snakes become a problem, the best solution is to eliminate snake hiding places. Clean up brush piles, wood piles, rock piles, and other debris. Keep shrubbery away from foundations. Cut high grass. Often snake problems follow rodent problems. Eliminate the rodents, the snakes' food, and the snakes will move elsewhere. Snakes often enter structures through broken block foundations, cracked mortar, damaged vents. These should be repaired.

In a rattlesnake infested area, a snake-proof fence can be installed around a backyard or play area. Bury a galvanized 1/4-inch hardware cloth (with a height of three feet) six inches in the ground and slant outward at a 30-degree angle. Keep all vegetation away from the fence.

a. Snake Removal

If a snake gets into a dwelling or other building, there are several methods to remove it:

- Place damp burlap sacks on the floor and cover them with dry sacks. Check them every few hours to see if the snake has crawled underneath. The snake and bags can be lifted with a shovel, taken outside, and the snake killed or released.
- Rat glue boards will capture all but the largest snakes. The glue boards should be tied down or attached to a plywood base. Place the glue boards along wall and floor junctions. Captured snakes can be killed, or they may be released. Before release, pour vegetable oil over the snake and glue. The vegetable oil will dissolve the glue to release the snake.
- Expanded-trigger rat traps set in pairs along wall and floor junctions can kill smaller snakes.

6. CONTROL OF SKUNKS, RACCOONS, AND OPOSSUMS

a. Exclusion

These animals can be denied entry to buildings by repairing breaks in foundations and screening crawlspace vents with hardware cloth. If the animal is currently living under the building, seal all openings but one, then sprinkle a tracking patch of talc at the opening. Examine the area after dark. If tracks show that the animal has left, close this last opening immediately. Seal attic

openings. Cap chimneys with a wire cage or other animal-proof cover.

When excluding animals in spring or early summer, be aware that young animals may also be present. Be sure that all animals have been removed before sealing the building. Otherwise, an odor problem from the dead animal could result.

b. Live Trapping

Remember to check state regulations before beginning any control program. The best way to remove animals from around buildings is to trap them. If the animal must be killed, lower the trap into a tub of water, or gas it with a fumigant. If the animal is to be released, do it far away from the development. Use information on the biology of the animal to find a suitable habitat. The release site for these large animals should be over ten miles away.

Set traps as close to the animal's den as possible (where damage is occurring), at corners of gardens, breaks in walls, or along obvious animal trails. Set multiple traps in several locations. Since these animals are active at night, check traps at least every morning, preferably twice a day. It is desirable, however, to check traps more often to spot and release nontarget animals.

Skunks should be trapped carefully. Since they don't "shoot" unless they see their target, the trap, except for its entrance, should be covered with burlap or canvas before placing, and a string twenty feet or longer attached to the release door. A commercially-sold, solid skunk trap should be used. Approach the trap slowly and transport it gently when a skunk is trapped. To release the animal, stand more than twenty feet away and release the trap door using the string.

The best baits for each animal are:

- Skunk: chicken parts and entrails, fresh fish, cat food, sardines, eggs;
- Raccoon: chicken parts and entrails, corn, fresh fish, sardines;
- Opossum: apple slices, chicken parts and entrails, fresh fish, sardines.

A WORD OF WARNING: in many areas of the country, releasing a trapped animal is illegal. This is particularly true with skunks and raccoons because they can carry rabies.
ANOTHER WORD OF WARNING: the spotted skunk is protected in some states.
A FINAL WORD OF WARNING: some of these animals may be regulated as fur-bearers under the fish and game laws of the state. Know the state and local regulations before proceeding.

END OF CHAPTER NINETEEN

MAINTENANCE GUIDEBOOK VII
TERMITE, INSECT, AND RODENT CONTROL
GLOSSARY

GENERAL INFORMATION:

For further definition of terms consult:

- The Federal Insecticide, Fungicide, and Rodenticide Act, as amended. Public Law 92-516 October 21, 1972, as amended by Public Law 94-140 November 28, 1975 and Public Law 95-396 September 30, 1978.
- *Federal Register*, November 7, 1990, Part II Environmental Protection Agency 40 CFR Part 171 Certification of Pesticide Applicator; Proposed Rule.
- Regional Offices of the EPA.
- State Lead Agency for the State Plan for Commercial and Private Applicators.
- Federal Agency Secretary's Office (For federal employees using restricted pesticides in performance of official duties).
- Indian Governing Body or Indian Reservation Recertification Plan Administrator.
- Local, State, and National Pest Control Associations.

