Naval Facilities Engineering Command
200 Stovall Street
Alexandria, Virginia 22332-2300

APPROVED FOR PUBLIC RELEASE

Pest Management Training Manual

Urban Integrated Pest Management

NAVFAC MO-310.2
September 1992

0525LP5423400

FOREWORD

Although there are many ways to manage or control pest problems, the use of pesticides is frequently selected. Some of these chemicals are extremely persistent in the environment and toxic by their very nature. Public concerns over their extensive use and their detrimental effects on human health, wildlife resources and other environmental components, demand that we provide continuous professional review and training in selection and application of sound control measures. Pesticides are unique because they are purposely released into the environment to affect pest plants or animals and simultaneously may become an environmental contaminant. It is our expertise that not only determines their efficacy, but also minimizes their adverse environmental impact. The objective of pest management is effective control with minimal use of the least toxic product available. The Department of the Navy, a steward of 3.9 million acres of land at some 250 shore installations and landlord to a million people, shall continue to support these concerns. Program emphasis shall be on professional management of installation pest management programs, controlled application by or under the supervision of trained and certified personnel, and use of cost-effective strategies, and use of approved pesticides and equipment. The purpose of this publication is to facilitate training the activity pest controller.

Pesticide use is closely regulated under the Federal Insecticide, Fungicide and Rodenticide Act and several other federal statutes. Navy pesticide applicators, in every case, should consider state or host country requirements in their pest management operations.

Recommendations for improvement are encouraged from any party and these should be furnished to the Commander, Naval Facilities Engineering Command, Code 1634, 200 Stovall Street, Alexandria, VA 22332-2300.

E. R. HAMM
Captain, CEC, U. S. Navy
Assistant Commander for
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ABSTRACT

This publication provides information on urban integrated pest management and applies directly to the type of pest management operations common to the Navy shore establishment. It is a companion to two basic training manuals: Military Pest Management (MO-310) and Basic Pest Management (MO-310.1). The manual specifically offers information on developing an effective control program, vulnerable stages in the life cycle of pests, use of equipment for handling and applying pesticides, and the safe, responsible use of pesticides. The text and figures were provided through the courtesy of the Certification and Training Branch, U.S. Environmental Protection Agency.

United States
Environmental Protection
Agency

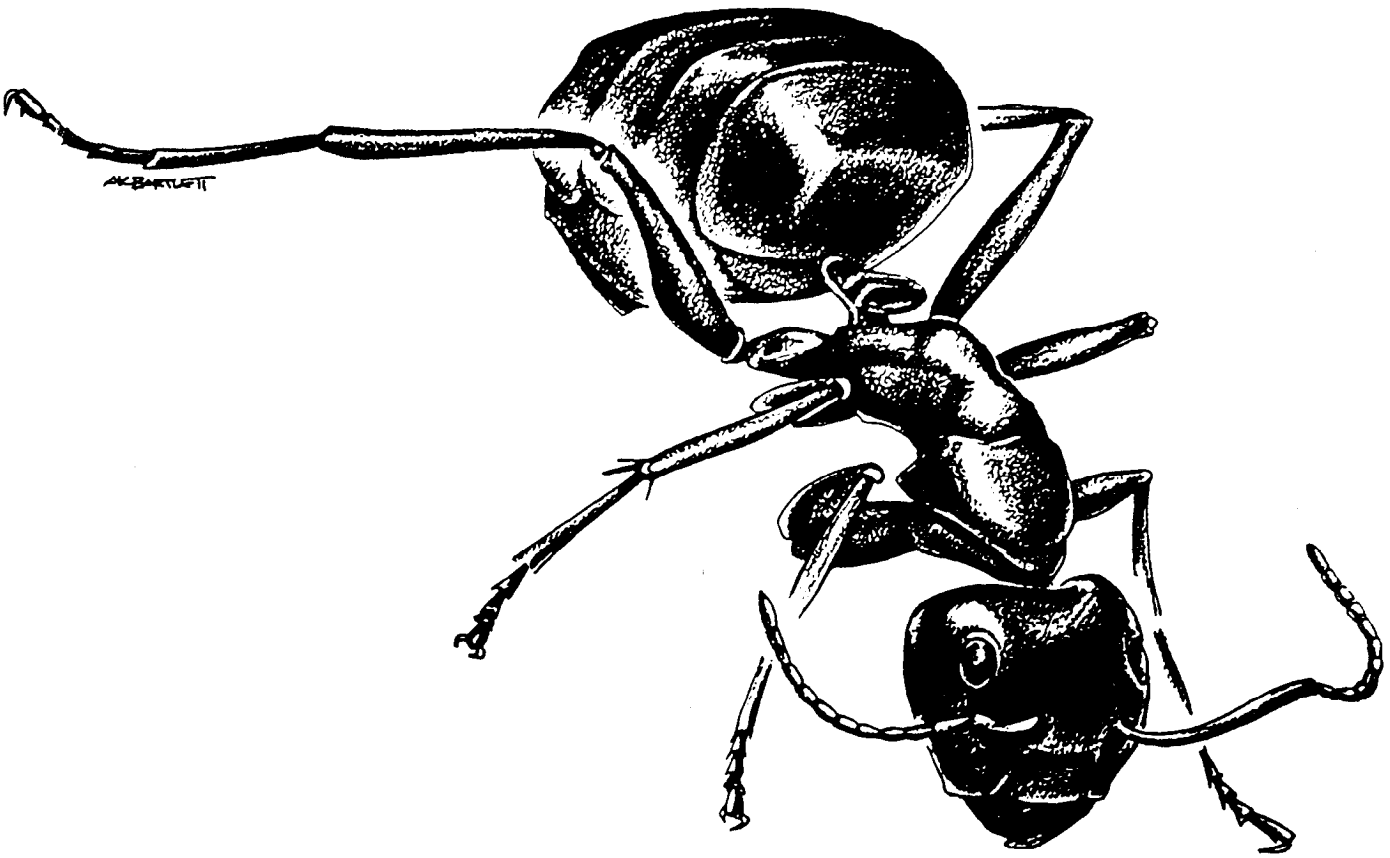
Pesticides And
Toxic Substances
(H7506C)

EPA 735-B-92-001
July 1992

EPA

Urban Integrated Pest Management

A Guide For Commercial Applicators



Prepared for
United States Environmental Protection Agency
Certification and Training Branch
Office of Pesticide Programs
Washington, DC 20460
under Contract No. 68D000ll

URBAN INTEGRATED PEST MANAGEMENT

A Guide for Commercial Applicators

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Published July 1992

Acknowledgements

Information accumulates from direct observations, scientific literature, and anecdotes from others. Information from these sources blurs together quickly, and consequently, unique ideas are rare in society. Credit for sources of information on urban pest control and management must go to:

- Land Grant University Extension and research workers, most entomologists, who pioneered this work, those who kept training and research alive during the period when the success of synthetic organic pesticides preempted nearly all but control evaluations from the 1940s to the 1960s, and those who persist today;

- Pest Control Industry workers who held training sessions nationally, regionally, and locally where information was disseminated among the experienced and provided to the inexperienced;

- Environmental Protection Agency personnel who molded modern training and influenced the need for national uniformity in training requirements;

- State regulatory personnel who cooperated with Universities and Industry and who strongly emphasized the importance of training;

- The few textbook authors in the United States and England who compiled the reference data in the understandable and usable form that allows urban pest management practitioners to be professionals.

Specific acknowledgements should go to biological illustrators who graphically render pest and beneficial animals where photographs fail; A.D. Cushman, Dean of USDA illustrators, A. B. Wright, and Joseph Papp provided many illustrations for these modules as did many anonymous illustrators whose work was stripped of identification through the decades of public use. Likewise, heartfelt credit must go to photographers who provide the illustrative color slides so important to training sessions. Slides used in this publication were provided by N. Briesch, University of Maryland; A. Greene, GSA; R.T. Lubbert, National Institutes of Health, J. Sargent, Great Lakes Chemicals; N. Swink, U.S. Fish and Wildlife Service; and the Fish and Wildlife Service, Audiovisual Office. And like all else, many other slides were provided by colleagues whose generosity goes unrewarded.

Individuals who were vitally helpful in the production of these training modules include Elaine Mesavage, University of Maryland Entomology Department; Robert Gillette, DUAL & Associates, Inc.; Robert Bielarski, Environmental Protection Agency; Lawrence J. Pinto, Pinto and Associates, Inc., who wrote the Vertebrate Module; and finally, Jann Cox, DUAL & Associates, Inc., whose abilities as technical and format editor were responsible for evaluating and bringing all of the information together in usable form.

URBAN INTEGRATED PEST MANAGEMENT
A Guide for Commercial Applicators

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PREFACE

PEST CONTROL IN URBAN AND INDUSTRIAL SITES

Pest management and control is a matter of using the right technologies. To be successful, it must be effective and not adversely effect people or the environment.

The purpose of this training manual is to provide a sound foundation for studying technical aspects of pest control. Its emphasis is on urban and industrial pest problems -- household and structural pest control. It will discuss control and management of insects, other arthropods (such as spiders and ticks), and vertebrate pests (such as mice and rats), in homes, businesses, office buildings, and industrial plants.

This manual is a valuable source of information for persons preparing for certification under the Environmental Protection Agency (EPA) and state programs for pesticide applicators. Pest control workers in urban and industrial sites not only apply pesticides but use many other activities and recommendations to suppress pests. These other practices increase the effectiveness of the control program, and often reduce pesticide use or make such use a secondary operation of the program. In recognition of the many tasks individuals in pest control must perform, the title ***technician*** is used in this manual to denote a pesticide applicator, a pest control operator, and other individuals with titles that refer to the job of suppressing or exterminating pests.

Written for technicians, supervisors, owners, and others involved in the control or management of pests, each chapter covers material considered essential to the proper understanding and carrying out of pest control or urban pest management. The training modules contain basic scientific information as well as guidelines for practical solutions to pest control problems. The manual is divided into four basic sections: a general discussion of pest management and control followed by three subsequent modules on specific application in terms of insects commonly found in urban structures, insects that invade structures, and urban vertebrate pests. Study questions may be found at the end of each chapter; answers, a supplementary reading list, and a glossary of terms are found at the end of the book.

Technicians will learn that proper integration of management and control depend on the pest, its habits, its location, its support system. With understanding of these areas, subsequent experience, and ongoing training, a technician will be able to perform successful pest control. A distinction is made in this manual between management and control: ***Management*** means the reduction of pest populations to tolerable numbers by changing practices, making habitat or structural alterations, and carefully using pesticides to kill pests only when indicated. ***Control*** of pests refers to a single principal measure taken to kill pests -- usually the application of pesticides.

An important area addressed throughout the manual is communication. Pest management and control is a service; technicians must not only know their job, but they also must be able to communicate confidently with their clients so clients will understand basic procedures and be satisfied that the technician can successfully meet their needs.

RESPONSIBILITIES OF SUPERVISORS AND TECHNICIANS

Prior to undertaking this training, commercial applicators should have received regionally-specific basic orientation in pest control. To train technicians to deal with pests correctly, this orientation should include

- recognition of pest species, and
- awareness of the importance of safety.

The goal of training is the development of a technician who

- possesses the basic pest control scientific information,
- can act to control pests after making judgments based on that information, and
- communicates knowledgeably with the client.

Those who train and manage technicians should be ***certified*** supervisors experienced in pest management (preferably beyond the minimum level required for certification). They should be able to provide their technicians with

- reference materials (see Appendix B),
- scheduled company meetings with open discussion and timely training,

- formal training sessions that provide information that meets minimal State training requirements, and
- most importantly, motivation to perform their job in a ***professional*** manner -- that is, safely, legally, and ethically.

CHAPTER 1

PEST MANAGEMENT AND CONTROL

Learning Objectives

After completion, of the study of Pest Management and Control, the trainee should be able to:

- understand why certain arthropods and vertebrates are considered pests
- relate the sequence of activities, involved in a pest control situation, and
- recognize the components of Integrated Pest Management.

WHAT ARE PESTS?

Pests are not pests because of what they ***are*** (bedbug, yellowjacket), but because of what they ***do*** (suck blood, sting).

According to the Federal Insecticide, Fungicide and Rodenticide Act FIFRA), a pest can be any insect, rodent, fungus, or weed as well as other organisms. Most simply defined in *The Dictionary of Pest Control*, a pest is "An unwanted organism. . . ." Urban pests can be generally characterized as organisms (excluding parasitic microorganisms) which have human health or aesthetic implications, or which damage wooden support structures of buildings. These pests can be contrasted from agricultural pests that cause direct economic damage to products. For instance, while roaches or rodents may cause an economic hardship, when restaurants or food packing plants are closed by the legal action, the action is taken for reasons of human health. Likewise, carpet beetles in woolens or museum tapestries degrade clothing or works of art, but the reduction of value of the pieces is primarily for aesthetic reasons not due to consumption of woven wool.

Ecosystem

Defined by the way they behave in an environment, or ***ecosystem,*** pests occur as a group, or ***population*** of individuals of a particular kind (e.g., German cockroaches). Different populations that exist together are called a ***community.*** One community may be fleas, pets, and people. A community together with its physical and biological supporting factors makes up ***the ecosystem*** (e.g., German cockroaches, fleas, people, pets, harborage [areas with food, water, and shelter]). The technician does not look at the pest infestation alone but must consider all elements in the ecosystem to design the best control and management methods.

METHODS OF PEST CONTROL

There are many variations and combinations of methods used to control pests, but the sequence of these methods follows a pattern: inspection, habitat alteration, pesticide application, and follow-up:

Inspection

Pests do not infest uniformly; they focus on specific areas. These sites must be located. Training and experience in conducting inspections are important for successful location of infested areas.

Habitat Alteration

Since infested areas provide ***harborage*** for pests (one of the elements along with food and water needed by pests to thrive), changing or eliminating some of these favorable elements will make survival less successful. Such changes commonly include increased sanitation, moisture reduction, and the elimination of clutter.

Pesticide Application

While successful habitat alteration can reduce or eliminate populations, it will often be less than

complete and pesticide application may be necessary. The key to pest control is the successful combination of these methods.

Follow-up

Simple styles of pest control do not include more than the minimum follow-up, such as legally mandated recordkeeping.

Follow-up practices, such as detailed recordkeeping, supervisor oversight, and a quality control program, can make the difference between the success or failure of moderate to complicated pest control problems.

STYLES OF PEST CONTROL

In the urban setting, current industrial or structural pest control activities can be characterized in four styles: prevention, reaction, extermination, and integrated pest management.

Preventive Pest Control

In preventive control, a technician follows a pre-established schedule, or route, to:

- make expected appearances
- make inspections
- apply pesticides (usually a spray)
- talk with the tenant or manager, and
- record information required by law.

While the inspection can indicate where pests occur, with this style, pesticides are usually applied regardless of whether pests are observed or not. Those who practice this style are satisfied that pests will be killed as they contact the pesticide residue.

Advantages

- Contracts can be fulfilled routinely.
- Work can be set up easily.
- The technician can proceed as rapidly as possible.
- Occupants are satisfied if pests do not appear.
- It is the most economical short-term style.

Disadvantages

- Time alone governs the schedule.
- Inspections are brief.
- Boredom from repetition affects the technician.
- Pesticides are used regardless of whether or not there is an infestation.
- There is no evaluation.
- Records are brief.
- No long-term solutions.

Discussion

The least technical expertise is needed for preventive pest control and the brevity of the activity and interaction gives clients the incorrect idea that controlling pests is elementary. This style can be more efficient with a quality control program.

Reactive Pest Control

In reactive pest control, a technician responds to special, unscheduled calls and

- talks with clients
- makes an inspection
- identifies infested sites
- applies pesticides to pests or sites
- records necessary information required by law

Advantages

- Response is relatively quick.
- The occupant is satisfied by the fast response and immediate pest suppression.
- The interaction with technicians is positive.
- Minor recommendations by the technician to clients are often accepted because they were requested by the client. [Such recommendations make pest control more effective.]
- Situations are more interesting for technicians, and boredom is reduced.

Disadvantages

- Complete extermination is often assumed (mistakenly) by clients.
- Clients are quick to anger if the problem recurs.
- Without a detailed inspection, failure is likely.
- Pesticides are often used as barriers if pests are not found.
- This style is less economical than scheduled, route-type responses.
- Records are brief.

Discussion

A higher level of technical expertise as well as better ability to interact with clients is needed than for preventive pest control. A quality control program will reinforce technician recommendations.

Pest Elimination or Pest Extermination

A senior technician, usually a supervisor, responds to an appointment, and

- interacts with clients
- makes an ***intensive*** inspection
- recommends methods to reduce pest food, water and harborage, such as sanitation, maintenance improvements, habitat alteration, etc.
- applies pesticides in a variety of formulations each time
- follows-up inspections, and
- records information on past inspection and recommendations as well as information required by law.

Advantages

- The client has a good understanding of the problem and the changes needed for control due to significant interaction with the pest control supervisor.
- The pest control supervisor interacts directly with clients.
- Longer-lasting control results from changes made by the client.
- Thorough pesticide application occurs.
- There is a high level of interest by technicians:

Disadvantages

- Mistakes in inspection and recommendations to clients, or subsequent lack of follow-through by clients will result in control failure.
- A maximum amount of pesticides are usually used; potential misuse, misapplication, and the possibility of pesticide accidents are increased.
- High pesticide and labor costs are sustained.
- Unexpected results are quickly noticed and questioned,
- The energy required to completely eliminate a pest population is much greater than that required to keep a pest population suppressed to a tolerable level.

Discussion

A high level of technical expertise is needed as well as superior ability of the pest control supervisor to get client cooperation.

Integrated Pest Management

A pest management program is requested by the client; a pest management or pest control supervisor makes a thorough inspection; and a detailed plan and schedule are provided that include:

- the ***designation of zones*** of probable infestation and ***sites*** of pest infestation within the zones
- ***recommendations*** for sanitation, maintenance improvements, habitat alteration, reduction of moisture, work procedure changes, safe practices, methods of application, etc.

Finally, pest management components are considered and integrated into the pest management plan (see below).

Advantages

- Long-term pest control procedures are used.
- Client management is involved.
- Costs are reduced over time.
- A reduction of pesticide use (e.g. elimination of preventive spraying) is attained.
- A low-toxicity pesticide response is possible.

Disadvantages

- Not every company or agency has the expertise to provide pest management programs.
- There is a labor-intensive start-up period.

- Costs are higher than “low bid”.

Discussion

Integrated pest management was first used in protecting agricultural crops; in recent years, it has proven effective in urban areas.

INTEGRATED PEST MANAGEMENT COMPONENTS

Pest management components are considered and integrated into an overall pest management plan.

Monitoring and Recordkeeping

Inspection, continuous sampling, and use of survey devices that will result in accurate recorded pest counts are emphasized. Monitoring goes on in identified zones of potential infestation and is intensified in infested target sites. Nontarget areas are not monitored.

Record books or logs are placed in central areas or management units. Records contain monitoring counts; sanitation, maintenance and personnel practice problems; pesticide use, formulations, and amounts. Records should be accessible to pest management technicians and client supervisors.

Education, Training, and Communication

Communication is an ongoing activity. ***To be effective, pest management must be desired by the client.*** Pests should be reduced to a level acceptable to the client. To achieve these goals, the pest technician interacts actively with the client. Ongoing informal training or instructive communication between the technician and the client group’s designated liaison is important. Formal training is provided by pest management supervisors, technical representatives, or consultants.

Designated liaisons are client onsite supervisory personnel with whom pest management technicians will review the record, problems, and control program each monitoring or treatment interval. Liaisons explain the pest management program to clients such as tenants or workers. Liaisons coordinate client efforts needed for the success of the program.

Integrated Control Methods

All practical measures to suppress the pest population to a tolerable level should be considered:

- cultural controls (e.g., regular cleaning schedule, garbage elimination, changes in worker procedures)
- physical modifications and maintenance changes (e.g., screening, caulking, etc.)
- pest control devices and pesticides.

Thresholds

Pest management is site specific. The number of pests that can be seen in each target site is determined. Setting thresholds, eliminates preventive spraying, curtails excessive pesticide application, and encourages good inspection.

Evaluation, Quality Control, and Reporting

No gains in pest management are made without evaluation. Interviews, surveys, and record examinations are made at scheduled times. Evaluations are conducted by personnel other than the pest management technician. Formal written and verbal reports are made at scheduled intervals by technical representatives or pest management supervisors to client management.

A CASE FOR IPM: RESISTANCE

Some insects become resistant to a pesticide, and the most complete application cannot achieve acceptable control. Of the urban pests, the house fly and the German cockroach lead in resistance to pesticides.

How Pests Become Resistant to Pesticides

Most pesticides are put together by combining chemical elements. Large pest populations have some individuals whose internal systems can reduce the pesticide to harmless elements. When the pesticide is applied, these pests live. They produce some offspring that can also reduce the pesticide. With each generation, more and more offspring inherit the ability. If applicators continue to apply that pesticide, more and more will be able to render the pesticide ineffective. Once present, genes for resistance will always be carried by some members of the population.