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ABSORPTION—The process by which a chemical or fluid is taken into the systems of human beings, plants, and animals.

ACARICIDE—A pesticide used to control mites and ticks. A miticide is an acaricide.

ACTIVE INGREDIENT—The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. (Listed separately in the ingredient statement.)

ACUTE TOXICITY—The ability of a pesticide to cause injury within twenty-four hours following exposure. LD_{50} and LC_{50} are common indicators of the degree of acute toxicity. (See also Chronic Toxicity.)

ADJUVANT—A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION—The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high-organic soils tend to adsorb pesticides.

AEROSOL—A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ALGAE—Simple aquatic plants that contain chlorophyll and are photosynthetic.

ALGICIDE—A pesticide used to kill or inhibit algae.

ANTI-SIPHONING DEVICE—A device attached to the filling hose that prevents backflow or backsiphoning from a spray tank into a water source.

ANTICOAGULANT—A chemical that prevents blood clotting. An active ingredient in some rodenticides.

ANTIDOTE—A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ARACHNID—A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are in the class Arachnida.

ARTHROPOD—An invertebrate animal characterized by jointed body and limbs. It is usually covered by a hard exoskeleton covering that is molted at intervals. For example, insects, mites, and crayfish are in the phylum Arthropoda.

ATTRACTANT—A substance or device that lures pests to a trap or poison bait.

AVICIDE—A pesticide used to repel or kill birds.

BACTERIA—Microscopic organisms, some of which are capable of producing diseases in people, plants and animals. Some bacteria are beneficial.

BACTERICIDE—Chemical used to control bacteria.

BAIT—A food or other substance used to attract a pest to a pesticide or a trap.

BAND APPLICATION—Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BARRIER APPLICATION—See band application.

BENEFICIAL INSECT—An insect that is useful or helpful to people, such as insect parasites, predators, or pollinators.

BIOLOGICAL CONTROL—Management of pests using beneficial arthropods as predators, parasites, and disease-causing organisms which may occur naturally or are introduced to reduce pest populations.

BIOMAGNIFICATION—The process by which one organism accumulates chemical residues in higher concentration from other organisms which they have consumed.

BOTANICAL PESTICIDE—A pesticide produced from chemicals found in plants. Examples are nicotine, pyrethrins, and strychnine.

BRAND NAME—The name, or designation of a specific pesticide product or device made by a manufacturer or formulator. (A marketing name.)

CALIBRATE, CALIBRATION OF EQUIPMENT OR APPLICATION METHOD—Measurement and adjustment to control the output or rate of dispensing pesticides.

CARBAMATES (N-Methyl Carbamates)—A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-Methyl Carbamates are insecticides and inhibit cholinesterase in animals.

CARCINOGENIC—The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER—An inert liquid, solid, or gas added to an active ingredient for delivering a pesticide to the target effectively. A carrier is usually water, oil, or other solvent, used to dilute the formulated product for application.

CERTIFIED APPLICATORS—Individuals who are certified by the state to use or supervise the use of restricted-use pesticides.

CHEMICAL NAME—The scientific name of active ingredients found in formulated products. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL—Pesticide application to kill pests.

CHEMOSTERILANT—A chemical compound capable of preventing animal reproduction.

CHEMTREC—The Chemical Transportation Emergency Center which has a toll-free number (800-424-9300) for providing 24-hour information only for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON—A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment, such as Chlordane and DDT. Few are registered for use in the U.S.

CHOLINESTERASE, ACETYLCHOLINESTERASE—An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-Methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY—The ability of a pesticide chemical to cause injury or illness (beyond twenty-four hours following exposure) when applied in small amounts repeatedly for a longer period of time. (See also **Acute Toxicity**.)

COMMERCIAL APPLICATOR—A state-certified applicator who for compensation uses or supervises the use of pesticides classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME—A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but the active ingredient has only one recognized common name.

COMMUNITY—The different populations of animal or plant species that exist together in an ecosystem (See also **Population** and **Ecosystem**.)

COMPETENT—Individuals properly qualified to perform functions associated with pesticide application. The degree of competency (capability) required is directly related to the nature of the activity and the associated responsibility.