How to Recognize Resistance

First, eliminate reasons for failure to suppress a pest population. If questions like these can be answered positively, the population might be a candidate for resistance testing:

- Are clients doing their job by improving sanitation, reducing clutter, etc.?
- Have inspections been complete?
- Have pests been correctly identified?
- Has habitat alteration been complete?
- Have pesticides been applied accurately?

The Way to Prevent Resistance

Use of a multicomponent approach such as integrated pest management prevents resistance that occurs when a single pesticide is consistently applied. When pesticides alone are used in a routine way for pest control, the pest population rebuilds between treatments. With repeated applications after population recovery, the more succeptable individuals are killed and those that are less succeptable become the parents of the next generation. Alternating pesticides with different modes of action (e.g., organophosphates and pyrethriods) can also be helpful.

SUMMARY

Pests are unwanted organisms -- unwanted because their activities run counter to those of the people living in the same ecosystem. This ecosystem is made up of a number of animal populations -- two of which are pests and humans. Together, these populations are called a community. The community along with biological (pest food, hosts, prey plants, etc.) and physical (hiding places, temperature, humidity) supporting factors are the components of an ecosystem -- a basic, selfsustaining natural unit. Pest control takes place within this unit; to be effective it acts on the parts of the ecosystem.

Pest control styles are set up to prevent, react to, eliminate, or manage pests. Each style has advantages and disadvantages; the most complete style is pest management which involves the coordination of many elements depends on the nature of the infested site.

Since pests are not evenly distributed in an ecosystem, an inspection is needed to locate them. To manage pests, the supporting factors of their population need to be identified and altered. When alteration alone is not sufficient, pesticides can be used to reduce the pest population to a tolerable level [this level may be zero].

Finally, an evaluation or follow-up assessment makes the control effort last longer and tells the pest control technician how well the job was done.

STUDY QUESTIONS FOR MANAGEMENT & CONTROL
CHAPTER ONE
PEST MANAGEMENT AND CONTROL

1. Define a pest in simple terms.

2. Pest populations are part of an ecosystem. What following elements are included in an ecosystem? _____
   A. Populations and a community.
   B. A community and biological and physical supports.
   C. Populations and biological and physical supports.
   D. Populations, a community, and biological and physical supports.

3. In infested apartments, pest infestations are evenly distributed.
   A. True.
   B. False.

4. In a simple sequence of methods, which of the following is the first method or activity a pest control technician should do? _____
   A. Pesticide application.
   B. Habitat alteration.
   C. Inspection.
   D. Follow up.

5. Which of the following are not integrated pest management components, goals or activities: _____
   A. Monitoring.
   B. Pesticide application.
   C. Preventive spraying.
   D Recordkeeping.
   E. Total pest elimination.

6. The pest management style of pest control, more than the other styles, emphasizes: _____
   A. Safe pesticide application.
   B. The reduction of pests to a tolerable number.
   C. Inspection.
   D. Client communication.

*For Answers refer **to** Appendix A*

CHAPTER 2

USING EQUIPMENT IN URBAN PEST MANAGEMENT

Learning Objectives

After completion of the study of Using Equipment in Urban Pest Management, the trainee should be able to:

- Know the benefits and limitations of pesticide application equipment.
- Know simple methods for calibrating urban pesticide application equipment,
- Understand how safety is part of every phase of equipment use.

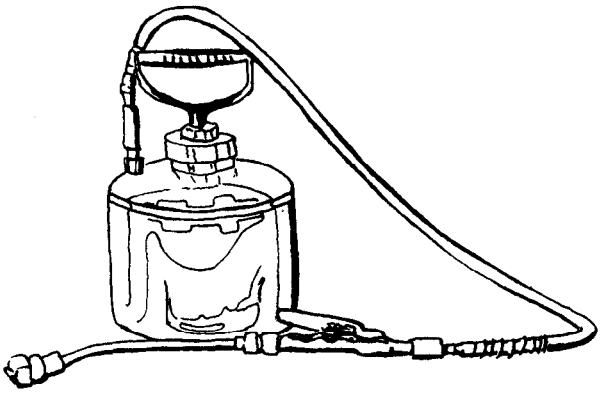
The most needed and reliable tool of all in pest management is the brain and ability of a technician to use his knowledge of pest management along with well-cared-for equipment and good supplies. Pesticide application equipment used in urban pest management is, for the most part, time tested and reliable. It is reassuring and convenient to have tools that seldom fail. Time, training, and the encouragement of regular cleaning, calibration, and repair of tools means a planned program and good supervision.

Failure to care for equipment properly can cause serious problems. Using worn or clogged spray nozzles or caked dusters results in misapplied pesticides. Accidents from breaking hoses and exposure from leaking valves can result in lost time, illness, and complaint or lack of confidence from clients. Lack of attention to these activities is a sign of mismanagement of time, overscheduling, miscommunications and unclear priorities.

The more commonly used equipment includes:

- Hand held compressed air sprayers
- Power sprayers
- Canned insecticides
- Aerosol and fog generators
- Dusters
- Bait Stations
- Traps, monitoring devices etc.

HAND-HELD COMPRESSED AIR SPRAYERS



The small (one or two gallon) stainless steel spray tank is the workhorse of pest control. It is the tool most familiar to pest control technicians. It can be used in many different ways (and by many different industries). In pest management, the "spray tank" is used to apply a flushing agent, or a residual pesticide. Depending on the nozzle selection, it applies different spray patterns; and depending on the amount of pumping, it delivers the pesticide under high or low pressure.

Spray Patterns

The most common nozzle for the hand-held compressed air sprayer is made of brass and usually can be set in one of four spray patterns. More than four patterns are available, however. The most common patterns include two pin streams, flat fans, and cones.

Pin streams can be coarse or fine. The coarse or fine pin streams do not produce the best crack and crevice application. Even when set for fine spray, a stream is produced that splashes back from all but the widest crack, so many nozzles have a connection for a narrow-diameter plastic extension tube. Remember to use equipment as directed (e.g., injection tool for crack and crevice application). The end of the extension tube is inserted into or at the edge of a crack and delivers an accurate pin stream: overall, the most effective spray pattern for cockroach pesticide application.

Coarse and fine flat fan streams are used to apply general or spot applications, as are hollow or solid cone sprays. Cone sprays deliver a circle of pesticide and are often used outside on uneven surfaces and plants.

Pressure

Spray tank air, pressure varies according to the amount of air the technician pumps into the tank. Pressure gauges can be attached to spray tanks. Low pressure is usually recommended for spray application inside structures. Constant use of high pressure with compressed air sprayers sets up the possibility of overuse and misapplication. It causes part of the sprayed liquid to break into droplets as soon as it exits the nozzle; this wastes material that can drift onto non-target surfaces. High pressure also causes splash back on surfaces or quickly traps air in crevices and keeps the pesticide from entering small spaces. As well as being uneconomical and wasteful, the practice encourages rapid application of pesticides whether they are needed or not, from distances that affect accuracy. This style of pesticide application will seldom result in effective pest control, especially where German cockroaches are a problem.

Technicians who use hand-held compressed air sprayers should periodically attend training for cleaning and sprayer maintenance. It is recommended that they familiarize themselves with their own equipment and be prepared to repair it. It is recommended that technicians

- Rinse the sprayer daily; especially the hose. [Always empty liquid from the hose: hold the nozzle high and squeeze the trigger to drain the hose into the tank. If this is not done, liquid from the last use remains; it will be applied first at the next use, regardless of any new spray mix in the tank.]
- Clean the sprayer on a regular schedule.
- Never use warm water to mix sprays. [Warm water helps break down pesticides, creates droplets that easily float, and increases a pesticide's odor.]
- As stressed in the core manual, always use gloves when spraying. Always use safety glasses or goggles when treating areas above the head or close to the face.

POWER SPRAYERS

As their name implies, power sprayers use electric or gasoline engines to pump liquid insecticides from a relatively large tank, usually over 100 gallons. The liquid is discharged thru a 3/8 - 1/2 inch hose of sufficient length to reach from the pump to the application site. Power sprayers are generally used for one of two types of urban pest control: (1) controlling termites, and (2) spraying building perimeters and lawns.

In the southern United States, power spraying outside in conjunction with inside treatment for cockroaches is common. In warmer climates, large cockroaches (American, oriental, smoky-brown, etc.) are active outdoors as well as indoors. Other types of outside pests (e.g. ticks, crickets, millipedes and other miscellaneous invaders) are also treated by spraying outside. Here too, low pressure is more effective than high pressure because the pesticide will not blast away the surface dust or soil and runoff. Low pressure allows for a more careful application, better soaking action, and better penetration through short grass.

Special attention should be paid to the hose of power sprayers -- both in the quality and points of wear. Wear or cuts cause hoses to burst; when this happens pesticides spill and cause contamination. Shut-off valves should always be in good working order.

Equipment to take care of spill contamination should always be carried in the service truck.

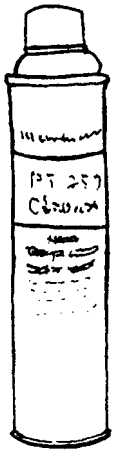
Why calibrate spraying equipment?

In urban pest management, much is up to the judgment of technicians. A pest control technician should know that the proper dosage of pesticide is being applied; accurate calibration of power sprayers is important or the amount of pesticide delivered will be incorrect. Overdosage will contaminate the spray area or result in runoff. Less than recommended dosage may fail to control the pest. Technicians need to regularly look at the output of their equipment. Flow meters are very helpful to let the technician know the output of the sprayer over time.

- It is estimated that 60 percent of sprayers have a calibration error up to 10 percent.
- A large percentage of sprayers have greater than 10 percent variation in discharge from individual nozzles or tips.
- Application methods used by different applicators vary, depending upon pressure, nozzle tip, etc.
- Soil types and types of soil cover (grass, mulch, gravel) can influence the rate of pesticides a technician applies.

Manufacturers' instructions, university extension training meetings, label instructions and company policy should be considered and used to calibrate sprayers. Refer to company policy and core manual for calibration instructions.

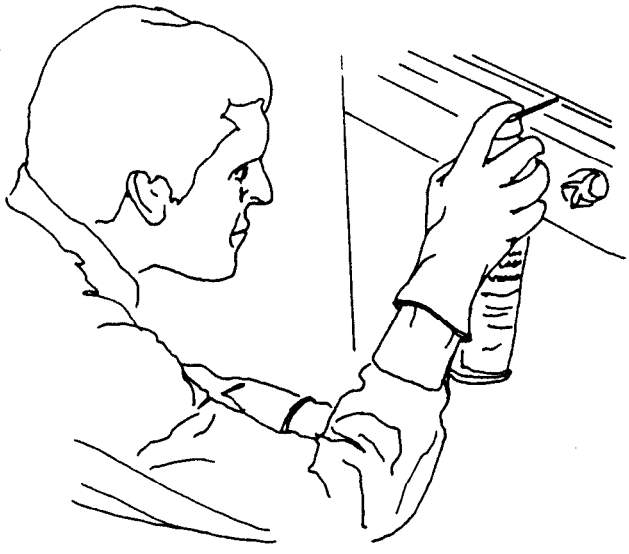
CANNED INSECTICIDES



Pressurized cans of insecticides became common in the late 1940s and were first used as aerosol foggers or "insect bombs." Canned insecticides in urban pest management include canned aerosol foggers (volumetric sprays, total release fogs) and pressurized liquid sprays. (The garden type aerosol or the over-the-counter aerosol generally sold to the public for contact spraying is NOT included in either of these categories.)

Canned Aerosol Pesticides

Canned aerosol pesticides consist of a pressurized fluid that produce an aerosol or fog droplet that floats in the air for a period of time, then settles to the ground. The droplet size is governed by the nozzle and valve at the top of the can. After use, a more or less uniform coverage will be attained on exposed horizontal surfaces. Very little pesticide lands on vertical surfaces, penetrates opened cabinets, or clings to undersurfaces. Droplets contact pests that have left hiding places, and other insects that fly into the insecticide are killed.



Canned Pressurized Liquid Sprays

Canned pressurized liquid sprays are not aerosols. Because the coarse, wet spray is not made up of aerosol droplets, little becomes airborne. Compressed gas mixes with the pesticidal liquid in a pressurized spray. The gas forces the pesticide through the exit port, quickly vaporizes, and leaves pesticide on surfaces. When canned pressurized liquids are part of a system that includes crack and crevice nozzles, the insecticide can be placed precisely on the target area. In a closed crevice, the expanding gas propels the insecticide in all directions forcing it on all surfaces in the crevice, rather than shooting it across in a straight line like a compressed air sprayer. Using canned pressurized liquid sprays requires a firm understanding of the target pests' habits so that pest harborage can be treated.

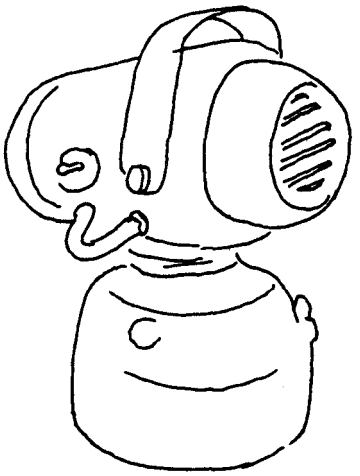
AEROSOL AND FOG GENERATORS

Power aerosol and fog generators break liquid pesticides into aerosol droplets. Reducing the liquid into droplets is done either mechanically (cold foggers) or by using heat (thermal foggers). Caution should

always be taken to protect the applicator's respiratory system when these generators are used.

Cold Foggers

Cold foggers break an insecticide into aerosol-sized droplets and propel them into the air in a light cloud or fog. Large, ultra low dosage (ULD) and ultra low volume (ULV) cold foggers are mounted on trucks and used in mosquito control programs, to control pests in large warehouses, and for fly control in some operations. Cold fog generators drive pesticidal fog over a relatively large area. Droplets fall on flying or resting mosquitoes or are deposited in very small amounts on plant leaves on which mosquitoes rest.



Hand-held cold foggers are used inside buildings where they fill rooms, small warehouses, etc., with aerosol droplets. These floating droplets kill flying insects as well as exposed insects on horizontal surfaces. Fogs do not enter tight spaces or cracks and crevices. While some aerosol generators are used for crack and crevice applications, they also produce aerosol droplets that float in the air.

Thermal Foggers

Thermal foggers use heat to vaporize oil in an oil-based insecticide formulation. Large truck-mounted thermal aerosol generators are used in mosquito control programs where the insecticide fog rolls across open spaces killing flying insects as air currents move it. Indoors, portable thermal foggers work like cold foggers except droplets are smaller.

Precautions. When using fogging or aerosol generating equipment indoors:

- Applicators should wear respirators.
- Occupants must leave until the area has been adequately ventilated.
- Pets must be removed; house plants and aquariums must be covered, and aerating pumps turned off.
- Exposed foods and food preparation surfaces must be protected. After treatment, food preparation surfaces and any exposed utensils must be washed.
- Pilot lights and any other open flame must be extinguished. This is particularly critical when the oil-based thermal fog is used. Any spark can set off a thermal fog atmosphere.
- Thermal fog generators can burn surfaces that are contacted, including the operator.
- Aerosol droplets will not move into spaces where air is not circulating nor into any dead air cracks and crevices (e.g., under molding into partially closed cabinets, drawers, closets.)
- Furnace, air conditioning, and ventilation equipment should be turned off. [Ventilation will evacuate the insecticide and may carry it to other places outside the target area.]
- After an appropriate interval, and before people or pets reoccupy the area, treated rooms should be thoroughly aired.

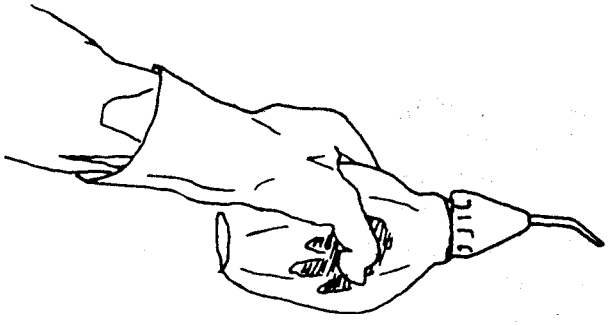
For General Application

Fogging should not be used as a single method of treatment but as a supplementary method to other types of application. Fogging or aerosol application is a general pesticide application and only pyrethrins or insecticides labeled for unclassified application can be used in this way. If fogging treatments begin to be used at increasingly closer intervals, it means that the pest population is not being suppressed and may be increasing.

DUSTERS

Dusters apply a fine, dry layer of a powdery mixture containing a small amount of pesticide. Dust applied on porous surfaces is not absorbed like liquids; it rests on them like a layer of insecticidal powder. This dust accumulates on body parts (insect hairs, legs and mouthparts) of insects who touch it. Pesticides in dusts are absorbed by the insecticide in the same way as liquid sprays. Additionally, if the pest ingests particles (when grooming or cleaning itself), the dust can also cause stomach poisoning.

Hand Dusters

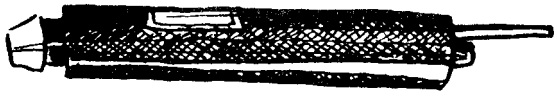


Three types of hand dusters are commonly used by pest management technicians: bulb, bellows, and plunger dusters. Dusts are also driven by gas in some formulations of canned insecticides, but with this method, dusts are applied like canned liquid pesticides.

Bellows dusters consist of a closed rubber cylinder made rigid by an internal spring, a spout at one end, and a stoppered refill hole at the other. These dusters, originally called Getz dusters, are held with the spout at the top. A slight pressure from top and bottom pushes air and dust from the spout. The more pressure applied, the more dust ejected. The spout is tapered at the tip and slight puffs will propel small amounts of dust into cracks and crevices. The slight puffs distribute a thin layer of dust in the pest harborage.

Bulb dusters have a rubber bulb with a removable spout at one end. The spout screws off to allow for refilling. Dust application is much like the bellows duster except that the bulb is squeezed. Both dusters come in several sizes.

Plunger dusters hold more dust than the first two hand-held dusters discussed. Plunger-type dusters have been used for garden dusting for a century, but the plunger duster used in urban pest management is smaller, made of high-impact plastic and has several styles of nozzles.



Power Dusters

Most power dusters use compressed air to deliver insecticidal dusts to large spaces. Fire extinguishers have been converted to dusters and filled with compressed air. Other dusters are plastic and are pumped up much like the hand-held compressed air sprayer used to applying liquids. The plastic dusters release small or large amounts of dust with better control than the fire extinguisher type.

Power dusters are often used in spaces where the dust can lie undisturbed providing a residual coating of pesticide. They are also applied in sewers as contact pesticides and in trash chutes of high rise buildings. The dust is introduced at the lowest level at a trash compactor and rises up through the chute where it is vented at the top. The chute must be closed at each floor. Dusts can also be placed in wail voids, crawl spaces and almost any unused space. Sometimes drilling into voids is necessary to inject dust. Great care must be taken to confine dust so that it does not drift and is not carried into non-target spaces. Remember to turn off pilot lights and flame- or spark-producing equipment if a combustible dust is used. Protect smoke alarms when using dust.

Dusters clog easily. They must be agitated often and the dust kept dry at all times. Dusters work much better if they are often washed and dried.

TRAPS

Traps, Bait Boxes, Monitoring Devices, and Pheromone Dispensers

Traps have been used for pest control for centuries. Rodent control traps range from snap traps to boxes that use trap doors, spring-loaded multiple catch traps, and small animal traps. Rodent bait boxes, or bait stations, are containers that hold poisonous baits or glue boards. Under certain conditions, they must be tamper proof for safety. Other traps to catch pest birds are baited so the bird will enter and cannot get out. Fly traps are sticky tapes or cylinders that hang vertically, taking advantage of the fly's tendency to cling to vertical poles, strings, etc. Electric fly traps are made with an attracting light that lures flies to electrocution grids or glue boards. Sticky traps are small glue boards used to catch cockroaches. These are used to monitor roach populations and to survey for other insects.

Pheromone traps lure insects with a pheromone (a natural attractant), to a sticky holding surface. These traps are used to evaluate insect populations; their catches indicate which species are present. They may also be used to control or reduce pest populations.

Bait Stations

There are many kinds of bait stations. These devices confine toxic substances to units that are removable rather than leaving them exposed. Cockroach bait stations offer pesticides as attractive

bait. The bait stations themselves offer natural harborage. They can augment sprays, dusts and fogs, or they can be used in place of other more toxic formulations. The key to using these devices is to know where and how to place them.

SUMMARY

Equipment is used in urban pest management and control to suppress pest populations; it is effective only when used by competent pesticide applicators. Pest control equipment used by an untrained applicator who has little practical knowledge will be used ineffectively. Ill-cared-for equipment in bad repair is ineffective and dangerous.

To use pesticides efficiently and economically (without under application [lack of control] or over application [unsafe]), applicators must understand the capabilities of their equipment and be able to depend on correct calibration. They must also be aware of the many types of equipment available. Urban pest control equipment is not only sprayers and dusters, but includes other devices such as traps, bait stations, lights, excluders, etc.

STUDY QUESTIONS FOR MANAGEMENT & CONTROL
CHAPTER TWO
USING EQUIPMENT IN URBAN PEST MANAGEMENT

1. New sprayers are well calibrated until they have been used one season.
   A. True.
   B. False.

2. Hand held sprayers can be calibrated if the following is known: _____
   A. Pressure used.
   B. Amount of liquid used.
   C. Time elapsed per liquid used.
   D. Area sprayed per amount of liquid used.
   E. All of these.
   F. None of these.

3. Fogging fills a room volume including cracks, crevices and cabinets.
   A. True.
   B. False.

4. High pressure must be maintained in hand held sprayers to be effective.
   A. True.
   B. False.

5. If a sprayer malfunctions, _____
   A. Repair it immediately.
   B. Increase pressure by pumping.
   C. Release pressure and remove it to a repair area.
   D. Use very soft thin wire to clear nozzle after releasing pressure.

6. Equipment safety is best maintained by _____
   A. Daily rinsing.
   B. Daily hose inspection.
   C. Scheduled cleaning.
   D. All of these.

For Answers refer to Appendix A

CHAPTER 3

LAWS AND REGULATIONS

Learning Objectives

After completion of the study of Laws and Regulations, the trainee should be able to:

- understand pesticide applicator certification, and
- appreciate how "pesticide laws and regulations protect individuals and the environment

APPLICATOR CERTIFICATION

Pesticide application is complex. Control of pests cannot be attained by simply spraying baseboards, as some novices assume. Certified applicators not only need to know about all phases of pest control for their own use, but also to pass this practical knowledge on to technicians under their supervision.

Pesticide technicians need to know more about safety and proper use than ever before. The number of pesticides has increased. Effects on wildlife, human health, and the environment are vital considerations. Highly toxic pesticides require special equipment and safety measures.

Certification requirements have been set to help protect the general public, the environment, and those who apply pesticides. Anyone using restricted use pesticides in any category must be certified or under the direct supervision of someone who is certified. [***Direct supervision*** refers to the availability of the certified applicator, either as directed by the label or else as related to the hazard of the situation. A competent person shall apply a restricted use pesticide under the instructions and control of a certified applicator who is available if and when needed. [Note: this requirement may be changed by new regulations. All certified applicators should be aware of current requirements.] ***Restricted use*** indicates that the environment, user, or others, could be harmed even though the pesticide is used as directed.] Certification is carried out by the states/tribes (except in Colorado and Nebraska which have federal programs).

Certification

Standards and testing for certification (and recertification) are part of EPA-approved and evaluated state and tribal plans for regulation of commercial applicators. Recertification intervals vary from state to state. Training has received increased emphasis in recent decades; today training programs have input from university extension services, state regulatory agencies, national and state pest control associations, pesticide manufacturers, and other pest control industry representatives.

Certification Records

Training seminars and certification programs are evaluated by state regulatory agencies as well as by the EPA. Records verifying attendance and participation in these training programs are important. Subjects covered, time, location, instructor, and testing results should be noted and signed by the instructor and student.

Every pesticide applicator should maintain a personal training record that includes classroom training and testing, on-the-job training, workshops, performance testing, use observations, etc.

CLASSIFICATIONS

There are two classifications of certified applicators: ***private*** and ***commercial.*** A private certified applicator uses or supervises the use of restricted use pesticides to produce agricultural commodities on property owned or rented by himself or his employer.

A commercial certified applicator uses or supervises the use of any pesticide that is classified for

restricted use for any purpose on any property other than those listed for private applicators.

FEDERAL COMMERCIAL CATEGORIES

Federal standards identify specific commercial pest control categories. State certification standards must meet federal standards, but they can be more stringent to meet needs of the state. 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.

1. ***Agricultural Pest Control***
2. ***Forest Pest Conto1***
3. ***Ornamental and Turf Pest Control***
4. ***Commercial Seed Treatment***
5. ***Aquatic Pest Control***
6. ***Right-of-Way Pest Control***
7. ***Industrial, Institutional Structural and Health Related Pest Control***

This category deals with urban pest management and control. It includes pesticide application in, on, or around food handling establishments, homes, schools, hospitals, other public institutions, warehouses, grain elevators, other industrial buildings, areas near these buildings and around stored, processed, or manufactured products.

8. ***Public Health Pest Control***
9. ***Regulatory Pest Control***
10. ***Demonstration and Research Pest Control***
11. ***Aerial Pest Control***

FEDERAL PESTICIDE LAWS

The United States Congress established the Environmental Protection Agency (EPA) in 1970 and required that the agency regulate pesticides. The EPA sets standards for pesticide registration, handling, and use. The standards are designed to help make pesticide use safer for both people and the environment. Some practices which were suggested for correct use in the past are now required by law. These requirements affect areas such as record keeping, transportation, storage and disposal procedures, entry intervals, and filling and mixing methods. For many applicators, these practices are already part of a regular routine. For others, some adjustment must be made to meet these requirements.

THE FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

Through its Office of Pesticide Programs (OPP), EPA uses the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to manage 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. This amendment shifted the emphasis from pest control regulations to the role of protecting the public health and the environment.

FIFRA governs the registration of pesticide products. No pesticide may be marketed in the United States until the EPA reviews an application for registration, approves each use, and assigns a product registration number. Pesticides must demonstrate that their use will not result in unreasonable adverse effect to human health. In other words, FIFRA balances a pesticide's risk with its benefit to society. [Risk is defined by EPA as the probability that a pesticide will have an adverse effect.]

In summary, FIFRA is the law; it requires that

- EPA register all pesticides as well as each use of that pesticide and approves the product label
- pesticides be categorized either as general use pesticides or restricted use pesticides, and
- users of restricted use pesticides be certified or 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. An applicator may request a hearing in their city or county before being fined.]
- 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 standards, but not more permissive standards.

STATE, TRIBAL, AND LOCAL LAWS AND REGULATIONS

Each state has laws governing pesticide use. The laws are written to comply with federal law and to handle state-specific pesticide-related problems. In some states, laws further restrict the use of certain pesticides in that state. State pesticide laws can be more stringent but cannot relax, overrule, or conflict with federal law. Careful study and a clear understanding of the state pesticide law as well as federal law is necessary to pass certification tests.

Some local jurisdictions have pesticide laws and regulations. Local statutes may not relax federal or state law. Every pest management technician who applies, mixes, or transports pesticides must be familiar with all rules that govern pest control activities.

Protection: The Applicator's Responsibility

Ultimately, protection of the environment from pesticides will fall to the pesticide technician. Preserving the biological diversity of our planet by protecting the environment will contribute to the overall quality of life. Each plant or animal is part of a complex food chain; break one of the links and others are adversely affected. One disappearing plant can take with it up to thirty other species that depend upon it, including insects, higher animals and even other plants. Urban pest management technicians will see their normal work as unlikely to affect the environment, but spills and leaks during mixing, loading, and transporting, and incorrect disposal, may easily wind up in ground or surface water or in the habitat of nontarget organisms, a stream, a marsh, or an estuary. National Parks and other sensitive areas are often serviced by commercial pest management technicians, and while the majority of urban pesticide application is indoors and minimized, some chemicals are applied outside; spills and accidents can occur in any situation.

SUMMARY

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) regulates pesticides to protect humans and the environment. Enforcement of this law is the responsibility of the EPA which in turn, may through cooperative agreements, delegate the authority for enforcing the Act to states and tribes. The Agency has developed regulations for pesticide registration and use. Registered pesticides are unclassified or for restricted use. Applicators of restricted use pesticides must be certified as private applicators (essentially agricultural pesticide applicators) or commercial applicators. Commercial pesticide applicators may be certified to work in certain categories. [One category is the Industrial, Institutional, Structural and Health Related Category for which this training module was written.]

Each state and tribe has laws governing pesticides and their use; these laws are as strict as with federal law. State certification plans are approved and evaluated by EPA. Since pesticide applicators are directly regulated and certified by their state agencies, a thorough knowledge of the state pesticidal law as well as federal law is essential.

STUDY QUESTIONS FOR MANAGEMENT & CONTROL
CHAPTER THREE
LAWS AND REGULATIONS

1. The responsibility of the Environmental Protection Agency is to _____
   A. Regulate pesticide use.
   B. Regulate pesticide applicators.
   C. Protect public health and the environment.
   D. Enforce FIFRA.

2. Pest control applicators may be certified in either of two classifications: _____
   A. Private and commercial.
   B. Fumigation and non fumigation.
   C. Urban and agriculture.
   D. Certified and non-certified.

3. Pesticide registration decisions are based on the demonstration that the use of a pesticide will not result in "Unreasonable human health or environmental effects". The law that mandates that is called the _____

4. The state plan that regulates pesticide applicators and their certification is approved and evaluated by _____
   A. FDA.
   B. USDA.
   C. EPA.
   D. OSHA.

*For Answers **refer to** Appendix A*

United States
Environmental Protection
Agency

Office of
Pesticide Programs
Washington DC 20460

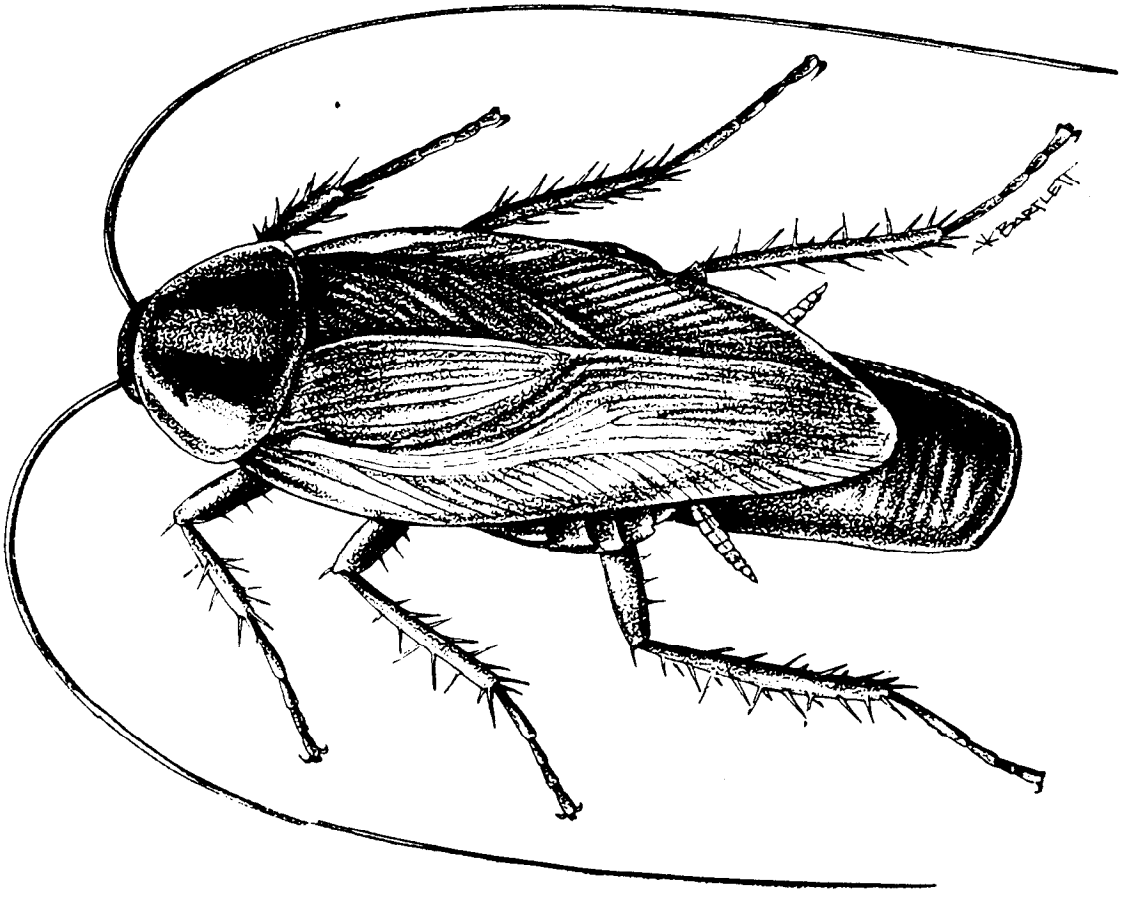
July 1992

EPA

Urban Integrated Pest Management

A Guide for Commercial Applicators

Structure Infesting Pests



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CHAPTER 1

INTRODUCTION: PESTS AND THEIR RELATIVES

Plants in their many forms from great trees to tiny mosses cover the land. The plant kingdom began as microscopic single cells -- pond scum. Their descendants are the algae, bacteria and fungi living today. Larger prehistoric plants developed from their smaller ancestors; finally, flowering plants, modern shrubs, and trees evolved.

Forebears of insects were the first animals to move onto land -- before plants had flowers. As plants developed, so did the insects, feeding on evolving plant structures, such as flowers, pollen, nectar, leaves, bark, stems, roots, and their dead remains.

At the time of early insect development, the land had a uniform climate: one with moisture and temperature adequate for constant growth. Later, the surface land mass (continents) shifted, moving northward and southward, creating seasons, and setting the stage for the world as we know it.

THE INSECT PLAN

Insects and their Relatives

Living things are divided into the Plant Kingdom, the Animal Kingdom, and several smaller kingdoms that include microscopic life. Insects are in the largest group in the animal kingdom -- the ***Phylum*** Arthropoda. In this group the "arthropods" include spiders, mites, ticks, millipedes, centipedes, crabs, shrimp, and insects.

Phylum Arthropoda

Arthropod classes have:

- a body made of segments, which are grouped or fused together
- legs, antennae and other appendages attached in pairs
- a hard or tough external covering with some pliable, or soft parts; an arthropod outer body that holds the body together and gives it shape. [It performs the same function as the mammal's bony internal skeleton, and is called an exo-skeleton].

Principal *classes* into which the phylum Arthropoda is divided include:

Arachnida

This class includes spiders, mites, scorpions, daddy long legs and others. These arthropods usually have mouthparts with two prominent structures that end in a needle-like piercing tip. They have four pairs of legs and two body regions: the mouthparts and legs are attached to the first region; the reproductive organs and digestive system is contained in the second.

Crustacea

This class mostly includes aquatic crabs, lobsters, and shrimp as well as crustacea that dwell on land, pillbugs and sowbugs.

Myriapoda

This group is made of two classes -- millipedes and centipedes. The millipedes are many-segmented and worm-like; they are cylindrical with short antennae and two pairs of legs per segment. Centipedes are also many-segmented and worm-like, but they appear more flattened; with one pair of legs per segment; antennae and hind legs are long (All legs of the house centipede are very long).

Insecta

This class contains the insects: arthropods with three body regions -- head, thorax and abdomen. The head bears a single pair of antennae; the thorax bears three pairs of legs, usually wings; the abdomen contains most of the digestive system and the reproductive organs.

Other Divisions Used in Classification

Classes of arthropods, insects, for example, are divided into ***orders.*** These are distinct groups that look very much alike (e.g., the order of moths and butterflies, or the order of beetles).

Orders are subdivided into ***families*** made up of related ***species.*** Species of animals can be thought of as "kinds of animals". Very closely related species are grouped together in a ***genus.*** Species or types of

animals (and plants) are given scientific names that always consist of two words; the first word is the genus name (the first letter is always a capital), the second is the species name (always lower case). Both are written in italics or underlined (e.g., ***Musca domestica).*** Well-known species can be given non-scientific names, called "common names" (e.g., house fly).

GROWTH AND DEVELOPMENT

Growth

The arthropod body is confined in its exoskeleton. This outer covering can expand only a little at pliable or soft places. It does not grow continuously. Arthropods grow in stages. They form a new soft exoskeleton under the old one, then shed -- or molt -- the old one. The soft new one fits the accumulated growth. The new exoskeleton is white at first, but it hardens and darkens in a few hours. After the molting process, which usually takes place in hiding, the arthropod resumes its normal activities.

Development

Arthropods hatch as tiny individuals and grow by molting, usually keeping the same appearance until they become adult. [The reader will find that a spectacular and very important exception occurs in the class Insecta.]

The insect class is divided into groups according to the way insects change during their development. This change is called by the technical term, ***metamorphosis,*** which means "change in form". Three main types of metamorphosis have been identified.

Group 1. Simple Metamorphosis

This group including the order of springtails and silverfish, makes no drastic change. They simply hatch and grow larger by molting periodically. Three small orders are included together in this group.

Group 2. Gradual Metamorphosis

In this group (e.g., cockroaches, crickets, grasshoppers, boxelder bugs, earwigs, etc.), individuals hatch from the egg only partially resembling the adults. The immatures, or ***nymphs,*** do not have wings. (Winged insects are always adults and have finished their growth.) Fourteen orders develop in this way. Some of these orders have many species and include many pests. Nymphs and adults are often found together and eat the same food.

Group 3. Complete Metamorphosis

The orders that develop by complete metamorphosis make a complete change in appearance. These orders contain the majority of insect species. ***In fact, they number more than all of the other species in the entire animal kingdom!*** This major group consisting of nine orders, includes beetles, moths and butterflies, flies, fleas, and the stinging insects, ants, bees and wasps.

Insects with complete metamorphosis hatch from eggs as ***larvae,*** (grubs, maggots and caterpillars). The mission of the larval stage is to feed and grow. Larvae continue their development through a number of molts until they become mature; then, they change into ***pupae.*** Not active like larvae; the purpose of the pupal stage is one of change or body rearrangement resulting in a complete change into the ***adult*** stage. The mission of the adult is to reproduce.

Considerations of Pest Management

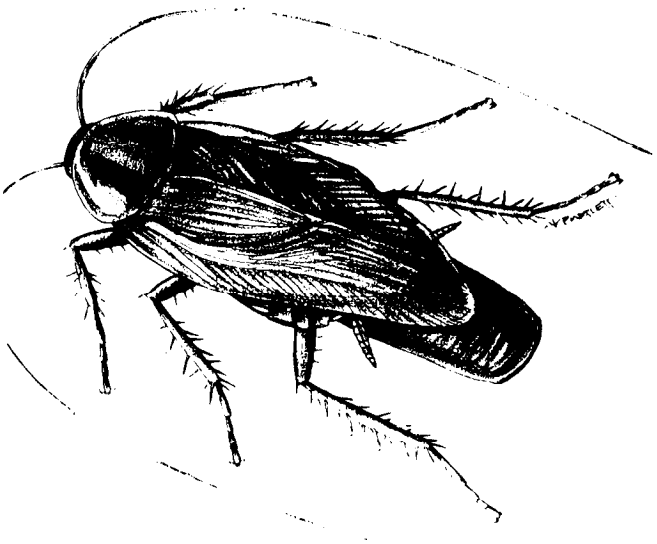
These developmental stages of insects with complete metamorphosis support rather than compete with each other. It is as if the single species is represented by two or three completely different animals with different needs and habits: The larvae feed and live in one spot; they sometimes leave that spot to pupate a short distance away. The adult emerges and often lives in another area, returning to the larval feeding site only to lay eggs. For this reason, pest controllers manage species with complete metamorphosis in different ways according to the different stages, where each lives, and what they do. The reader will want to pay special attention to sections that discuss the growth cycle, behavior, and harborage (the area in which the animal lives and finds its food) of each animal.

CHAPTER2

COCKROACHES

Learning Objectives

- After completion of the study of Cockroaches, the trainee should be able to:
- Given a cockroach specimen, hand lens, or pictorial key, identify the specimen by common name.
- Given a list of common cockroaches, match each with its habitat.
- Cite monitoring strategies for cockroaches.
- Given an actual control situation,, apply all elements of cockroach management to include sanitation, proper selection of pesticides, application techniques, and other control methods.



Cockroaches have survived for more than 300 million years. Ancient fossils had the same appearance as today's cockroaches: oval and flat with long legs and antennae. The modern cockroach has the same need for a warm, moist climate. Worldwide there are 3,500 kinds of cockroaches. While most live wild in the tropics, a few, called urban cockroaches, choose to enjoy the moist, even temperature humans maintain in their homes and workplaces.

Applying pesticides where and when the insects can be found allows technicians to manage control measures most effectively. Knowing similarities and differences are important clues: [Communicating this knowledge, will give clients more confidence in the professional ability of their pest controllers.] By considering the habits discussed below, the applicator can begin to consider effective measures to control cockroaches. Except for size, all cockroaches are relatively similar in overall shape and appearance. They are nocturnal and stay in the dark whenever possible. [When they are seen in the open or in the light, it usually means that a large infestation is present.] Cockroaches also like tight places where their bodies can touch surfaces both above and below. As they grow to adulthood, they will seek varied harborage (living space) to accommodate their increasing size. Cockroaches are particular as to where they live. They do not uniformly infest one room or all rooms.