CONCENTRATION—Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTACT PESTICIDE—A pesticide that causes death or injury to pests when in contact with it. The chemical does not have to be ingested. It is often used to describe a spray applied directly on a pest.

CONTAMINATION—The presence of an unwanted substance (sometimes pesticides) in or on a plant, animal, soil, water, air, or structure.

CULTURAL CONTROL—A pest control method that includes changing human habits, such as sanitation, changing work practices, or cleaning or garbage pick-up schedules.

DECONTAMINATE—To remove or break down a pesticidal chemical from a surface or substance.

DEGRADATION—A process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT—The amount of pesticide on a treated surface after application.

DERMAL TOXICITY—The ability of a pesticide to cause acute illness or injury to human beings or animals when absorbed through the skin (see **Exposure Route**.)

DESICCANT—A type of pesticide that draws moisture or fluid from a plant or arthropod pest, causing it to die. Certain desiccant dusts destroy the waxy outer coating that holds moisture within an insect's body.

DETOXIFY—To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS—The positive identification of a problem and its cause.

DILUENT—Any liquid, gas, or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT—A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE—Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT—The airborne movement of a pesticide spray or dust beyond the intended target area.

DUST—A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM—The pest-management unit. It includes a community (of populations) with the necessary physical (harborage, moisture, temperature), and biotic (food, hosts) supporting factors that allow a population of pests to persist.

EMULSIFIABLE CONCENTRATE—A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER)—A chemical that aids the suspension of a liquid in another that normally would not mix together.

EMULSION—A mixture of two liquids which are not soluble in one another. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION—A pesticide formulation with its active ingredient enclosed in tiny capsules of polyvinyl or other materials; principally used for slow release. The enclosed active ingredient moves out to the capsule surface as pesticide on the surface is removed (volatilizes, or rubs off).

ENDANGERED SPECIES—Individual plants or animals with a population that has been reduced to the extent that it is near extinction and that has been designated to be endangered by a federal agency.

ENTRY INTERVAL—See **Re-entry Interval**.

ENVIRONMENT—Air, land, water, plants, people, animals, and the interrelationships which exist among them.

EPA—ENVIRONMENTAL PROTECTION AGENCY—The federal agency responsible for ensuring the protection of people and the environment from potentially adverse effects of pesticides and other contaminants.

EPA ESTABLISHMENT NUMBER—A number assigned to each pesticide-production plant by the EPA. The number indicating the plant at which the pesticide product was produced must appear on all labels of that product.

EPA REGISTRATION NUMBER—An identification number assigned to a pesticide product when it is registered by the EPA for use. The number must appear on all labels of pesticide products.

ERADICATION—The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE—The manner—dermal (through the skin), oral (through the mouth), or inhalation/respiratory—in which a pesticide may enter an organism.

FIFRA—The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that controls pesticide registration and use.

FLOWABLE—A pesticide formulation in which very finely ground solid particles are suspended (not dissolved) in a liquid carrier.

FOG TREATMENT—A pesticide in aerosol-sized droplets (under 40 microns). Not a mist or gas. After propulsion, the fog droplets fall on exposed surfaces.

FORMULATION—The pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert ingredients), with other additives making it easy to store, dilute, and apply.

FUMIGANT—A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state, penetrating voids to kill pests.

FUNGICIDE—A chemical used to control fungi.

FUNGUS (plural=fungi)—A group of small, often microscopic, organisms in the plant kingdom which cause rot, mold, and disease. Fungi need moisture or a damp environment (wood rots require at least 19 percent moisture). Fungi are extremely important in the diet of many insects.

GENERAL-USE (UNCLASSIFIED) PESTICIDE—A pesticide which can be purchased and used by the general public. (See also **Restricted Use Pesticide**.)

GRANULE—A dry pesticide formulation. An active ingredient is either mixed with or applied as a coating to an inert carrier to form a small, ready-to-use, low-concentrate chemical which normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER—Water source located beneath the soil surface from which springs and well water are drawn (see also **Surface Water**.)

HABITAT MODIFICATION—Removing food, water, shelter, and other conditions that support pests, or excluding access by pests to the site.

HARBORAGE—Shelter that provides the basic needs, including a safe place for the pest population.

HAZARD—See **Risk**.

HERBICIDE—A pesticide used to kill or inhibit plant growth.