The five most common kinds of cockroaches found in urban areas in the United States (listed in order of frequency found) are the

- German
- Brown-banded
- American
- Oriental, and
- Smoky-brown cockroach.

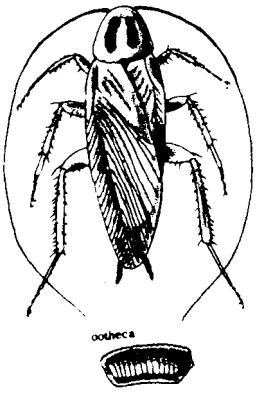
There are five other kinds, or species, that can be found in unusual urban situations in the United States:

- Brown
- Australian
- Surinam
- Woods, and
- Asian cockroach.

GERMAN COCKROACH
Blattella germanica

The German cockroach is not only the cause of the largest number of phone calls requesting pest control, but also represents the largest number of control failures of any household pest. It is most successful at infesting human structures and withstanding pest control activity. Pest control technicians will need to double their efforts in analyzing every German cockroach infestation, and should be prepared to use more than one technique to bring the infestation under control.

Appearance



Adult German cockroaches are l/2 inch long or slightly longer. Males are grayish-tan with two black stripes on the pronotum, and have a tapering abdomen. Females are usually darker and their abdomens are more rounded.

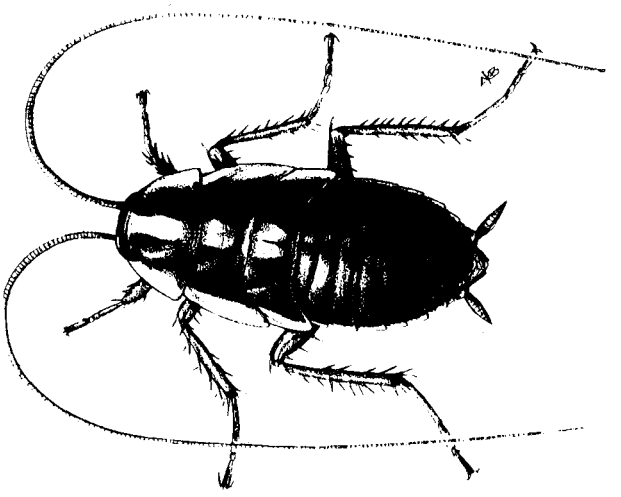
Nymphs are sometimes not recognized as cockroaches; they appear quite different than the adults. After molting, they will be ivory white for several hours before turning dark. People who see them at this time often think they are albino cockroaches. [Actually, such observations mean that the cockroach population is so large, the nymphs cannot find unoccupied spaces in which to hide and molt, for they normally leave their aggregations to molt in private.] In the first stage, nymphs are very dark. In later stages, a pale tan stripe appears down the middle from front to rear. This stripe divides the nymphal markings into two dark, long stripes. The stripes remain as two dark streaks on the adult's pronotum, while the rest of the body is covered by the tan or brown wings.

Life Cycle

Eggs. The egg capsule of the German cockroach is about 1/4 inch long. Half of it protrudes from the female's abdomen. It is carried in this way for three weeks until it is dropped, about one day before the eggs hatch. The drop usually takes place in a secluded portion of the infested habitat. [If the egg case is dropped much more than one day before hatching time, the young die.] Each egg capsule contains 30-40 eggs. Altogether, the female will produce from four to eight capsules in her lifetime. Four capsules will have a full complement of eggs, but subsequent capsules can contain less.

When the female goes into safe hiding, she takes the capsule with her, reducing exposure to possible harm. In extreme danger, she will detach the capsule and flee. The capsule has a relatively impervious surface to protect its eggs. It does, nonetheless, receive moisture from or give moisture to the female. In extremely dry atmospheres, however, the female will abort the egg capsule. In all large infestations, there are egg capsules present. Even if the cockroach population is eliminated, as many as one in every twenty egg cases can still hatch.

Nymphs. The eggs hatch when the nymphs inside create pressure that splits the case and allows the young to escape. They often will stay around the opened egg capsule after hatching. Then, as they develop, they ***molt*** six or seven times before reaching the adult stage, Females often have one more molt than males. When molting, nymphs are very soft and vulnerable.



German cockroach nymph

Adults. Adult cockroaches emerge from the last nymphal molt fully winged. They join a nearby aggregation made up of other adults and larger nymphs. The aggregation is held together by a very short-range odor called the ***aggregation pheromone.***

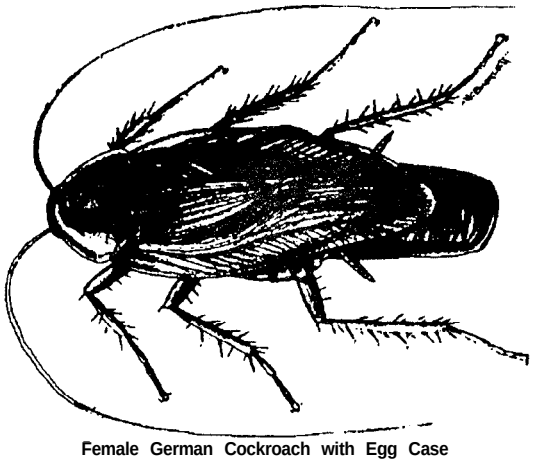
Behavior and Harborage

Aggregations of cockroaches live in areas of high humidity and nearby food. They will find harborage into which they can fit closely. As the number of roaches increase and favorable harborage is filled, roaches are forced to leave the aggregation or remain in less favorable harborage. They will find these new sites during their foraging periods just before dawn and after dark.

Aggregations:

- serve as the natural group where nymphs soon to be adults and adults of both sexes remain together, thus facilitating mating
- are maintained in areas with favorable temperature, humidity, food supply, and protection.

Mating. Females do not respond to mating behavior for more than one week after becoming adult. Proximity for mating is especially important, as males and females have to touch antennae and exchange sex pheromones to initiate mating. After mating, females feed intensively for several days, then seek secure hiding places where they can be safe with their egg capsules.



Female German Cockroach with Egg Case

Such seclusion means that females with egg capsules feed less frequently and are exposed to pesticides less often. Preventive pesticide applications are likely to be less toxic by the time female roaches come in contact with them. Clients often report seeing no adult roaches after a technician's last treatment, but later will observe "little black ones." The client is reporting the success of the females with egg capsules that were deep in harborage and did not come in contact with superficially or inexpertly applied pesticides.

Foraging. The foraging pattern of German cockroaches is much less random than one would expect. The roaches leave their harborage and usually go to the first perpendicular surface they find, where they stop, turn, and move along the intersection of the two surfaces (usually a floor and a wall). As one can imagine, food crumbs often wind up in the same places, that is in wall moldings, corners made by walls, stoves, counters, canisters, etc.

The most convenient harborage, in and around refrigerators, stoves, under sinks, and undisturbed cabinets, provides both protection and food. The most favorable humidity level is found in kitchens with sink traps, leaking faucets, standing water, wet sponges, etc. A bathroom is popular because of its toilet bowls, sinks, wet wash cloths, and sometimes, water heaters. While there is less food in bathrooms, food areas are usually nearby or available through holes around plumbing pipes. These pipes provide additional harborage and areas for population expansion into adjacent rooms or apartments.

German cockroaches are not likely to leave favorable harborage unless population pressure or other negative changes occur. Such "other" changes can be caused by:

- intensive cleaning
- pesticide applications
- reduction of temperature or humidity.

If cockroaches find new locations with favorable conditions, they can migrate from one harborage to another, or develop new infestations.

In areas of great infestation, German cockroaches can build up outside heavily infested apartment units in the summer. Most often, outdoor infestations are found only outside the structures from which steady roach migrations occur and near dumpsters and garbage cans.

CONTROL AND MANAGEMENT of the German Cockroach

Inspection

With Flashlights. An active flashlight inspection is the most intensive method of locating roaches. The technician can search dark, undisturbed, or remote places of roach harborage that a client may have thought too inaccessible.

With Traps. Passive use of sticky traps is a common inspection or monitoring method used for roach detection. Correct trap placement depends upon the applicator's understanding of roach foraging habits: for instance, jars and traps baited with fermenting materials such as beer, bread, potatoes or softened raisins indicate population size, but are not especially helpful for finding harborage. Hand mirrors, magnifying hand lens, or other small tools may be helpful to some technicians.

Habitat Alteration

Speak to clients in a friendly, knowledgeable way. Technicians should explain that changes can be made that will alter or eradicate the insect problem. These recommendations should include how clients can eliminate or restrict material that supports roach populations.

Pesticide Application

In attacking roaches, concentrate on injecting pesticides into active harborage rather than preventively treating uncertain harborage.

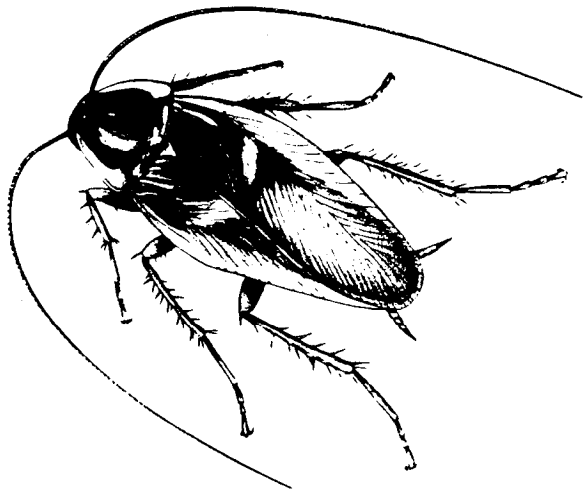
- The ***crack and crevice*** type of pesticide application is preferred. Use a narrow diameter extension tube in infested cracks and crevices to provide a thorough application of residual insecticide: under furniture, drawers, sinks, around pipes and in high cabinets. First remove utensils and supplies in cabinets; do not treat shelf surfaces.
- In homes, offices and other non-food areas, ***spot applications*** apply pesticides to areas where insects are likely to occur. Apply spot treatments only when they can be safely used in areas of known infestation [application areas, ideally, of no more than two sq. ft.].
- **Space treatments** include aerosols, fogs, or ultra-low dosage dispensers. They flush cockroaches, causing them to cross residual pesticide applications, or they land on the insects killing them by direct contact. They lack crack and crevice penetration. The need for repeated fogging at short intervals indicates populations are rising, not decreasing. Fog treatments should not be used in food or occupied areas without prior removal of food and follow-up surface cleaning before use.
- ***Bait stations*** should not be contaminated by sprays or dusts that may be repellant. Place an adequate number of stations in or very near harborage.

Follow-up

A technician should record the data collected with each activity. Such information is not only helpful in understanding the problem over time, but with providing clear communication with clients.

BROWN-BANDED COCKROACH
Supella longipalpa

Brown-banded cockroaches are not generally as widespread as the German cockroach, but where they find favorable harborage, such as warm apartments and overheated office buildings, they build up infestations rivaling the German cockroach. They can be found across the United States.



Appearance

Adult brown-banded cockroaches are the size of German cockroaches -- about 1/2 inch long. The female is a little longer than the male. Her wings are reddish-brown to dark-brown, and a little shorter than her broad, rounded abdomen. The male, slightly less than 1/2 inch long, has wings that are dark-brown at the base but light-brown at the tips, which are slightly longer than the tapering abdomen. Both sexes have a light band behind the pronotum at the base of the wings, and another or partial band about one-third of the way back from the pronotum. The pronotum is dark-brown with very light side margins and never shows two stripes as the German cockroach does. Nymphs are dark with two very light bands separated by a dark band just behind the pronotum. These nymphal markings are more obvious than the banded markings of the adults.

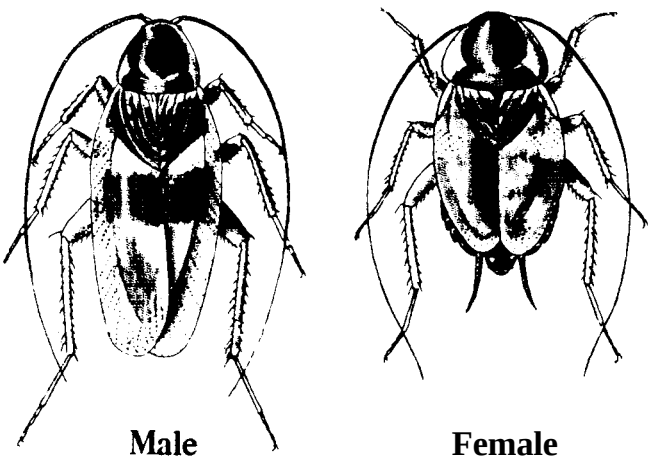
Life Cycle

Eggs. The brown-banded cockroach female forms an egg capsule and carries it less than two days when she glues it to an object in the harborage site. The capsule is very small, only about l/8 inch long, and a little less than l/8 inch wide. It is oval and light tan to brown in color. The female usually glues these in clumps underneath furniture, behind kitchen cabinet drawers, and in corners inside cabinets and cabinet frames. These capsules hatch in around 50 days; they take longer at cooler temperatures (e.g., up to 95 days at a room temperature of 72 degrees Fahrenheit). A female may deposit 14 egg cases in her lifetime; 13 to 18 nymphs can hatch from one egg case.

A parasite of the brown-banded cockroach egg capsule is a small wasp, *Comperia merceti.* A female wasp seeks dark areas where she can find brown-banded cockroach egg capsules in which to lay her eggs. The tiny wasp larvae eat the roach eggs, then emerge from the capsules, fly to windows where the sexes meet and mate -- and the cycle begins again. This wasp parasite has been used as part of a cockroach pest management program.

Nymphs. Nymphs molt six to eight times before becoming mature for a total of five to six months at around room temperature. At higher temperatures the nymphal period is nearly halved.

Adults. Adult brown-banded cockroaches live about six months past the nymphal stage. Males fly readily, as can be seen when lights are turned on during their foraging periods. The females do not fly.



Male **Female**

Behavior and Harborage

Brown-banded cockroaches, like German cockroaches, build up the highest populations in kitchens. Their tendency is to flourish in apartments and homes where high temperatures are maintained. They frequent high cabinets and favor areas near stoves and warm motors, such as those in refrigerators, electric clocks, light timers, televisions, and radios.

Control and Management

Inspection

Search areas frequented by the brown-banded cockroach. Look for roaches and egg cases.

Habitat Alteration

Apply caulk around pipes and other wall penetrations. Where possible, suggest that the client clean and replace shelf paper and drawer liners, reduce clutter, and consistently remove garbage before nightfall. Eating in non-dining areas should be discouraged.

Pesticide Application

- Use a narrow diameter extension tube in infested cracks and crevices to provide a thorough application of residual insecticide: under furniture, drawers, sinks, around pipes and high cabinets. First remove utensils and supplies in cabinets; do not treat shelf surfaces.
- Consider pesticide formulations not readily absorbed by unpainted wood.
- Bait stations with a long active period are effective, but should not be contaminated by sprays or dusts that may be repellant. Place an adequate number in or very near harborage.
- Spot sprays often break down before egg capsules hatch.
- Space sprays lack crack and crevice penetration.

No pesticide application used alone will control roaches satisfactorily without habitat alteration.

Follow-up

The long egg hatching time of the brown-banded roach requires treatments to be monitored and follow-up provided treatments, if indicated.

AMERICAN COCKROACH

Periplaneta americana

The American cockroach is cosmopolitan and is often cited in historical accounts. Its worldwide distribution has been aided by its ability to thrive aboard ships. Like the Oriental cockroach, the American cockroach is sometimes called Waterbug. In the southern United States, it is called Palmetto bug.

Appearance

Adult American cockroaches are long: 1 1/3 to 1 1/2 inches. The wings of the male extend slightly beyond the tip of the abdomen, but those of the female do not. This roach is reddish-brown in color, and its pronotum is ringed by an irregular light color that is almost yellow. Often this margin is bright and wide, darkening toward the center of the pronotum. In other cases, the lighter margin is barely discernible, but it is always present on the rear margin of the pronotum.

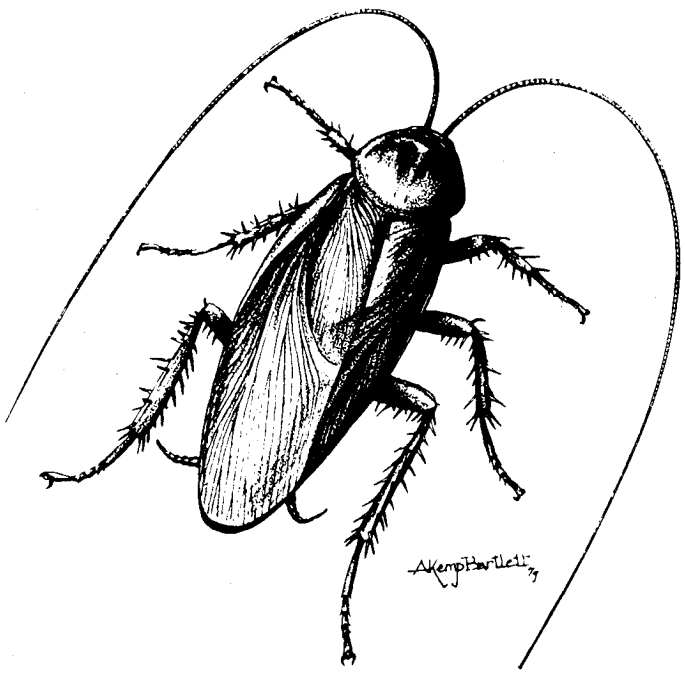
Life Cycle

Eggs. The American cockroach female drops her egg capsules about one day after they form. The capsules are only about 5/16 inch long and 3/16 inch

wide, and are sometimes covered with dust, because they are left by the female in out of the way places. [Egg capsules that are clean, dark, and often dropped in the open, are an indication of a high population.] Where climate allows American cockroaches to spend most of their lives outdoors, egg capsules can be found in moist wood. Although females produce egg capsules throughout the year, they produce more of them in the summer. An egg capsule can form in about one week, so from 12 to 24 capsules can be produced in the warm months. An average of 14 eggs per capsule hatch in 30 to 50-plus days.

Nymphs. When they first hatch, nymphs are gray. After their first molt, they are reddish-brown in color like the adults. They molt up to 13 times before reaching adulthood. Depending on temperature numphs can take from six to 20 months to mature. Mature American and Oriental nymphs can be difftcult to tell apart.

Adults. Adults commonly live more than one year, giving the American cockroach an entire life span of 20-21 months. Flying American cockroaches are found only in the southern United States.



Behavior and Harborage

Large populations of American cockroaches live in warm moist habitats. They can be found outdoors in the southern United States in alleyways, dumps, stacked firewood and rotting wood, and in tree canopies as far north as Maryland. [they winter in landfills of decaying trees at that latitude.] In the North, they can be found in boiler rooms or other harborage with water heaters, floor drains, water sumps, and warm moist basements.

Control and Management

Inspection

Search areas that provide warmth and high humidity.

Habitat Alteration

- Caulk around plumbing and other penetrations in walls, screen equipment drains, floor drains, keep drain traps full or capped.
- Remove firewood stacked in attached garages, porches, patios, etc.
- Replace mulch near doors and window wells with plastic absorptive ground cover and gravel.
- Ventilate humid places.

Pesticide Application

- Use pesticide formulations that are not readily absorbed by porous surfaces (concrete floors, bricks, stones, soil, etc.). Apply them in cracks and crevices.
- Apply pesticides as outside barriers or spot treatments when they can be safely used in areas of known infestation.
- Use space sprays to quickly reduce large populations indoors.
- Large bait stations are effective when properly placed in proper quantities.
- A sex pheromone is available to attract males to traps.

Follow-up

Ongoing monitoring is important due to the long life span of this roach.

ORIENTAL COCKROACH

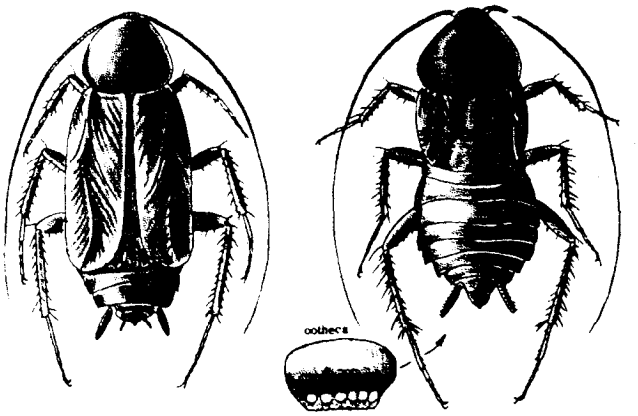
Blatta orientalis

The Oriental cockroach is often called the waterbug, and sometimes the black beetle, or just plain, beetle. It is the most common urban roach in England.