HIGH-RISK PERSON—A person who has some condition that may put him or her at risk from exposure to pesticides. Such persons include children, the elderly, pregnant women, newborns, asthmatics, the neurologically impaired, the environmentally ill (EI), and those with multiple chemical sensitivity (MCS).

HOST—Any animal or plant on or in which another lives for nourishment, development, or protection.

IGR, INSECT GROWTH REGULATOR JUVENOID—A pesticide which mimics insect hormones that control molting and the development of insect systems affecting the change from immature to adult (see **Juvenile Hormone.**)

INERT INGREDIENT—An inactive material without pesticidal activity in a pesticide formulation.

INGREDIENT STATEMENT—A portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION—Taking a substance in through the lungs (breathing in). (See **Exposure Route.**)

INSECT GROWTH REGULATOR—See **IGR.**

INSECTICIDE—A pesticide used to manage or prevent damage caused by insects.

INSECTS, INSECTA—A class in the phylum Arthropoda characterized by a body composed of three segments and three pair of legs.

INSPECTION—A process for detecting pests, pest damage, and evidence of pest activity in a managed site. (See **Monitoring.**)

INTEGRATED PEST MANAGEMENT—See **IPM.**

IPM—Integrated Pest Management. A planned pest-control program in which methods are integrated and used to keep pests from causing economic, health-related, or aesthetic problems. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary control method, but is an element of IPM, as are cultural and structural alterations. IPM programs stress communication, monitoring, inspection, and evaluation (keeping and using records).

JUVENILE HORMONE—A hormone produced by an insect that inhibits change or molting. As long as juvenile hormone is present the insect does not develop into an adult, but remains immature.

LABEL—All printed material attached to or on a pesticide container.

LABELING—The pesticide product label and other accompanying materials that contain directions for use, which pesticide users are legally required to follow.

LARVA (plural=larvae)—The developmental stage of insects with complete metamorphosis that hatches from the egg. A mature larva becomes a pupa (some invertebrates have larvae, but they are not urban pests).

LC_{50}—Lethal concentration. The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC_{50} is usually expressed in parts per million (ppm). The lower the LC_{50} value, the more acutely toxic the chemical.

LD_{50}—Lethal dose. The dose or amount of a pesticide that can kill 50 percent of the test animals when eaten or absorbed through the skin. LD_{50} is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD_{50}, the more acutely toxic the pesticide.

LEACHING—The movement of a substance with water downward through soil.

METAMORPHOSIS—A change in the shape or form of an animal. Usually used when referring to insect development.

MICROBIAL DEGRADATION—Breakdown of a chemical by microorganisms.

MICROBIAL PESTICIDE—Bacteria, viruses, fungi, and other microorganisms used to control pests. Also called biorationals.

MICROORGANISM—An organism so small that it can be seen only with the aid of a microscope.

MITICIDE—A pesticide used to control mites (see **Acaricide.**)

MODE OF ACTION—The way in which a pesticide exerts a toxic effect on the target plant or animal.

MOLLUSCICIDE—A chemical used to control snails and slugs.

MONITORING—Ongoing surveillance. Monitoring includes periodic inspection and record-keeping. Monitoring records allow technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the pest-management program.

MSDS—Material Safety Data Sheet required by Department of Labor to be provided by manufacturers to those that request information on chemnical substances.

NECROSIS—Death of plant or animal tissues which results in the formation of discolored, sunken, or necrotic (dead) areas.

NONTARGET ORGANISM—Any plant or animal other than the intended targets of pesticide application.

NYMPH—The developmental stage of insects with gradual metamorphosis that hatches from the egg. Nymphs become adults.

ORAL TOXICITY—The effect of a pesticide resulting in injury or acute illness when taken by mouth.

ORGANOPHOSPHATES—A large group of pesticides that contain phosphorus and inhibit cholinesterase in animals.

PARASITE—A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PATHOGEN—A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT—Devices and clothing intended to protect a person from exposure to pesticides, including items like long-sleeved shirts, long trousers, coveralls, hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT—See **IPM.**

PEST—An undesirable organism including any insect, rodent, nematode, fungus, weed, or some terrestrial and aquatic plants and animals, virus, bacteria, or micro-organism which the Administrator declares to be a pest under FIFRA, Section 25(c)(1).

PESTICIDE—A chemical or other agent used to kill, repel, or otherwise control pests or to protect from a pest.

pH—A measure of acidity/alkalinity of a liquid: acid below pH7 (down to zero); basic or alkaline above pH7 (up to 14).

PHEROMONE—A substance emitted by an animal to influence the behavior of other animals of the same species. Some are synthetically produced for use in insect traps.

PHOTODEGRADATION—Breakdown of chemicals by the action of light.

PHYSICAL CONTROL—Habitat alteration or changing the infested physical structure, such as by caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, and other means.

PHYSIOLOGICAL SENSITIVITIES—Human physiological reaction from exposure in the environment to perhaps minute amounts of chemicals that produce an adverse response.

PHYTOTOXICITY—Injury to plants caused by a chemical or other agent.

POINT OF RUNOFF—The point at which a spray starts to run or drip from the surface to which it is applied.

POISON CONTROL CENTER—A local agency, generally a hospital, which has current information on the proper first-aid techniques and antidotes for poisoning emergencies. Such centers are listed in telephone directories.

POPULATION—Individuals of the same species. The populations in an area make up a community (see **Ecosystem**.)

PORT—Small sealable hole that allows injection of pesticidal material into a wall or other void in a structure.

PRECIPITATE—A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR—An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are hawks, owls, snakes, spiders, lady-bird beetles, and other insects.

PROFESSIONAL—One who is trained to conduct an efficient operation and able to make judgments based on training and experience.

PROPELLANT—The inert ingredient in pressurized containers that forces an active ingredient from the container.

PUPA (plural= pupae)—The developmental stage of insects with complete metamorphosis when major changes from larval to adult form occurs.

QUALIFIED APPLICATOR—An applicator who is certified (and licensed in some states) to apply restricted-use pesticides in the state. Qualification may also include training or experience.

RATE OF APPLICATION—The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured per acre, per 1,000 square feet, per linear foot, or per cubic foot.

RE-ENTRY INTERVAL—The length of time following an application of a pesticide during which entry into the treated area is restricted. Also known as **Entry Interval**.

REGISTERED PESTICIDES—Pesticide products which have been registered by the Environmental Protection Agency for uses listed on the label.

REPELLENT—A compound that keeps insects, rodents, birds, or other pests away from plants, domestic animals, buildings, or other treated areas.

RESIDUAL PESTICIDE—A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE—The pesticide active ingredient or its breakdown products which remain in or on the target after treatment.

RESTRICTED-USE PESTICIDE—A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RISK—A probability that a given pesticide will have an adverse effect on people or the environment in a given situation.

RMSF—Rocky Mountain Spotted Fever is an acute infectious rickettsial disease transmitted to humans by the American dog tick.

RODENTICIDE—A pesticide used to control rodents.

RUNOFF—The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SANITATION—The practice of removing undesirable substances that support a pest or pest population (for instance, food or water).

SIGNAL WORDS—Required wording which appears on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, or CAUTION.

SITE—Areas of actual pest infestation. Each site should be treated specifically or individually.

SOIL INJECTION—The placement of a pesticide below the surface of the soil, a common application method for termiticides.

SOIL DRENCH—To soak or wet the ground surface with pesticide. Large volumes of pesticides are usually needed to saturate the soil to a sufficient depth.

SOIL INCORPORATION—The mechanical mixing of a pesticide product with soil.

SOLUTION—A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are dissolved. Example: sugar in water.

SOLVENT—A liquid which will dissolve another substance (solid, liquid, or gas) to form a solution.

SPACE SPRAY—A pesticide which is applied as a fine spray or mist to a confined area.

STOMACH POISON—A pesticide that must be eaten by an animal in order to be effective; it will not kill on contact.

SURFACE WATER—Water on the earth's surface such as rivers, lakes, ponds, and streams. (See **Groundwater**.)

SUSPENSION—A pesticide mixture consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: Wettable powders in water.

TARGET—Plants, animals, structures, areas, or pests toward which the pesticide or other control method is directed.

TECHNICAL MATERIAL—Pesticide active ingredient in pure form, as it is manufactured by a chemical company. It is combined with inert ingredients or additives in formulations such as wettable powders, dusts, emulsifiable concentrates, or granules.

TOXIC—Poisonous to living organisms.

THRESHOLD—A level of pest density. The number of pests observed, trapped, or counted that can be tolerated without an economic loss or aesthetic injury. Pest thresholds in urban pest management may be site specific. For example, different numbers of cockroaches may be tolerated at different sites (hospitals and garbage rooms would have different thresholds).