Appearance

Adult Oriental cockroaches are very dark-brown or shiny-black. The female is slightly longer than the male -- 1 1/4 inch to his 1 inch. Unlike other domestic

cockroaches, the female does not develop wings, but produces only short triangular wing pads. The male has wings, but they are short and broad, leaving about l/4 of the abdomen exposed.



Male Adult Female

Life Cycle

Eggs. The Oriental cockroach female produces an average of eight egg capsules from spring to mid-summer. Unlike other urban cockroaches, the Oriental roach produces only one generation per year where temperatures are cool in winter. The egg capsule is carried for little more than 24 hours, and then is placed in a protected spot; it is irregularly shaped, black, 3/8 inch long, and l/4 inch wide. Eggs hatch in two months.

Nymphs. Nymphs are active from about March through much of the summer. During this period they molt seven to ten times, and are reddish-brown to black in color, except in the first stage when they are pale tan. The older brown Oriental cockroach nymphs are very difficult to distinguish from the American cockroach nymphs.

Adults. In early spring, only adult Oriental cockroaches are found. By late spring, nymphs are abundant. As nymphal numbers increase, the adults die off and by August any adults are new ones. By fall, almost the entire population is adult. Neither males nor females fly.

Behavior and Harborage

Oriental cockroaches favor crawl spaces, spaces between the soil and building foundations, the undersides of stoops and sidewalks, landscaping mulches, water meters, basements and their floor drains, and other such moist places. These cockroaches frequently live in floor drains that drain directly outside; these drains are also used as entrances to homes. The Oriental cockroach prefers starchy food, and builds up populations around garbage cans. They tolerate lower temperature ranges than other roaches and may winter in rock walls or such protected sites. These cockroaches are more sensitive to lack of water than other roaches.

Control and Management

Inspection

Search areas of high humidity.

Habitat Alteration

- Caulk all penetrations through ground level walls.
- Stop water leaks, screen equipment overflow drains, and take overflow water away from buildings; keep drain traps full or capped.
- Remove rotting leaves from window wells.
- Move garbage cans out of preferred moist habitat.
- Stop erosion that causes soil voids. Ventilate moist spaces.

Pesticide Application

Many of the same insecticide applications used to reduce American cockroaches will work for the Oriental cockroach. Particular attention must be paid to pesticide degradation due to moisture.

Follow-up

Numbers observed in the spring may appear low or under control only to build-up by mid-summer.

SMOKY-BROWN COCKROACH
Periplaneta fuliginosa

The Smoky-brown cockroach is a relative of the American cockroach and resembles it in size and shape. These cockroaches are more common in the southern United States and are not found in all parts of the United States.

Appearance

Adult Smoky-brown cockroaches are slightly over 1 inch long, and both sexes have wings that are longer than the abdomen. Their very dark-brown mahogany color is striking; no light markings appear on the pronotum or wings. Nymphs, like adults, are also dark-brown. Antenna1 tips of young nymphs are white, and the base segments of the older nymphs' antennae are white.

Life Cycle

Eggs. The egg capsule of the Smoky-brown cockroach is large and dark-brown. The female usually glues it to objects in the harborage. An average of 17 eggs are in each capsule; as many as ***24*** eggs have been found. Nymphs hatch within 50 days.

Nymphs. Nymphs hatched in summer overwinter.

Adults. The life cycle of a Smoky-brown cockroach is about one year. A large adult die-off occurs each fall. Both sexes fly.

Behavior and Harborage

The Smoky-brown roach is found in the Gulf States from central Texas to Florida, in Georgia, South and North Carolina, southern California, and in some parts of the midwest. It is a plant feeder, and occurs in greenhouses. While it is mainly an outdoor roach, it is often transported indoors. Populations build up outside homes and enter around doors, garages, and in the eaves of roofs [where they live in gutters and under roof shingles and easily find their way into attics]. This cockroach is very dependent on moisture. With the high humidity of coastal areas, populations can build up and infest every level of a structure.

Control and Management

Inspection

Search gutter and roof overhang and attics,

Habitat Alteration

- Tighten doors and window wells. Eliminate overhanging tree limbs [especially pines].
- Keep gutters clean.
- Close all roach entry at the roof from the edge of eves to house wall. Use care not to obstruct screened ventilation of soffets or attic areas.
- Attach lights away from the house.

Pesticide Application

- Use microencapsulated insecticides at the edge of the roof, behind gutters, etc.
- Use dusts in infested areas of attics where the dust will not get into living spaces.
- Use granules in outdoor harborage.

Follow-up

Monitor -- especially in unoccupied vacation homes. Attics of all infested homes can be heavily infested, especially unoccupied homes.

BROWN COCKROACH

Periplaneta brunnea

The Brown cockroach, another close relative of the American cockroach, is transported in plant soil.

Appearance

The brown cockroach closely resembles the American cockroach in color but lacks the light coloration on the margin of the pronotum. Its cerci (short appendages at the end of the abdomen) are wider and have blunt tips; the American roach has slender, pointed cerci. It is not as uniformly dark as the Smoky-brown cockroach.

Life Cycle

Eggs. Egg capsules of the Brown cockroach are over l/2 inch long and contain an average of 24 eggs. They average 35 days from deposition to hatching.

Nymphs. Nymphs mature in little over nine months. The antenna1 segments of the first nymphal stage are white both at the base and tip.

Adults. Adults are associated with trees and feed on plant materials. This species has a somewhat yearly growth cycle.

Behavior and Harborage

The Brown cockroach is found from eastern Texas to Florida. They build up large populations in some areas. They live outdoors, but enter homes on occasion, and they often are transported into new areas with the movement of plant soil. Brown cockroaches can be found on the trunks of palm trees and in places such as sewers, crawl spaces, and garages.

Control and Management

Inspection

Pay careful attention to outdoor populations near buildings. In areas outside the Gulf Coastal region, inspect shrubs and trees that have been imported for indoor use.

Habitat Alteration

See American Cockroach.

Pesticide Application

- Inside the Gulf Coastal region, use the same treatment as for the American cockroach, including the American roach sex pheromone.
- Outside the Gulf Coastal region, treat areas where specimens are found rather

than typical American cockroach harborage.

- Large bait stations can be placed in and around plants and sprays or dusts can be used for residual effects.

Follow-up

Continue monitoring until the population is eradicated where these roaches occur inside.

AUSTRALIAN COCKROACH
Periplaneta australasiae

Another relative of the American cockroach, the Australian cockroach, is introduced (brought in from outside the continental United States) and rarely found out of doors in the United States except in the Florida Keys.

Appearance

The Australian cockroach is similar to the American cockroach in appearance but is slightly shorter and somewhat oval. Australian cockroach adults have conspicuous light-yellow margins on the pronotum. The reddish-brown base color is slightly darker, and the outside edges of the wings just behind the pronotum are light-yellow, sometimes nearly-white. Nymphs are brown but have yellow streaking across each thoracic and abdominal segment.

Behavior and Harborage

The Australian cockroach is more commonly introduced with trees and other plants used inside shopping malls than the Brown cockroach. It burrows into soil and is not easily detected. The Australian cockroach can build up in large numbers in buildings with high humidity.

Control and Management

Inspection

Inspect the entire infested area. Concentrate on locating the plant soil in which they are burrowing.

Pesticide Application

- The American roach sex pheromone can be used to trap or bait males.
- Large bait stations and granules can be placed in and around plants; limit water where possible to protect baits; maintain a high degree of sanitation to force the roaches to baits.
- Plants may have to be removed and treated elsewhere.

Follow-up

Continue monitoring until the population is eradicated.

SURINAM COCKROACH
Pycnoscelus sufinamensis

The Surinam cockroach is another hitchhiker in plant soil and infests plants used in building interiors.

Appearance

The adult female is about one inch long, and has a shiny-black head and pronotum, with uniformly dark-brown or sometimes lighter-brown wings. No males are found in the United States.

Behavior and Harborage

The species is established in southern Florida and Texas.

Control and Management

Granules or soil drenches labeled for that use can be administered to the plant soil. Large bait stations and sticky traps will control roaches that leave the pot. Plants may need to be removed and treated elsewhere.

The last cockroach species listed here can be very difficult to control when they become established in areas that import tropical plants to simulate rain forests and other tropical ecosystems. This is particularly so when tropical birds and other animals are also part of the system.

WOODS COCKROACH
Parcoblatta pennsylvanica

This is the most common species of Woods cockroach among the several that exist. They all live outdoors exclusively.

Appearance

The adult female is slightly less than 1 inch long, and her short wings cover less than half of her abdomen. She cannot fly. The male Woods cockroach

is one inch long, and has richly-colored, dark-brown wings that extend well over the tip of his abdomen. The woods cockroach is slender (three times longer than wide). The pronotum and fore-part of the wings of both sexes are margined with light yellow or white, but the pronotum is very dark between these margins.

Behavior and Harborage

Woods cockroaches live in rotted logs, tree stumps, hollow trees, stopped-up rain gutters, under loose bark of trees, and in piles of firewood. The males fly to lights, landing on windows and door screens. They then make their way indoors or fly into the house. Sometimes they are brought in with firewood. However, once indoors, Woods cockroaches soon die; human habitats do not provide the moisture of their normally shaded woodland. Even with sufficient moisture they would not live long without females. Woods cockroaches range across the southern, midwestern, and eastern United States into Canada.

Control and Management

Male woods roaches can be excluded by caulking and tightening around screens in rooms that face woods habitat. Outside lights that attract flying roaches can be regulated. Nearby windows and doors where light-attracted roaches may enter should be tightly screened. No pesticide applications are needed.

ASIAN COCKROACH
Blattella asahinai

Appearance

The appearance of the Asian cockroach is identical to the German cockroach.

Behavior and Harborage

The Asian cockroach is essentially an outdoors roach; its populations are seasonal. It is native to and widespread in southeast Asia and other parts of the Pacific, but it has successfully colonized urban neighborhoods after being introduced into the Tampa, Florida area of the United States. This roach lives outside and builds up under fallen leaves and ground cover. It favors shady, moist areas, and builds up rapidly under trees. Unlike most roaches, it is attracted to light, and adults fly to lighted windows, doors, yard lights, and parking lot lights at dusk. From these points they often crawl into buildings or fly to indoor room lights.

The Asian cockroach begins building up its population in spring, and produces several generations through the summer. It is limited to warm and moist regions, and may become a serious problem in areas of the United States Gulf Coast where the climate permits it to begin a population increase earlier in the year.

Control and Management
Inspection

Inspect large yard trees and waste areas next to suburban yards. Locate favorable harborage.

Habitat Alteration

- Caulk or use other methods of exclusion on the sides of building the roach is most actively entering.
- Minimize leaf litter and ground cover under large yard trees. Keep areas mowed.
- Attractive blue or cold lights should be located away from buildings and directed so they do not shine on the building walls.

Pesticide Application

- Select pesticidal baits most favored by this species for use in their harborage.
- Before migration to lights begins, apply pesticides labeled for use on cockroaches to populations in favored harborage outdoors.

Follow-up

Monitor to find when populations begin to increase.

SUMMARY

Four factors explain the success of the German cockroach as a pest in human habitations: They

- flourish in the human tropical environment
- can utilize human clutter and interior building design for their harborage
- feed on a wide range of food and are not subject to periodic scarcities, and
- develop in a short period of time allowing them to adapt and overcome environmental (and pesticidal) stresses.

German cockroaches in particular live on the same wide range of food that humans eat, and have no strict preferences that would limit them to periodic scarcities that might endanger their numbers.

Accepting many different foods shortens not only foraging time, but foraging distance as well. German cockroaches build large populations quickly. They produce a large number of eggs per capsule and have a shorter developmental period than other domestic cockroaches.

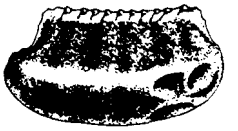
Urban cockroaches are adaptable. Generally, their rapid population growth allows for increased variation in each generation. In terms of pesticides, this means that some individuals can chemically break apart a pesticide in their body rendering it ineffective. When these roaches mate, some pass this ability on to some of their offspring, resulting in a population with increasingly larger numbers resistant to the pesticide.

COCKROACHES: KEY TO EGG CASES OF COMMON DOMESTIC SPECIES

Harold George Scott, Ph.D. and Margery R. Borom

less than ¼" long
subsegments apparent

more than ¼" long
subsegments inapparent



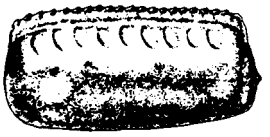
with about 16 subsegments
length more than twice width

Blatella germanica
GERMAN COCKROACH

with about 8 subsegments
length less than twice width

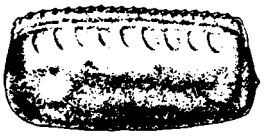
Supella supellectilium
BROWN-BANDED COCKROACH

with lateral indentations



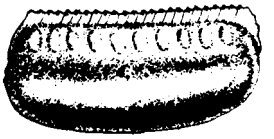
without lateral indentations

terminal point strong



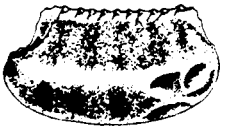
Periplaneta brunnea
BROWN COCKROACH

terminal point weak



Periplaneta fuliginosa
SMOKY-BROWN COCKROACH

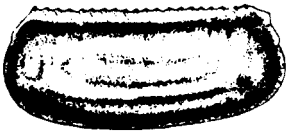
not symmetrical



Blatta orientalis
ORIENTAL COCKROACH

symmetrical

length more than twice width



Periplaneta australasiae
AUSTRALIAN COCKROACH

length less than twice width

Periplaneta americana
AMERICAN COCKROACH

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

STUDY QUESTIONS FOR MODULE ONE
CHAPTER TWO
COCKROACHES

1. The cockroach that requires the most control effort is the _____
   A. Asian
   B. American
   C. German
   D. Australian

2. American cockroaches like an environment that is _____
   A. Slightly cool, moist
   B. Very warm, moist
   C. hot, dry
   D. lukewarm, average humidity

3. Oriental cockroach populations consist mostly of _____ in the winter.
   A. adults
   B. nymphs
   C. eggs
   D. pupae

4. Cockroaches need _____ to be successful.
   A. food, moisture, harborage
   B. food, moisture, open spaces
   C. warmth, food, cracks
   D. cracks, crevices, food

5. Oriental cockroaches prefer a _____ environment.
   A. moist
   B. warm
   C. high
   D. small

6. Brown-banded cockroaches prefer a _____ environment.
   A. cool
   B. very warm
   C. sanitary
   D. very moist

7. Smokey brown cockroaches prefer a _____ environment.
   A. open
   B. very warm
   C. very moist
   D. high

8. German cockroaches have _____
   A. two bands across their thorax
   B. two stripes on their thorax
   C. light markings on their thorax
   D. short wings.

For Answers refer to Appendix A

CHAPTER 3

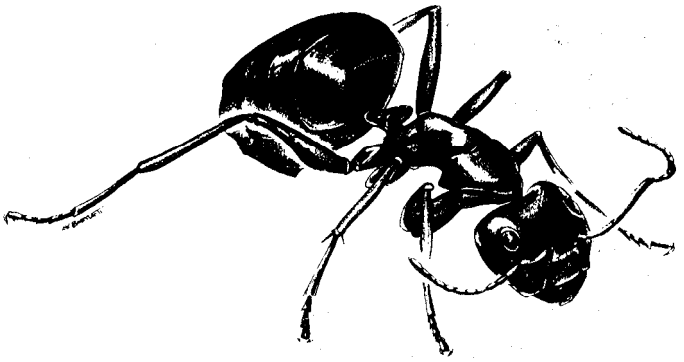
ANTS

Learning Objectives

After completion of the study of Ants, the trainee should be able to:

- Identify key features in the life cycle, habitat and appearance of the common species of ants.
- Given a problem situation for each species of ant, select appropriate control and management procedures including both chemical and non-chemical.

Ants are-the dominant group of social insects. Except for the polar regions, they flourish on all land areas of the earth, from rain forests to deserts. All pest control technicians become involved with ant problems at some point in their career -- most commonly because ants are found foraging or nesting inside structures -- or because swarming ant reproductives are confused with swarming termites.



INTRODUCTION TO ANTS

The Ant Colony

The winged female reproductive mates with a male reproductive either during the swarming flight or on the ground. The male dies shortly afterwards. The female then digs or adapts a cavity, usually in the soil, and walls herself in. At this time, if her wings are not already broken off, she tears them off. She then produces eggs. When the tiny, white, legless grubs (larvae) hatch, they are fed with salivary secretions from the female's stored fat cells and the breakdown of her now useless wing muscles.

After several molts, the larvae change into soft, white, pupae that look like motionless, white adults. Before they pupate, the larvae of some ants (carpenter ants and others) spin a silk cocoon -- a white or tan papery capsule. When the pupae have made all the internal changes for adult functioning, they molt into the adult stage. Adults take on one of three roles or castes of the community: workers (all females), female reproductives, or male reproductives.

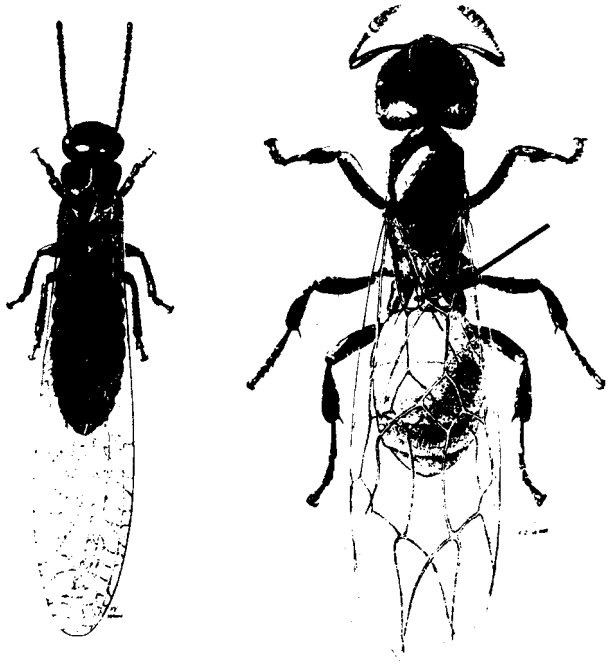
- Males live short lives, they mate and die.
- Ant queens are females. They mate and raise the first brood by themselves. Afterwards, they produce eggs for the subsequent broods that go on to make the colony. They may live many years.
- Workers, also females, tend the eggs, larvae, and pupae. They forage outside for food and enlarge and defend the colony workings.
- Other specialized groups may arise from the worker caste in certain species, soldiers, for example.

Foraging

Ants eat a wide variety of food, including other insects, seeds, nectar, meats, greases, sugars and honeydew. [Honeydew is a liquid produced by plant-sucking insects, such as aphids or plant lice, mealy bugs (groups of small insects with a white powder clinging to them), scale insects, and planthoppers.] These insects feed in groups on plant stems and leaves. Many species of ants protect these aggregations from other insects. Ants are a part of this pattern; they also take drops of honeydew continuously produced by the small sap-sucking individuals.]

Some ant species appear to just wander randomly, others trail each other precisely from colony to food source and back. Ants communicate with each other

using different methods for transmitting messages. Workers foraging for food attract attention and communicate their messages when they return to the colony.



Reproductives Termite (L). Ant (A).
(Arrow indicates narrow waist of ant.)

ANT AND TERMITE SWARMERS

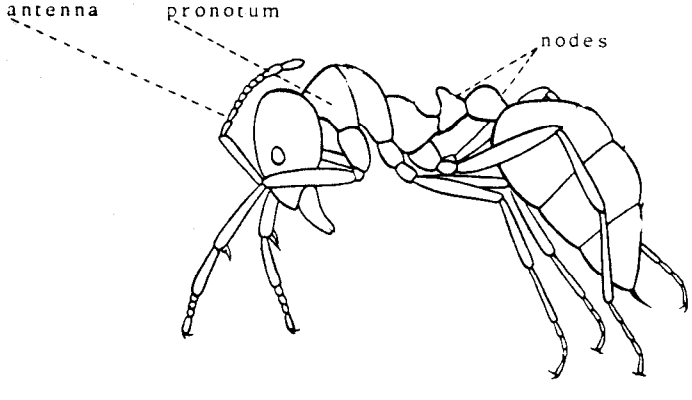
The swarming of small, dark insects near or inside a structure panics people who fear their home is infested by termites. Pest control technicians must recognize the difference between ant and termite reproductives, and communicate it clearly and confidently to their clients.