TOLERABLE LEVELS OF PESTS—The presence of pests, at certain levels, is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, or unacceptable cost. The tolerable level in some situations will be near zero. Urban pest-management programs may have lower tolerable levels of pests than agricultural programs.

TOXICANT—A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY—The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. (The degree or extent that a chemical or substance is poisonous.)

TOXIN—A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by snakes, the botulism toxin.

UNCLASSIFIED PESTICIDE—See **General-Use Pesticide**.

URBAN—A Standard Metropolitan Area (SMA) or a town of 2,500(+) occupants.

URBAN PEST MANAGEMENT—Management of pest infestations that are normally problems in urban areas. Urban pest management involves reducing pest populations to tolerable numbers in and around residences, in structures, and those pests that cause health-related problems. Urban pest management may or may not focus on reducing economic injury, but it always deals with health or aesthetic injuries.

USE—The performance of pesticide-related activities requiring certification including application, mixing, loading, transport, storage, or handling after the manufacturing seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR PRESSURE—The property which causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical or the more easily it will evaporate.

VECTOR—A carrier, an animal (such as an insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE—Animal characterized by a segmented backbone or spinal column.

VIRUS—Ultramicroscopic parasites composed of proteins. Viruses can only multiply in living tissues, and they cause many animal and plant diseases.

VOID—Space inside walls or other inaccessible space that may harbor pests.

VOLATILITY—The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE—The upper level of the water-saturated zone in the ground.

WETTABLE POWDER—A dry pesticide formulation in powder form that forms a suspension when added to water.

ZONE—The management unit, an area of potential pest infestation made up of infested sites. Zones will contain pest **food, water, and harborage**. A kitchen-bathroom arrangement in adjoining apartments might make up a zone; a kitchen, storeroom, and loading dock at food-service facilities may make up another. Zones may also be established by eliminating areas with little likelihood of infestation and treating the remainder as a zone. A zone will be an ecosystem.

END OF GLOSSARY

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BIBLIOGRAPHY

General Pest-Control References in Print:

Bennett, G. W., J. M. Owens, and R. M. Corrigan. *Truman's Scientific Guide to Pest Control Operations.* 4th ed. Duluth, MN: Edgell Communications, 1988.

Mallis, A. *Handbook of Pest Control.* Cleveland, Ohio: Franzak & Foster Co., 1990.

Olkowski, Daar, Olkowski. *Common Sense Pest Control: Least Toxic Solutions for Your Home, Garden, Pets and Community.* Newtown, CT: The Taunton Press, 1991.

General Pest-Control References Out of Print But Available from Local or State Libraries:

Ebeling, Walter. *Urban Entomology.* University of California Division of Agricultural Sciences, 1975.

Kraft, S. K. and L. J. Pinto. *The Dictionary of Pest Control.* Pinto and Associates, Inc., 914 Hillcrest Dr., Vienna, VA, 1985.

Sweetman, Harvey L. *Recognition of Structural Pests and Their Damage.* Dubuque, IA: Wm. C. Brown Company, 1965.

Selected Subject References (subjects are in **boldface**):

Akre, R. D., A. Greene, J. F. MacDonald, P. J. Langdolt, and H. Davis. ***Yellowjackets*** *of North America North of Mexico.* U.S. Dept. of Agriculture Handbook No. 552, 1980.

Baur, F. J., ed. *Insect Management for* ***Food*** *Storage and Processing.* St. Paul, MN: American Association of General Chemists, 1984.

Bell, W. J. and K. G. Adiyodi, eds. *The* ***American Cockroach.*** New York, NY: Chapman and Hal, 1981.

Bennett, G. W. and J. M. Owens, eds. *Advances in Urban* ***Pest Management.*** New York, NY: Van Nostrand Reinhold Company, 1986.

Biery, T. L. ***Venomous Arthropod*** *Handbook.* Disease Surveillance Branch, USAF School of Aerospace Medicine. Washington, D.C.: Superintendent of Documents, U.S. Govt. Printing Office.

Bio-Integral Resource Center, "Non-Toxic Technology Targets Termites," *Common Sense Pest Control Quarterly*, Vol. IX, No. 1, Winter 1993 (Berkeley, CA).

Bio-Integral Resource Center, "Borates Provide Least Toxic Wood Protection," *IPM Practitioner*, Vol. XIV, No. 10, October 1992 (Berkeley, CA).

Borror, D. J. and R. E. White. *A Field Guide to the* ***Insects*** *of America North of Mexico.* Boston, MA: Houghton Mifflin Co., 1970.

Bottrell, D. G. *Integrated* ***Pest Management.*** Council on Environmental Quality, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1979.

Cornell Cooperative Extension Chemicals—Pesticides Program. *Industrial, Institutional, Structural, and Health Related Pest Control: Subcategory 7C-Termites and Principles of Control.* Ithaca, NY: Cornell University, 1988.

Cornwell, P. B. *The **Cockroach**: A Laboratory Insect and an Industrial Pest.* London, England: Huchinson and Company, Ltd. 1968.

Cornwell, P. B. *The **Cockroach**: Insecticides and Cockroach Control.* New York, NY: St. Martins Press, 1976.

Cotton, R. T. ***Pests of Stored Grain** and Grain Products.* Minneapolis, MN: Burgess Publ. Co., 1968.

Crompton, J. *The Life of the **Spider**.* New York, NY: The New World Library of World Literature, Inc. (A Mentor Book), 1950.

Darsie, Jr., R. F. and Ronald A. Ward. *Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico.* Fresno, CA: American Mosquito Control Association, 1981.

*Diagnosis and Treatment of Poisoning by **Pesticides**.* Washington, D.C.: U.S. Environmental Protection Agency, 1983.

Edwards, R. ***Social Wasps**: Their Biology and Control.* W. Sussex, England: Rentokil Limited, 1980.

Fichter, G. S. ***Insect Pests**.* New York, NY: Golden Press, Inc., 1966.

Furman, D. P. and E. P. Catts. *Manual of **Medical Entomology**,* 3rd ed. Palo Alto, CA: Mayfield, Publishing Co., 1970.

Gertsch, W. J. *American **Spiders**,* (2nd ed). New York, NY: Van Nostrand Reinhold Co., 1979.

Greenholl, A. M. *House **Bat** Management.* Resource Publication 143. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service, 1982.

Gullin, C. M. and Gaines W. Eddy. *The **Mosquitoes** of the Northwestern United States.* U.S.D.A. Agricultural Research Service Technical Bulletin No. 147. Washington, D.C.: U.S. Government Printing Office, 1972.

Hall, D. *The **Blow Flies** of North America.* Columbus, OH: Thomas Say Foundation, 1948.

Harwood, R. F. and M. T. James. ***Entomology** in Human and Animal Health,* 7th Ed. New York, NY: Macmillan, 1979.

Hawley, William A. "The Biology of *Aedes albopictus*," *Journal of the American Mosquito Association,* Supplement No. 1, 1988.

Hayes, Jr., W. J. *Clinical Handbook on **Economic Poisons**.* Atlanta, GA: U.S. Dept. of Health, Education and Welfare, Public Health Service, 1963.

Herms, William B. and Maurice T. James. *Medical Entomology,* 5th edition. New York, NY: The Macmillan Company, 1965.

Katsuyama, A. M. and J. P. Strachan, eds. *Principles of **Food Processing Sanitation**.* Washington, D.C.: Food Processors Institute, 1980.

Keegan, H. L. ***Scorpions** of Medical Importance.* Jackson, MS: University Press of Mississippi, 1980.

Kerckhoff, A. C. and K. W. Back. *The June Bug: A Study of **Hysterical Contagion**.* New York, NY: Appleton-Century-Crofts, 1968.

King, W. V., G. H. Bradley, and W. C. McDuffie. *A Handbook of **Mosquitoes** of the Southeastern United States.* USDA Agriculture Research Service Agricultural Handbook No. 173. Washington, D.C.: U.S. Government Printing Office, 1960.

Levi, H. W., and L. R. Levi. ***Spiders and Their Kin**.* New York, NY: Golden Press, Western Publishing Co. (A Golden Nature Guide), 1968.

Levy, Michael P. *A Guide to the **Inspection** of Existing Homes for Wood-Inhabiting Fungi and Insects.* Washington, D.C.: USDA/Forest Service/Department of Housing and Urban Development, 1982.