Principal differences are

- ***Ants*** have a complete metamorphosis, that is, they go through the egg, larva, pupa and adult stages all which have different appearances. Ant workers are adult and look like the adult ant.
  Termites have a gradual metamorphosis. They go through the egg, nymph and adult stages. Nymphs look like adult workers. Reproductives are dark-bodied.
- ***Ants*** have a thin or "wasp" waist between their thorax and abdomen (called the petiole).
  Temite waists are NOT narrow. Termite bodies are straight-sided with no constriction. Thorax and abdomen blend together.
- ***Ants*** have elbowed antennae. A long straight segment connects to the head. Remaining segments flex and bend.
  Termite antennae are entirely flexible. They are made of many small segments strung-out like beads. Termites wave them in front, using them to touch and feel.
- ***Ant*** reproductives have two pairs of wings. The front pair is wider and markedly longer than the back pair. Often ants have a black dot near the tip of the front wings, and dark wing veins can be seen. Ant wings do not break off easily.
  Termite wings are long and narrow; both pairs are the same shape and almost the same length. Termite wings break off with a touch. If termite swarmers have been crawling, their broken wings litter the swarm area. Termite wing veins cannot be seen with the naked eye.

ANT CONTROL AND MANAGEMENT

It is important to note that of the ants found indoors, only a few species are responsible for the majority of infestations; some species are not common but appear sporadically; and other types of ants are found inside only under rare or accidental conditions. While the third group is difficult to prepare for, the first group should be studied, discussed, and control experiences analyzed. The middle group may take an inordinate amount of the pest controller's time, with inconclusive results. These elusive ants may appear several times in one year, then not be encountered for several years. Some are more or less common in some regions and uncommon in others.



The best way to learn about ants is to build a collection and keep it for comparison. Elements important to consider when identifying an ant species and its control plan are:

Size. Ant species have fairly consistent size.

Nodes. Nodes are swollen segments of the petiole (the narrow connection between the thorax and abdomen). Most species have one; others have two.

Color. Color may vary within the same species of ant, but it also can be a useful eliminating factor. Be sure to note the surface appearance of the exoskeleton.

Range. Most ant species are known to occur in a specific region.

An important first consideration in the control of ants is to determine whether:

- the colony is located inside the structure, or
- the colony is located outside the structure.

Indications that a colony is inside are when:

- ant workers are consistently found inside over a long uninterrupted period
- nest building is observed inside [Look for wood shavings of carpenter ants, "dumping" materials of pavement ants, etc.]
- the infestation is located in a highrise building, or
- inside swarming is observed.

Indications that a colony is outside are when:

- ants inside can be "trailed" outside
- ants outside can be seen coming inside
- nesting sites outside are near the structure with an inside infestation [Look for mounds next to the foundation, or trees with large carpenter ant colonies touching an infested portion of the house.]
- ants nest under slabs or swarm inside, but workers do not forage inside.

Whether the colony is in- or outdoors, ants that are known to tend honeydew-producing insects often forage inside before plant insect populations can build-up outside. After populations of aphids, mealybugs, scale insects, white flies and planthoppers become numerous (in late spring), ant colonies nearby put a great deal of energy into tending and protecting these plant-sucking insects. Worker ants foraging inside kitchens and basements often leave houses at this time. They may return in dry weather seeking moisture, but often will not be seen until the next spring. When pest control efforts coincide with this period, it is often difficult to tell whether the pest management procedures are effective, or whether the ants abandoned the structure due to natural habit.

Attend to the following general considerations in developing an ant control plan:

Inspection

- Talk to the client. Get all information possible from the resident.
- Observe ant worker movement and plot on diagram if need be. Look for the focus of the infestation.
- To confirm observations, use traps baited with a grease and a sugar or syrup or other ingredients suggested in pest control references (e.g., peanut butter and cookies).

Inside: Inspect holes and cracks where workers enter, old or new moisture stains, food accumulations (e.g., dry pet food), activity near appliances (e.g., dishwasher and washing machines), under bath tubs, showers, in drawers, corresponding areas in adjoining room or rooms above and below activity.

Outside: Inspect for workers behind vines, shrubs, other plants near house, expansion joints, slabs, patio blocks, bricks, boards, plant pots, under and inside wooden columns and pillars, outside door and window frames, window wells, penetrations of house wall by telephone wires, air conditioning refrigerant pipes, trees that harbor colonies and provide access to houses by overhanging limbs that touch or even scratch shingles; water meters and storm drain inspection manholes. Inspect plants for ants tending aphids, mealybugs, etc.

Habitat Alteration

- Caulk wall penetrations and mortar masonry cracks. Wall penetrations include utility lines, air conditioning, refrigerant pipes, phone lines, etc.
- Tighten door and window frames.
- Repair water leaks.
- Trim shrubbery away from house.
- Remove firewood that is stacked close to house; boards, stones, etc. that encourage nesting; screen openings in hollow pillars, columns, and ventilators
- Control ant-tended aphids and mealybugs with horticultural pesticides, such as oils or soaps.

Pesticide Application

- Consider the species when choosing bait. Use baits with stomach poisons or with insect growth regulators. Baits are excellent in critical areas (e.g., computer or hospital rooms). Do not spray or dust around baits. Never store baits or bait materials where they can be contaminated with any other odors especially fumes of pesticides. ***Ants and other insects can detect minute amounts of foreign or repellant chemicals.***
- Use crack and crevice treatment in areas where a nest is suspected, use dust in wall voids; use canned pressurized liquid pesticides with small diameter crack and crevice device. [Tubing can be obtained in long lengths and can be threaded through construction elements to treat areas distant from the pressurized can.]
- Apply wettable powder or micro-encapsulated spray formulations where pesticides may be absorbed into surfaces.
- Drill holes where practicable (e.g., false floors in sink cabinets, window frames, wall panel grooves, and other voids). Use spot treatments when necessary but be wary of repellant activity.
- Use granules and drenches with registered formulations outside.

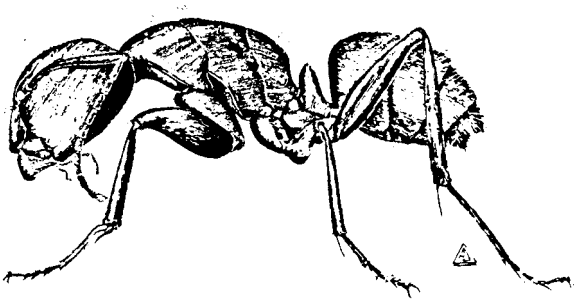
Develop a specific pest management plan. Where large outside areas need treatment (e.g., fire ant problems) do not treat as an extension of a yard problem. Consider spot treatments and perimeter spraying carefully; drawbacks to these reactive treatments include:

- nest areas can be completely missed
- ants move to other areas of activity.

Follow-up

Reinspect or contact clients with troublesome ant control problems within one week to 10 days depending on the control strategies (e.g, baits and insect growth regulators (IGR) take longer than dusts to show results). Remember, pesticide treatments can repel ants and make them active in other areas. Colonies with multiple queens may break up into several colonies.

LARGE ANTS (1/2 Inch or Larger)



CARPENTER ANT *CAMPONOTUS*

There are many species of Carpenter ants in North America; few enter structures to forage; fewer nest in structures. But these two habits (foraging and nesting inside) coupled with their large size and vigorous activity make these invaders impossible to ignore. Two species claim the majority of attention: the Black Carpenter ant of the eastern and southern United States and the Western Carpenter ant, a particular problem in the Pacific northwest. As their name implies, carpenter ants work in wood; they do not digest it.

BLACK CARPENTER ANT
Camponotus pennsylvanicus

The workers range in size from l/4 inch to almost l/2 inch with the queen being 3/4 inch. Outside workers can be confused with field ants (Formica) which do not enter structures. Carpenter ants have an even, smooth, arching profile beginning just behind the head and descending to the waist, or petiole, which has one node. [Field ants and most other ants have bumps or spines along the profile of the thorax, particularly near the petiole.] The Black Carpenter ant's abdomen is covered with gray or yellowish hairs, but the basic black color is still obvious. The head and thorax is also black in the majority of individuals but the sides of the thorax and part of the legs of a few may be dull red. In the northern states where subterranean termites begin to be relatively less common than in the south, Carpenter ants become more obvious as structural pests.

A Carpenter ant colony begins in isolation, but not necessarily in wood. This first brood may be under a stone, in a roll of tarpaper, or in innumerable other secretive spots, but the colony soon moves into wood

(such as a fallen log, tree hole, stump or a structure wall). When Carpenter ant workers excavate nest galleries, they use their jaws as gouges and make tunnels by shaving out small pieces. Unlike termites, they do not eat the wood; it has no nutritional value to them, and they discard it by dropping it out of the nest area or by piling in one place and discarding the whole pile later (similar to the Pavement ant's dumping habit). This pile of Carpenter ant shavings, called sawdust, is very soft and is made up of pieces a fine chisel would make. [Gritty construction sawdust in attics or on sills can be left over from construction or repairs and might suggest carpenter ant shavings to those who do not know the difference.] The process of ant gallery excavation results in galleries with very smooth sides. No mud is involved (like in the tunnels of subterranean termites), and there is no dust or pellets (like that produced by woodborers or dry wood termites) -- only numerous large, smooth, brown-stained tunnels that provide harborage for the Carpenter ant colony. A nest or colony might harbor several thousands of inhabitants. Large colonies of carpenter ants in critical areas of structures can cause structural damage, but the colony more likely resides partially in structural wood and partially in void spaces (e.g., between roofboards, between studs under windows or between subflooring and shower bases).

The most common urban outdoor harborage is a living tree with a rotted spot inside; other common sites are stumps or firewood. The Carpenter ant is a valuable link in the reduction of plant cellulose. It is not surprising that mature wooded neighborhoods often have structural Carpenter ant problems. New neighborhoods or developments built on cleared woodlots can inherit ant colonies from their trees; some colonies are brought in with building materials. Rustic cabins, summer homes, and park structures will likely become infested sooner or later.

Black Carpenter ant workers forage for food such as honeydew, insects, and juices from ripe fruit. Indoors, they like sweets, meats, fruit juices and moist kitchen refuse. [Carpenter ants always prefer to operate in a humid atmosphere.] Vines on building walls, branches, telephone wires provide a bridgelike access into structures.

Control and Management

Inspection

It is important to discover whether Carpenter ants are nesting inside or outside. If nesting inside

- their presence usually indicates a moisture problem in the building, and
- they have excavated galleries for harborage in structural wood.

Moisture problems and Black Carpenter ants are nearly inseparable. In the majority of cases Carpenter ants make their nests in wood that has been wet and infested by a brown rot fungus. Dark fungus stains on the wood is an indication of the presence of such moisture. Moisture in wood can be caused by

- improper attachment of wooden additions, dormers, and hollow wooden columns that absorb moisture
- patios or porch floors, door sills, downspouts, or grading where water collects or drains toward the structure
- regular gutter overflow pouring rainwater down the side of the building as well as back onto roof boards, facia, soffets, etc.
- leaking roof valleys
- improper flashing especially around chimneys, vents, and skylights
- improper roofing or holes in the roof
- window sills directly exposed to rain, or
- lack of ventilation in any area where moisture accumulates.

Inside moisture accumulates

- around any leaking plumbing or drains (especially shower drains)
- unvented attics and crawl spaces, or
- unvented dishwashers, washing machines, icemakers, etc.

The many nesting sites, foraging entrances and food and moisture sources offer clues for inspection and location of the nest. The area where the majority of ant activity is seen may identify a nest site if entry from the outside can be ruled out. Carpenter ants are more active at night and inspection at that time may be helpful.

Harborage Alteration

- Where nests are located inside, remove and replace infested structural wood.
- Stop the intrusion of moisture.
- Advise the client to or perform caulking and screening of actual and potential ant entryways.
- Ventilate areas where moisture accumulates, regrade where necessary and repair roofing, guttering etc.
- Recommend trimming trees where branches touch a structure or overhang roofs. Tree removal may be necessary.

Pesticide Application

Eliminating colonies and nesting sites is a primary way to eliminate Carpenter ant infestation.

- Use pesticidal dust or pressurized canned aerosols when nests are in wall voids. Sprays are less effective.
- With the use of flushing agents, hundreds of ants may remain unaffected and can relocate the colony in a matter of hours or less to trunks, storage boxes, furniture drawers, and other voids.
- When indirect treatment is required, liberal placement of acceptable bait stations can be used.
- Dust, spray or bait can be used on outside colonies (e.g., in tree rot).
- Honeydew-producing insects involved in feeding Carpenter ants should be treated with pesticides that will not eliminate parasites and predators (e.g. oils and pesticidal soaps).
- Trees with rotted places should be evaluated by professionals.

Follow-up

Carpenter ant infestations often cannot be controlled in one visit. Painstaking inspection is needed to make management effective. Annual follow-up also assures that necessary habitat alterations have been made by clients.

Maintain records of all inspection discoveries and subsequent recommendations as well as records mandated by law.

WESTERN CARPENTER ANT
Camponotus modoc

The principal Carpenter ant species in the northwestern states is the Western Carpenter ant. This ant is very similar to the Black Carpenter ant common in the eastern United States.

Appearance

The Western Carpenter ant has a black body with a slight gray sheen. Its abdomen has a thin covering of hairs on each segment like the Black Carpenter ant, but it is less yellow -- more gray. The legs of *C. modoc* tend to be reddish.

Behavior and Harborage

The background of the principal eastern and western Carpenter ants are similar, but the *C. modoc* produces larger colonies. Clean grass trails an inch wide are more prevalent in the northwest than in the east. These trails and other routes of march are extremely active from sunset through the early part of the night.

The Western Carpenter ants have principal colonies in trees and stumps from which they forage. This activity, especially in springtime, brings them into the proximity of buildings. They enter structures through construction gaps, particularly along electric lines.

Control and Management

Inspection

Search for activity in wall voids, around electric outlets, wall panel grooves, under attic insulation.

Habitat Alteration

Management of the *C. modoc* may include

- removal of stumps
- trimming trees
- elimination of infested firewood near the house
- caulking of entrances through wall penetrations
- control of wood moisture
- repair of roof leaks, and the
- construction of vapor barriers in the soil surface of crawl spaces, attic ventilation areas and crawl spaces.

Pesticide Application

Outside:

- Direct flowable microencapsulated formulations or emulsifiable concentrates on foraging paths.
- Inject or spray stumps and decayed spots in trees.
- If needed for immediate control, spray perimeters. [Use care not to contaminate fish, pets, or other outside animals when spraying. Boric acid dust, an effective indoor pesticide, can kill plants outside.]

Inside:

- Dust wall voids.
- Apply pesticides around electric outlets. [Always turn off the main power switch when injecting dust around the outlet boxes; be careful of electrical wires.] Drill 1/4 inch holes for dust or 1/8 inch holes for pressurized canned liquid pesticide.
- Dust under attic insulation, if necessary.

LARGE YELLOW ANT
Acanthomyops

Yellow ant workers are between 1/8 and 1/4 inch long; reproductives are larger. They have one node and are yellow or tan in color. Yellow ant workers and reproductives emit a lemon or citronella odor from the head. This can be detected when the head is crushed. If the abdomen is crushed, a strong formic acid odor is produced.

Workers forage outside in lawns, fields and open woodland. Colonies are sometimes located next to or under basement slabs; in late winter, workers will excavate the soil and enter through cracks in the slab. They commonly pile their anthill on concrete or between cracks in basement floor covering. If undisturbed, many hills may appear. Winged ants occasionally swarm from these hills, but workers do not forage inside.

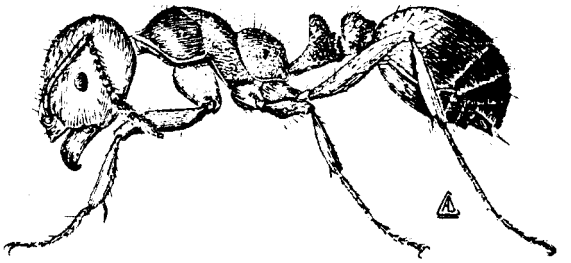
Vacuuming the soil hills is recommended, Treatment of yellow ant hills outside near the building foundation may be indicated in the spring with repeat cases.

ALLEGHENY MOUND ANT
Formica exsectoides

Allegheny Mound worker ants are over 1/4 inch long. These large black and red ants are found in the eastern United States making mounds often up to two feet high. More common in mountains than at coastal elevations, these ants forage actively around their mounds which often are interconnected. They are harmless ants and never forage inside. All efforts should be made to educate the public NOT to destroy these ants.

FIRE ANT
Solenopsis

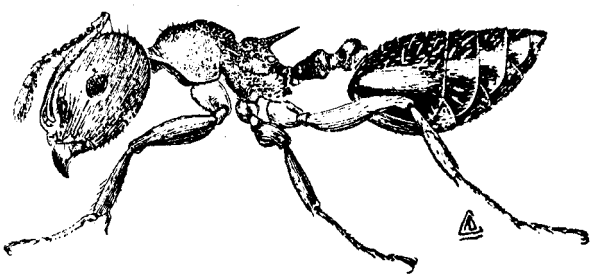
Several species of fire ants will sting. The most common has a reddish color and is a mound builder. Fire ants are found in North Carolina south to Florida and west to Texas. Fire ant controls are recommended by state University Extension offices in each county where they are a problem. These ants are rare in homes.



SMALL TO MEDIUM SIZED ANTS
(1/8 inch or slightly larger)

Acrobat Ants *(Crematogaster)*

Worker ants measure around 1/8 inch long. The ant has two nodes; it is shiny-brown to nearly-black in color. The workers appear to have their abdomens attached ***upside down:*** flat on top, "bellied" below, and pointed at the tip. When excited they point their abdomens up or even over their heads, hence, their name. Acrobat ants are common over most of the United States. There are many species.



Acrobat ants tend aphids and mealybugs for honeydew and also feed on other insects. They usually establish their colonies in or under rotting logs and stumps in nature and sometimes live in abandoned carpenter ant galleries if the wood is damp enough. They can also engrave their own small galleries in wet roof boards, house siding, porch rafters, pillars, sill plates, any part of a structure where the wood does not completely dry out. Like Pavement ants, Acrobat ant colonies occasionally dump their refuse. It consists of tiny wood shavings like those of the Carpenter ant. [The difference between Acrobat ant and Carpenter ant shavings is that those of the Acrobat ant are smaller and always dark stained from fungus.] Acrobat ants may feed inside in kitchens.

Inspection

Look where structural wood has been subjected to water leaks:

- the porch roof near the house, porch floors, siding where gutters overflow, ends of rafters in the shade, sills, and

window and door casings where rain water hits, or

- older buildings and historical buildings that haven't been kept up. [Fungus or rot problems are very likely more important here than ant damage.]

Habitat Alteration

- Remove and replace damaged wood.
- Change grade and redirect downspouts that pitch water toward structural wood.
- Clean or replace gutters.
- Trim overhanging tree limbs that keep wood from drying.
- Move logs, stumps, leaves and grass clippings away from structures.

Pesticide Application

Habitat alterations will usually stop the problem. Use contact sprays if needed.

Follow-up

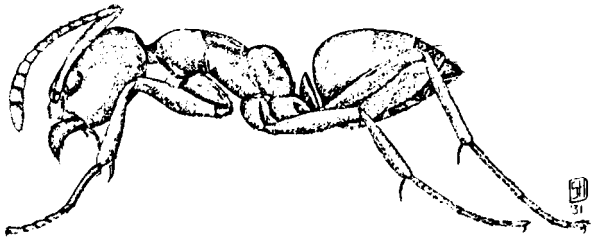
Susceptible structures, especially buildings with historical significance should always be periodically monitored. Detailed records concerning pest infestations, treatments and repairs should be kept on file.

Other small to medium-sized ants are the Small Honey Ant *(Prenolepis imparis)*, Corn Field ants *Lasius species)*, and the Velvety Tree ant *(Liometopum occidentale)*.

SMALL ANTS
(around 1/8 inch long)

In this group of ants the workers are larger than the tiny ants, but well under 1/4 inch in length. Several interesting structure-infesting ants are in this group.

THE ARGENTINE ANT
Iridomyrmex humilis



This slender ant is about 1/8 inch long; it has only one node; it is light to dark brown with a silky shine; the head is triangular or heart shaped. As it's name indicates, it was introduced from South America. Its habits in its primary continuous range -- from the Gulf Coast to southern California -- is different than in isolated urban centers in other parts of the United States.

In the primary range, these ant populations are intense. They constantly infest and reinfest structures and agricultural land (e.g. citrus orchards and cane fields). Argentine ant colonies are often large and compatible: Workers and queens of different colonies are not antagonistic toward each other; foragers maintain vigorous trails that often coalesce with those of other colonies. Argentine ants tend honeydew-producing insects, protect them from their predators, and are known to move aphids to other plants where they begin new infestations. They will not tolerate other species of insects, especially other species of ants, within their foraging range. Argentine ants seek sweets: outdoors -- honeydew from insects and plant nectar; indoors -- juices, sugar, and syrups.

Populations have been introduced in urban areas outside the primary range with the transfer of plants and household goods; these infestations are smaller and local. This secondary distribution includes many southern cities where exterminations and reintroductions proceed on a case-by-case basis. Other more northerly cities (where the Argentine ant is established but not a primary problem ant) include St. Louis, Chicago, Baltimore and probably other areas where it has not been recognized. They usually do not overwinter outside in these areas.

Inspection

In the Primary distribution area where Argentine ants commonly infest the majority of structures, make every effort to locate nests outside near the infested structure. Outside:

- Inspect soil area next to foundations especially moist soil.
- Survey for colonies of honeydew-producing insects.
- Inspect shrub stems and under plant leaves.
- Follow ant trails and identify nests, food, and active entry points into structures.
- Inspect nearby manholes and steamline tunnels.

Inside populations tend to be relatively small, less active, and can be eliminated temporarily. Locate the

most active areas. Decide whether the activity is because of a food source or an entry point. Inspections for Argentine ant in urban areas outside the primary range requires closer inside inspection. Often the nest and entire population is within the area of activity.

- Beginning with the problem location, first inquire whether the resident has used pesticides that may have spread the population or repelled them from another area.
- Ask if goods have been brought in from other infested structures in the past year.
- Inspect for moisture sources and sweet food sources. Use non-toxic sweet bait cups if necessary, and make close inspection in the kitchen and adjoining rooms,
- Inspect steamline tunnels connecting buildings.

Habitat Alteration

- Recommend trimming back shrubs and other plants next to foundations to facilitate inspections and ventilation.
- Reduce sources of water that contribute to moist soil.
- Eliminate plants that support honeydew-producing insects if possible (e.g. citrus, bamboo, oleander, cherry laurel, fig). Replace with low maintenance plants or recommend treatment of aphid, scale insect, mealybug and planthopper colonies with low-toxicity sprays registered for use on plants.
- Caulk ant entryways into structures such as foundation cracks, openings under siding, frames around windows and doors, wall penetrations of wires, plumbing, etc.

Pesticide Application

Outside:

- Drench nests according to insecticide label directions.
- If indicated, granules can be applied next to structure foundations and along infested pavement and watered in.
- Residual dusts and sprays can be used at known entry points.

Inside:

- Available registered sweet baits either toxic or with growth regulators can be applied according to label recommendations. Use baits that will be taken back to the queen and larvae. Baits are more effective during periods of low honeydew production.
- A treatment with residual dusts and sprays should be thoroughly applied in cracks and crevices. Some dusts applied in cracks and crevices (boric acid) and some micro encapsulated pesticides are transferred in the nest by preening of other workers, but this method alone may not control a population.
- Isolated spot treatments can be used but ants are easily repelled by some pesticides. Concentrate pesticide applications only in the area of ant activity.

Follow-up

Ongoing monitoring is recommended where Argentine ants are recurrent problems. Monitor for honeydew-producing insects as well as for ants.

Little follow-up is necessary after treatment of isolated infestations outside the area of primary distribution. Repeat precautions on bringing in goods from known sources of infestation without first inspecting them.

THE PAVEMENT ANT

Tetramorium caespitum

Around 1/8 inch long, the Pavement ant has two nodes. It has a shiny abdomen but a dull red-brown head and thorax; the abdomen is darker, legs lighter. Common along the Atlantic seaboard, it is less common in the southern states. This ant is found as well in cities in the midwest and California. The red-brown head and thorax are dull because of minute, parallel furrows found on the front and sides.

Pavement ants nest outside under rocks, at the edge of pavement, door stoops and patios. They

commonly move their colonies inside between the foundation and sill plate. Outside, pavement ants tend honeydew-producing insects, and feed on other insects and seeds.

Pavement ants store debris in certain areas of the colony or nest. When this area is needed for nest expansion, workers clean out the junk accumulation and dump it. Colonies located on foundation walls drop debris over the side in a pile on the basement floor. The ant dump consists of sand, seed coats, dead insect parts, and sawdust from the house construction. Not knowing the source, householders often view these dumps with alarm.

A closely related species with good trailing habits and rapid movement is commonly introduced with tropical plants and flourishes in warm moist environments.

Control and Management

Inspection

- Inspect along sill plate in basement, around heat ducts and baseboards in areas where ant workers are active.
- Look for foraging in the kitchen; such activity may indicate a nest in the basement below or just outside.
- Outside, look for tiny mounds next to the house near windows and doors or nest openings under stones.

Habitat alteration

- Remove stones that are sheltering ants.
- Recommend indoor sanitation including the elimination of moist garbage in dry weather.
- Caulk observed ant entrance points.

Pesticide Application

Inside:

- Apply dusts or sprays in cracks and crevices of baseboard molding where activity is noticed.
- Treat cabinet cracks around kitchen sinks.

Basement:

- Treat cracks along foundation walls, under sill plates, and cracks near heat ducts.
- Be careful not to contaminate heat or air conditioning ducts.
- Treat cracks in slab on-grade foundations as well as the base of outside door jambs.

Outside:

- Treat nests, Use pressurized gas aerosols to penetrate nest galleries.
- Treat cracks and entry points.

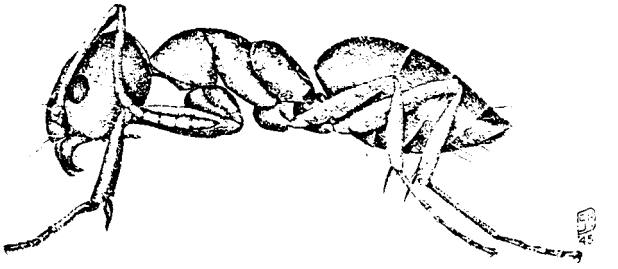
Follow-up

Follow-up is usually not needed, but where control is not achieved, an intense inspection is indicated.

THE ODOROUS HOUSE ANT
Tapinoma sessile

This ant, slightly broad, measures around 1/8 inch long; it has one node, is dark brownish-gray in color and covered with a velvety sheen. It can be found from Canada to Mexico including all of the lower 48 United States. It is the most common ant found in structures in North America, except for the Argentine ant within its primary range (the Gulf Coast and southern California).

The body of the odorous house ant is relatively soft and can be easily crushed. When this occurs, a foul odor is released. The single node of the petiole is very small and hidden by the overlapping abdomen. [This identifying characteristic is best seen by crushing the soft ant and with a good hand lens noticing the absence of a distinctive node.] From above, the abdomen is broad compared with the width of the thorax.



An average colony will have 3-4,000 members and several queens. Outdoor nests are shallow and are located under stones and boards. Inside, a colony can nest in many types of cavities.

The workers trail each other. Outside they actively tend honeydew-producing insects and take flower nectar. Inside, workers seem to prefer sweets. In California, workers forage indoors late in the warm season and during rainy spells, possibly in response to reduced sources of honeydew.

Control and Management

Inspection

- Begin by investigating locations where ant activity is observed.

- Pyrethrins can flush ants causing them to rush around erratically, excitedly elevating their abdomens. [This could cause the colony to split itself and relocate, as with the Pharaoh ant.]
- Always inspect outside close to the location of inside activity. Look under stones and boards for colony openings and activity.

Habitat Alteration

- Remove stones and boards harboring odorous house ant colonies.

Pesticide Application

- Use dusts or residual sprays applied in cracks and crevices in the area of entering worker trails. [Any ant exhibiting strong affinities to the outside environment (honeydew insects, flower nectar) and with nesting mobility (shallow nests, cavity nests, utilization of protective objects) should be sought outside as well as inside, unless its locality inside precludes its reaching the outside.
- Control populations of honeydew-producing insects on plants near the structure.
- Use pesticides registered for the insects on plants. To maintain parasites and predators of these plant insects, use low-toxicity pesticides such as insecticide soaps and oils.

Follow-up

Impress the client with the need to control honeydew insects on plants and to eliminate nest harborage near structures.

THE CRAZY ANT

Paratrechina longicornis

This ant has a very slender body about 1/8 inch long; it has only one node; and is glossy dark-brown, nearly-black in color. It can be found along the Gulf Coast from Florida to Texas and in some scattered locations in all states. It is common along the eastern seaboard in the middle Atlantic states.

The Crazy ant is unique in appearance. The antennae and hind legs are each as long as the body. These ants do not trail each other, but large numbers follow pathways along foundation walls, pavement, and such. The Crazy ant gets its name from its rapid, jerky gait; in large numbers it runs so rapidly, it is impossible to focus on a single individual. Some colonies become immense and have been observed both outside and inside throughout an apartment complex. Populations fluctuate during the summer rebounding after wet weather, declining during dry weather. Crazy ants accept broad menus of food including insects and especially enjoy concentrations of house fly larvae, garbage and kitchen scraps.

Colonies have been repeatedly introduced to the United States with plants from South America, Puerto Rico, and the Philippines. Colonies exist outside in the southern United States and commonly overwinter in buildings and manholes in the northern portion of its range along the Atlantic and Pacific coasts.

Inspection

Crazy ant infestations quickly call attention to themselves by their activity.

- Inspect manholes, crawl spaces, window wells, refuse piles.
- Inside, inspect garbage rooms and kitchens as well as apartments.
- Give special attention to entry through doors and windows on ground floors.
- Investigate connections such as pipe chases between kitchens and garbage rooms.

Habitat Alteration

Recommend the highest standard of sanitation both in homes, commercial food services, and food processing establishments.

- Always ‘leave food areas clean after work.
- Recommend garbage schedule control (dump before dark) and cleaning of garbage rooms, garbage cans, and dumpsters and their surroundings.
- Caulk and tighten-up around doors and windows and low wall penetrations.

Pesticide Application

- Granules around foundations and dumpsters can be applied and watered-in to give initial population suppression.
- Residual pesticides alone, or fogs in garbage rooms and food areas that are not also cleaned up, will not control large populations.
- Baits are helpful.
- Crack and crevice application must be thorough.
- Spot treatment around doors reinforce other control and management efforts.
- Dusts in infested manholes and other protected voids kill large numbers.

Follow-up

Large Crazy ant infestations need to be followed and treated until the population is controlled. Monitor areas that support high populations such as garbage rooms, etc.

TINY ANTS
(about 1/16 inch long)

THE PHARAOH ANT
Monomorium pharaonis

A tiny ant, not much more than 1/16 inch long, the Pharaoh ant has two nodes. Its head and thorax are dull-yellowish to light-orange or little darker. It has a shining dark abdomen, especially at the end.

It is found in most urban centers in the United States. Pharaoh ants prefer warmer buildings and warm areas (80-85 F.) in buildings for nesting. These ants are active year-round in houses and portions of large buildings such as hospitals, office buildings, laboratory buildings, etc. Nesting sites include wall voids, cracks in woodwork, stacks of paper, envelopes, bed linens, bandage packs, harborage in desk drawers, etc. It is common to find many colonies in one building and, perhaps, several in one room. Colonies have multiple queens and increase by dividing: one portion of the colony going with each queen. No swarms have been recorded, so new infestations are apparently transferred by moving infested objects.

Pharaoh ants trail each other and are attracted to grease, meats, insects, and sweets. These harborage and food preferences bring it to coffee areas, kitchens, paper and other supply storage, office equipment, medical storage, laboratory benches, many kinds of biological cultures including insect-rearing chambers, hospital rooms with wound or burn patients; the ants have turned up in I.V tubes, medicine droppers, and bandage stacks.

Control and Management
Inspection

- Inspect where sanitation is slipping.
- Ants are found where food is available, particularly sugars: where coffee is made, lunches eaten, especially in desks where snacks are stored.
- Inspect storage room spills, laboratory media, culture and formula preparation rooms, nurses' stations, unwashed cups, and coin machine canteens, and kitchens frequented by children.
- Use small disposable peanut butter baited cups to demonstrate where ants are most prevalent (e.g. desk drawers, opened food boxes). [Pharaoh ants are easily baited.]
- Look at water sites. [These ants are attracted to dripping faucets; they drown in plant water bottles and coffee water held overnight. Floating ants are frequently the first sign that these ants are present.]

Habitat Alteration

- Reduce stored supplies.
- Clean, rearrange, and rotate supplies to expose nests.
- Clean food areas before the end of the work day or bedtime and empty water containers that stand overnight.

Pesticide Application

Several baits are available for Pharaoh ant control. Place a bait station where every positive monitoring trap was located.

- Set commercial bait stations. One that uses a stomach poison well accepted by ants, and a grain-based bait that includes ground insect exoskeletons are

specifically manufactured for Pharaoh ant control. [These bait stations can be placed in desks and used in hospital rooms and laboratories.]

- Use a mixture of liver extract (or strained-liver baby food), angel food cake and honey or syrup with a registered growth regulator or boric acid powder. This bait can be placed in small cups, screened vials or injected into cut drinking straws using a food baster. Mix to a usable consistency.
- Use a commercial preparation of mint apple jelly and boric acid; ingredients can also be purchased separately and mixed. Place the preparation on pieces of masking tape for easy retrieval.
- Apply sprays or dusts in cracks and crevices when preferred. All potential harborage near positive monitoring locations should be treated thoroughly.

Follow-up

Reinspect by monitoring bait cups. When sprays or dusts are used, or when colonies are disturbed by inspection or habitat alteration, colonies may move or split.

OTHER STRUCTURE-INFESTING TINY ANTS

THE LITTLE BLACK ANT

Monomorium minimum

This little ant is no more than 1/16 inch long; it has two nodes and is shiny black; the ant is widely distributed in the United States especially in the northern and eastern States and southern Canada. It normally nests outdoors and tends honeydew-producing insects.

THE THIEF ANT

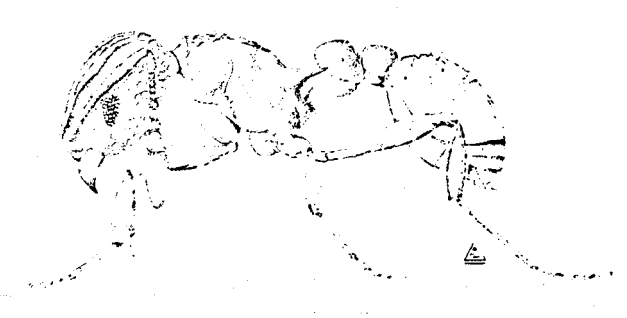
Solenopsis molesta

Less than 1/16 inch long, the Thief ant has 2 nodes and is shiny with a yellowish or slightly darker color; it is widely distributed throughout the United States, especially in the eastern and southern states. The Thief ant nests both inside and outside and tends honeydew-producing insects.

THE LITTLE FIRE ANT

Wasmannia auropunctata

The Little Fire ant is less than 1/16 inch long with two nodes and two spines near the hind end of the thorax. It is not shiny and is yellow to brown in color with a darker abdomen. The ant is established in localities in Florida and California. It usually nests out-of-doors, tends honeydew-producing insects, and feeds on insects. This tiny ant can sting and sometimes infests bedding. It is not related to fire ants and does not make mounds.



SUMMARY

Ants are the dominant group of social insects. Their relatives are bees and wasps, some of which also have social habits. All of these insects undergo complete metamorphosis. Ants have three principal castes: the female reproductives, the male reproductives, and female workers. Each caste has different tasks and behavior. Ants, being social, live in colonies. A single female starts the colony after being fertilized by males. Most of the offspring of this female (often called the queen) are also female and they do the work of the colony such as food gathering and rearing the young (larvae and pupae). Many ants tend insects that suck plant sap and produce a liquid that ants eat. Many species also have a broad diet, feeding on other insects, sugars and greases; their habits may change seasonally. Most ants have subterranean colonies and do not enter buildings, but some can live outside or set up their colonies inside. One species, the Pharaoh ant lives inside almost exclusively. Knowing the behavior of the common ant species will help to decide the control measures needed to suppress pest ants.

STUDY QUESTIONS FOR MODULE ONE
CHAPTER THREE
ANTS

1. Ants and termites are both closely related social insects.
   A. True
   B. False

2. The ant species that almost always has its colony inside is _____
   A. Carpenter ant
   B. Pharaoh ant
   C. Fire ant
   D. Odorous House ant

3. Carpenter ants make galleries in wood which is also one of their principal foods.
   A. True
   B. False

4. The ant caste system consists of _____
   A. workers, drones, soldiers
   B. soldiers, workers, reproductives
   C. male and female reproductives and workers
   D. larvae, pupae, adults

5. Ants found inside a structure always come from a colony that is located inside.
   A. True
   B. False

6. Ants forage for _____ to sustain themselves and the colony.
   A. honeydew, greases, sugars and insects
   B. wood
   C. honeydew alone;
   D. pheromones

For Answers refer to Appendix A

CHAPTER 4

STORED PRODUCT PESTS

Learning Objectives

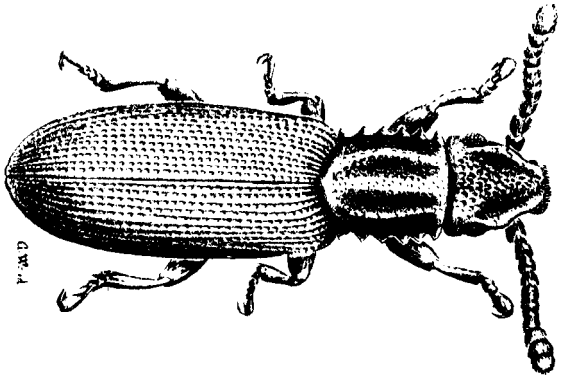
After completion of the study of Stored Product Pests, the trainee should be able to:

- Identify common stored product pests.
- Identify factors that contribute to pest infestations in stored products.
- List the key features in the life cycle and habitat of common stored product pests.
- Discuss monitoring and survey techniques for stored product pests including pheromone use.

Stored products can be infested at every point from their origin to final use; in:

- the field, where the product is grown, picked, or harvested
- storage bins or granaries, where it is held until sale
- mills, where it is ground, mixed, or packaged
- warehouses, where it is held for use or redistribution
- food processing plants, where it is added to other products (e.g., candy, pet food, baking mixes)
- food serving establishments, where it is prepared for public consumption
- retail food stores, where it is sold, and in pantries and cupboards, where it is held for use.

The most commonly attacked products are cereal grains, spices and nuts. Less commonly attacked are dried fruits, candy, rodent bait, dried dog food, dried decorative flowers and such diverse materials as museum artifacts, cosmetics, and drugs. Old, neglected, or hard-to-reach products provide the greatest potential for infestation and reinfestation.



CONTROL AND MANAGEMENT

Inspection

In large facilities, a pest control technician will want to become familiar with the entire operation before making an inspection. The pathway a product takes is vitally important to detection. Pests can occur in machinery, stacked products, waste dumps, delivery spills, etc. In homes and retail businesses, excess clutter, bad lighting, storage areas with blocked access, and rooms located above or below infested materials are special target sites.

- All inspections should be conducted with strong flashlights. A knife, a good hand lens, screwdrivers and mirrors are also useful equipment.
- Flushing agents can be used, but care must be taken not to contaminate foodstuffs.
- Special attention should be given to all spills. Check for pests, cast skins, and tracks in spilled products or dust.
- Inspect the back of pantry shelves, floors under shelves, and all dark areas.
- Pheromone traps, available for nearly all stored product pests, should be used where routine inspections are made.
- Keep detailed inspection records. Written inspection findings and recommendations for changes by management or maintenance must be clear.

- Be safe. Use bump hats and be careful of heat machines, and electrical hazards.

Habitat Alterations

- Institute a good ongoing cleaning program. Pesticide use without cleaning will not control stored product pest infestations.
- Caulk cracks (especially wall penetrations) that communicate with other rooms.
- Screen out birds and rodents.
- Recommend good lighting.
- Stop and repair moisture problems.
- Point out areas that need ventilation.
- Recommend reduction of clutter and excess product in cabinets or storage.
- Collect and discard old rodent bait.
- Maintain alleys or inspection paths between stacks of products and between products and walls. [Have them painted a light color.]
- Install air curtains at doors to keep out flying insects.
- Recommend rotating stock.
- Recommend storing materials that are not commonly infested (e.g., animal bedding, paper products, canned goods) away from infestible products.
- ***Discard infested materials.*** [Sanitation is the primary method of population reduction where infested stored products are found.]

Pesticide Application

- Pesticides registered for use in the infested area should be carefully applied to cracks and crevices.
- Apply spot treatments only in areas where there is an obvious and immediate need to kill migrating insects.
- Install insect electrocuters properly to attract flying insects.
- Investigate pheromone trapping for killing in conjunction with other methods.

Follow-up

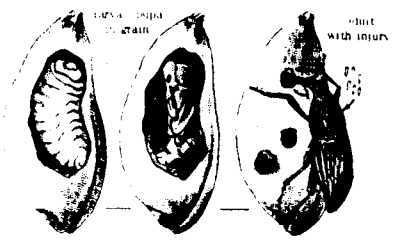
Ongoing monitoring and inspection plans should be put into effect in all food handling establishments. A complete pest management program is recommended for these operations. Clear communication with clients is important. Recommendations on cleaning and sanitation should be evaluated continuously.