Marsh, R. E. and W. E. Howard. *The **House Mouse**: Its Biology and Control.* Leaflet 2945. Berkeley, CA: University of California Extension Service, 1981.

Marsh, R. E. and W. E. Howard. *The **Rat**: Its Biology and Control.* Leaflet 2896. Berkeley, CA: University of California Extension Service, 1981.

Moore, Harry B. *Wood-Inhabiting Insects in Houses: Their Identification, Biology, Prevention, and Control.* Washington, D.C.: USDA/Forest Service/Department of Housing and Urban Development, 1979.

National Pest Control Association. ***Bird** Management Manual.* Dunn Loring, VA: National Pest Control Association, 1982.

National Pest Control Association. ***Encyclopedia** of Structural Pest Control*, 7 volumes. Dunn Loring, VA: National Pest Control Association, 1982.

National Pest Control Association. ***Pest Control Publications**.* Publications Resource Center, 8100 Oak St., Dunn Loring, VA 22027.

National Pest Control Association Sanitation Committee. ***Sanitation** and Pest Control Floor-Level **Inspection** Manual.* Vienna, VA: National Pest Control Association, 1972.

National Pest Control Association. ***Wood-Destroying Insects** Manual.* Dunn Loring, VA: National Pest Control Association, 1986.

Pratt, H. D. and R. Z. Brown. "Manual 10, Biological Factors in Domestic **Rodent Control**." *Communicable Disease Control, Homestudy Course 3013-G, Vectorborne Disease Control.* Atlanta, GA: Health and Human Services Publication No. (CDC) 86-8396.

Pratt, H. D., B. F. Bjornson, and K. S. Littig. "Manual 11, Control of Domestic **Rats** and **Mice**." *Communicable Disease Control, Homestudy Course 3013-G, Vectorborne Disease Control.* Atlanta, GA: Health and Human Services Publication No. (CDC) 86-8396.

Schoenherr, W. *A Guide to Good Manufacturing Practices for the **Food** Industry, [**Pests**].* VIII Sections. Danville, IL: Lauhoff Grain Co., 1972.

Schoenherr, W. and J. H. Rutledge. *Insect **Pests of the Food Industry**.* Danville, IL: Lauhoff Grain Company, 1972.

Smith, Marion R. *House-infesting **Ants** of the Eastern United States.* USDA Technical Bulletin 1326, 1965.

Smith, R. L. ***Venomous Animals** of Arizona.* Bulletin 8245. Tucson, AZ: University of Arizona Extension Service, 1982.

Steysk, G. C., W. L. Murphy, and E. M. Hoover. *Insects and Mites: Techniques for **Collection** and **Preservation**.* USDA, ARS, Miscellaneous Publication Number 1443.

Strickland, R. K., R. R. Gerrish, J. L. Hourrigan, and G. O. Schubert. ***Ticks** of Veterinary Importance.* USDA Agricultural Handbook No. 485, 1976.

Su, Nan-Yao. "Field Evaluation of a Hexaflumuron Bait for Population Suppression of **Subterranean Termites** (Isoptera: Rhinotermitidae)." *Journal of Economic Entomology*, Vol. 87, No. 2, April 1994.

Timm, R. M., ed. *Prevention and Control of **Wildlife** Damage.* Lincoln, NE: Cooperative Extension Service, University of Nebraska, 1983.

"U.S. Borax Service Bulletin 200." Los Angeles, CA: United States Borax and Chemical Corporation, 1991.

White, R. E. *A Field Guide to the **Beetles**.* Boston, MA: Houghton Mifflin Co., 1983.

Wilson, E. O. *The **Insect Societies**.* Cambridge, MA: Harvard University Press, 1971.

Zim, H. S. and C. Cottam. ***Insects**.* A Golden Nature Guide. New York, NY: Simon and Schuster, 1956.

Trade Magazines:

Pest Control. P.O. Box 6215, Duluth, MN 55806-9915.

Pest Control Technology. P.O. Box 5817, Cleveland, OH 44101-9599

Pest Management. National Pest Control Association, 8100 Oak St., Dunn Loring, VA 22027.

Trade Newsletters for Pest-Control Technicians:

IPM Practitioner. Bio-Integral Resource Center (BIRC), P.O. Box 7414, Berkeley, CA 94707.

Techletter. Pinto and Associates, Inc., 914 Hillcrest Dr., Vienna, VA 22180.

END OF BIBLIOGRAPHY

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