PESTS OF WHOLE GRAINS AND SEEDS

Most stored product pests feed on readily-available starch of broken or ground-up seeds and grains. Few species can chew through the strong seed coat or place eggs inside intact grains. Pests that can are: the rice and granary weevil, the Angoumois grain moth, the lesser grain borer, several species of seed beetles, or pea and bean weevils in the family *Bruchidae.*

RICE WEEVILS AND GRANARY WEEVILS
Sitophilus oryzae and *Sitophilus granarius*

These two similar snout beetles are found in stored whole grain throughout the United States. Adult beetles have snouts with jaws (mandibles) at the tip. With these jaws, females chew holes in the grain and deposit eggs. Larvae devour the inside of the seeds, pupate, and later, emerge to renew the cycle. ***Rice weevils*** (common in the southern states) can fly. ***Granary weevils*** (more common in cooler climates) cannot fly. These two weevils are more common in granaries and mills than in stores and homes, but they infest a wide variety of cereal grains and seeds that are found in storerooms, pantries, garages, and other storage sites. [The word "weevily" is still used in general reference to infested grain products whether or not the infesting pest is a weevil.]

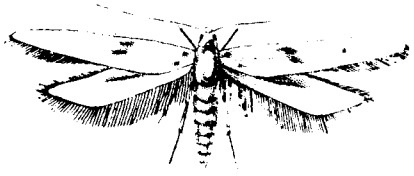


Another weevil with a much longer snout infests acorns, pecans and hickory nuts. ***Acorn*** weevil larvae leave the acorns and nuts to pupate. When infested nuts are brought inside, fat white larvae often escape and wriggle across tables, floors, etc.

ANGOUMOIS GRAIN MOTH
Sitotroga cerealella

This buff, tan, or golden moth, with a wing span of 1/2 inch, is larger than the common golden-colored clothes moth. With wings folded it is more than 1/4 inch long. The Angoumois Grain moth is most commonly found in whole corn in the south and midwest. Like the weevil, it is more often a problem

in grain storage; but if whole corn is brought into homes or stores, sooner or later these moths are likely to become pests and fly about.



LESSER GRAIN BORER
Rhyzopertha dominica

A small cylindrical brown beetle about 1/8 inch long, this beetle is an important damaging pest of grain in storage or transport (trains, ships, etc.). Like many of its relatives (the *Bostrichids,* most of which are wood borers), the Lesser Grain borer has strong jaws and can chew through seed coats into grain where it completes its life cycle. This beetle is rarely a problem in urban homes or stores.

SEED BEETLES OR PEA AND BEAN WEEVILS

These beetles are not true weevils and do not have the weevil snouts. They infest only the seeds of one large plant family, the Legumes: peas, cowpeas, most beans (including mung beans). Each of these pests specializes in seeds of only one kind.

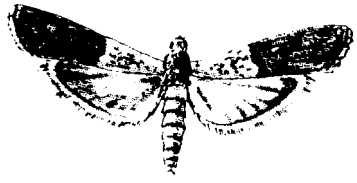
Most species measure 1/8 to less than 1/4 inch long. They are rather broad and have light and dark markings. They lay eggs on beans; larvae bore inside, devour the middle, then emerge through obvious 1/8 inch holes. The pest can be a problem in restaurants and homes. Infested and potentially-infested legume seeds should be discarded.

PESTS OF GROUND, MILLED, OR PROCESSED GRAIN, SPICES, SEEDS AND NUTS

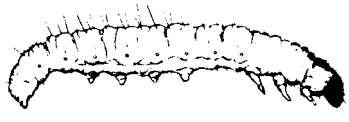
This large group of pests [Some are called, "bran bugs."] infests stored products that have seed coats that are broken or removed by processing. [Potential infested products are listed with each species.]

INDIAN MEAL MOTH
Plodia interpunctella

The Indian meal moth is a small colorful moth. Sitting on a wall, it is 1/3 inch long (somewhat longer with wings folded backward). The head and thorax is brown; the basal half of the wings are gray, and the last half coppery with dark bands. These moths can fly short distances indoors. Active flight for several days wears off most of the colored scales, but their gray band and coppery scales can be seen using a hand lens.



Larvae, or caterpillars, grow to be about 1/2 inch long, cream colored (sometimes pinkish or greenish) with a brown head. Although not easily seen, fairly long hairs grow sparsely on each larval segment; when the larva is in a dusty environment, small particles will stick to the hairs. The Indian meal moth's life cycle is about two months.



Infestations in packaged products numbers; the longer the product is kept without use the larger the population grows. Larvae spin silk from their lower lip wherever they go. In large numbers, they can cover the top of a product with silk as they wander around on the surface. As a population grows, larvae may wander outside the package [often for long distances: from a room in lower levels, through holes in the floor into upper areas, from a pantry to the ceiling]; they may dangle from ceilings on silk strands. Their numbers, wandering habits, and large size easily distinguish Indian Meal moth larvae from the tiny Clothes moth larvae that do not wander openly. A pheromone that specifically attracts the flying Indian Meal moth is a very effective monitoring tool to use in warehouses and food service or retail sale food stores; in large areas, pheromone trap results reveal infested areas.

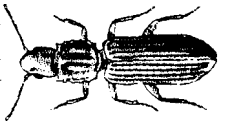
Indian meal moths infest most milled or ground cereals such as flour and cornmeal; all starchy processed products such as crackers, cake mixes, pasta, dog food, and rodent bait. They particularly respond to nut meats like pecans and walnuts, nuts in candy, powdered milk, some spices, and dried fruit. Products stored or unused for a long time are always primary suspects for infestations.

Control and management of these pests is the same as that for the Saw Toothed Grain Beetle (see below).

SAW-TOOTHED GRAIN BEETLE
Oryzaephilus surinamensis

The saw-toothed grain beetle is a tiny, slender, dark-brown beetle that measures a little under 1/8 inch long. With a good hand lens, a pesticide applicator can

identify three ridges that appear as fine lines on top of the thorax with six fine teeth on either side. Eggs are deposited on infested food and hatch into tiny white larvae.



At full growth, larvae are slightly smaller than the adults. They become covered with the material they infest and appear to be very small lumps. (Pupae are equally inconspicuous.) Larvae do not leave the infested material. Adults do, and while they do not fly, they wander in conspicuous numbers in the same vicinity as the infested material. [A similar species is the Merchant Grain beetle.]

Little harborage alteration is indicated. Older products will produce large populations simply because more generations develop over time. Sawtoothed Grain beetles infest the same materials as the Indian meal moth. Likewise, finding the infested product and cleaning the area of infestation is of prime importance.

Cockroach bait stations with a grain base may be useful in attracting and killing these beetles. [Capture in these bait stations may be the first indication of beetle infestation.] Pesticide sprays are of little use when infested material is discarded and cracks and crevices cleaned. Follow-up normally is not needed.

CABINET OR WAREHOUSE BEETLES
Trogoderma species

In the same family as Carpet, Hide, and Larder beetles (see Fabric Pests, Chapter Five), *Trogodema* and closely-related species (Cabinet, Larger Cabinet, and Warehouse beetles) principally infest grain-based products. One species, the *Khapra* beetle, is a very serious grain pest; routine federal quarantine inspections are made to prevent its entry and establishment in the United States. It has been known to build-up in large infestations.

Trogodema adult beetles range from 1/16 inch to about 1/4 inch in length. They are about half as wide as long, which gives them an oval appearance. Their base color is black with three reddish-brown, golden, or gray irregular lines across the body. Larvae are stout and capsule-shaped; their segments are seen as stripes across the body.

Species that infest processed grain can be found in warehouses, storage rooms and homes. These beetles commonly infest cereal, spices, rodent bait, dry dog food, wheat germ and other processed cereal products with a high-protein content.

Inspection

- Give special attention to products with a long shelf life such as dry animal food; large pest populations can build up because more attention is given to the rotation of more perishable products.
- Make extensive inspection to locate all infested material.

Habitat Alteration

- Advise intensive cleaning of warehouses and storage rooms.

Pesticide Application

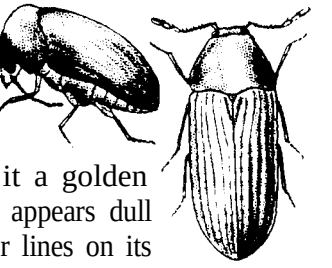
- Limit use of pesticides registered for food areas to application in cracks and crevices.
- Fumigate mills or warehouses as needed.

Follow-up

Set up regular monitoring programs in warehouses and food storage areas. [Pheromones for stored product infesting beetles are very helpful in such programs.]

CIGARETTE AND DRUGSTORE BEETLES
Lasioderma serricorne, Stegobium paniceum

These beetles are similar in appearance; while related to some wood borers or Powderpost beetles, their habits are quite different. Adult Cigarette and Drugstore beetles oval, about 1/8 inch long and reddish-brown in color; they can fly. The Cigarette beetle is covered with tiny hairs that give it a golden sheen. The Drugstore beetle appears dull and darker because of deeper lines on its wing covers.



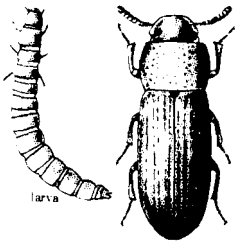
Larvae are tiny, white, curved, and covered with infested material causing them to look like tiny lumps of the stored product. They are difficult to detect unless the product is dumped and sifted.

These beetles are commonly found in spices (paprika, ground pepper, ginger), milled cereals (flour and cornmeal), dry dog food, cosmetics, drugs, as well as some human poisons, pyrethrum dusts, and dried flowers (through the glue that attaches the flower head to wire stems). In homes, spices are favorite foods, especially paprika.

Locate the infested material (beginning with spices) and discard all infested products. Follow-up is seldom needed.

FLOUR BEETLES
Tribolium castaneum and *T. confusum*

Two common species of similar flour beetles infest dry milled cereal products in flour mills, retail food stores, and homes. Other closely related species are found from time to time, but the two that are best known are the Red Flour beetle and the Confused Flour beetle. These beetles are about 1/8 inch long, reddish-brown in color, with short, stout antennae. Larvae are slightly longer than adults, creamy-white, with few hairs.



Only those flour mills with the most thorough cleaning programs keep populations of Flour beetles low. [These beetles can live on flour spills.] Packaged milled cereals such as flour, cornmeal and cake mixes bought in large quantities may be stored long enough to allow eggs or larvae that have slipped through the milling and packaging process to develop.

Control and Management

- Inspect processed flour products and discard those that are infested.
- Recommend a sanitation and cleaning program for mills.
- Recommend that stored products be rotated, bought in smaller quantities, and older packages discarded if use is not planned.
- Follow-up in homes is usually not needed. Retail food stores and warehouses should have ongoing monitoring programs.

SPIDER BEETLES

A number of species of these small, oval beetles are scavengers on stored products. Spider beetles range in size from less than 1/8 inch long to nearly 1/4 inch long. They have long legs and antennae. Their abdomens are usually oval and much larger than their head and thorax combined. Most species have short hairs covering their thorax and wing covers; several common species have shiny, hairless, globular wing covers making them look like large mites.

Spider beetle larvae are white and grublike. Pupae are enclosed in silk cases covered by the materials they infest; they look like lumps of the stored product.

The variety of foods they infest is inexhaustible: flour, cornmeal, all broken cereal grains, fish meal, seeds (including tobacco seeds), spices, dried fruit, dog biscuits. In museums they infest skins, hair, wool, feathers, textiles, insect specimens, leather goods, brushes and wooden artifacts. Other materials include soap, rat, mouse, and house fly manure, mammal and bird nests, decaying animal and vegetable refuse and even opium cake.

Inspection

- Use sticky traps or cockroach monitors.
- When small infestations of spider beetles are found, search for their source.

Habitat Alteration

- Discard the product source; clean thoroughly.
- Eliminate all clutter and unused products.

Pesticide Application

- Apply spot treatments in cleaned, non-food areas.

Follow-up

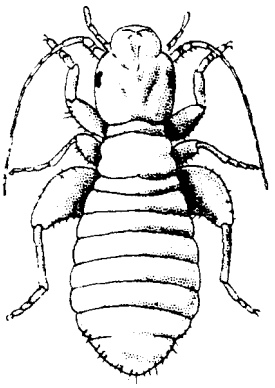
A monitoring program using sticky traps should be followed until the population is eliminated.

PESTS OF MOLDY, DAMP, OR OUT-OF-CONDITION GRAIN AND GRAIN PRODUCTS

Milled or ground cereals and cereal-based products become heavily infested with fungi and bacteria when their moisture content is high. Many insects feed on the decaying organic matter that involves starches, proteins, certain vitamins, and other chemicals produced in the process of decomposition by microorganisms. Spoiled products may include animal foods, milled cereals, flour spills, caked milled grain. Pests can be found in unclean grain storage elevators, barns, and mills as well as in kitchen pantries and cabinets with moisture leaks or ineffective ventilation. The infesting pests are scavengers whose nutritive requirements are met by fungal-infested cereal products; they can develop into large populations. These pests include grain beetles, mealworms, and mites. Two merit special attention:

PSOCIDS

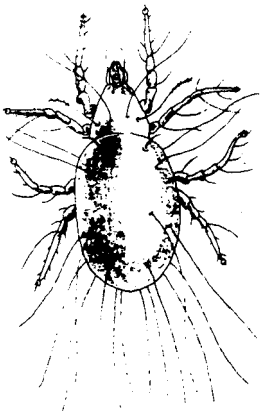
Psocids are tiny, pale gray or yellowish-white, wingless, soft-bodied insects little more than 1/16 inch long. They feed primarily on mold that grows on decomposing starchy materials. Psocids are sometimes called "book lice" because they are found in great numbers on books and papers sized with starch and stored in damp situations. Psocids require a minimal relative humidity of at least 60 percent; this level accomplishes two purposes: the moisture keeps the Psocids from drying out, and it promotes the mold or fungal growth on which they feed. A relatively high humidity can be maintained in poorly-ventilated rooms, closets, basements, cabinets and pantries with a moisture source. To eliminate Psocids, discard the starchy source of mold and dry out the storage area.



GRAIN MITES

The most common grain mite is called *Acaras siro*. These tiny tick relatives look like dust with a slightly brownish tinge. A constant humidity level is even more important to Grain mites which prefer relative humidities between 75 and 85 percent. Grain mites are almost colorless but have long microscopic hairs. When they molt, the hairs of the cast skins cling to those of others. [They can pile up in a fluffy ball the size of a man's palm. A population of that size can be produced in a humid kitchen cabinet with as little as a scant dusting of flour over the shelf.]

Like Psocids, Grain mites can be eliminated by discarding infested materials and cleaning and drying out the chamber. Grain mites have been known to be responsible for allergies like those caused by house dust mites in humid homes. Use preparations containing tannic acid (carpet cleaners or brewed tea) applied to mite cast skins to suppress this protein allergy.

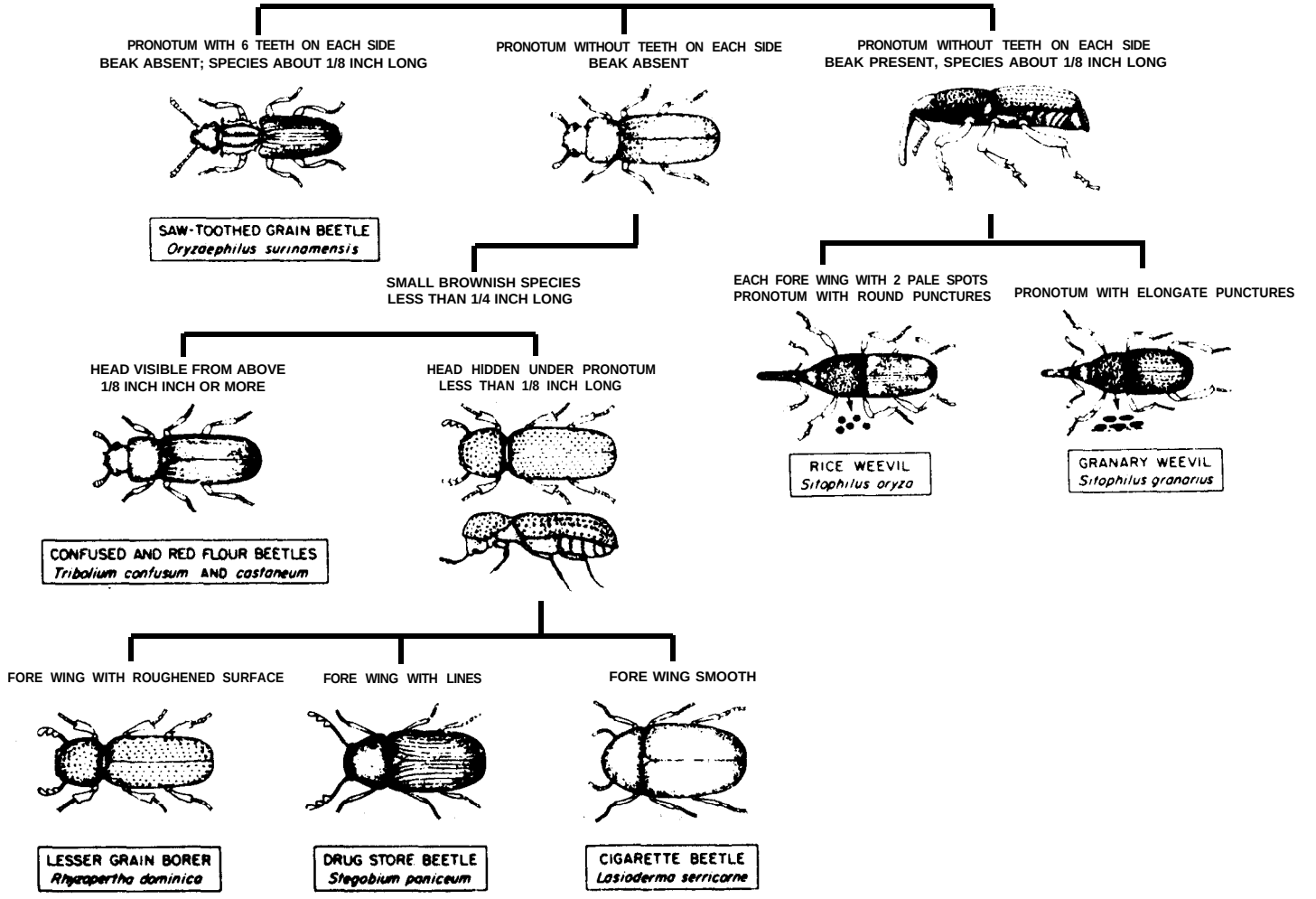


SUMMARY

Stored product pests include a wide range of insects that feed on grain, seeds and other plant parts that are stored, milled, or processed. Some of these pests infest stored products at every point from their origin in fields to granaries, mills, processing plants, warehouses, retail stores, food serving establishments, and homes. Some species of stored product pests can feed on the whole intact grain. Most can only feed on grains that have been broken or milled, and some feed on processed herbs and spices. Each pest species has a preferred environment and group of foods. Stored product pest infestations are not easy to discover when populations are low or building up. Pheromone traps (traps that use specific attractants) are very helpful in monitoring stored products in a pest management program. Locating and discarding infested products in homes and restaurants is a common method used in stored product pest control.

BEETLES: PICTORIAL KEY TO SOME SPECIES COMMONLY ASSOCIATED WITH STORED FOODS

Harry D. Pratt



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE

STUDY QUESTIONS FOR MODULE ONE
CHAPTER FOUR
STORED PRODUCT PESTS

1. Some common stored product pests that attack whole grains and chew through the seed coat are _____
   A. rice and granary weevils
   B. red and confused flour beetles
   C. psocids and grain mites
   D. sawtoothed and merchant grain beetles

2. Pheromones are used in _____
   A. sprays
   B. traps
   C. dusts
   D. warehouses

3. _____ is not commonly a food of stored product pests.
   A. dried fruit
   B. paprika
   C. paper products
   D cornmeal
   E. mung beans

4. Psocids and grain mites need _____ to build large populations.
   A. grains
   B. processed meal
   C. high protein grain
   D. high humidity.

For Answers refer to Appendix A

CHAPTER 5

FABRIC PESTS

Learning Objectives

After completion of the study of Fabric Pests, the trainee should be able to:

- Identify common fabric pest groups.
- List the key features in the life cycle and habitat of some common fabric pests.
- Discuss inspection and prevention techniques for fabric pests.
- Discuss pest management procedures for fabric pests.

Fabric, or textile, pest infestations sometimes present the most difficult problems a pest management technician can encounter. Except for fumigation, pesticide use alone is never an effective control for textile pest problems.

Textiles that are infested and consumed by pests are usually wool-based such as woolen clothing, carpets, and tapestries. Two types of insects are responsible for the usual woolen fabric damage but by their nature these pests -- carpet beetles and clothes moths -- feed on a broader diet than wool alone. Besides textiles made of processed wool, many other substances with a high-protein content are eaten by these insects. One particular protein, keratin, is present in wool and other hair or fur. The same material is also found in feathers, skins, horns and hoofs. Other materials that are high in protein are insect bodies, pollen, silk, grains and seeds (particularly the "germ," as in wheat germ, or non-starchy portions). Insects are the only animals capable of digesting keratin. Only a few microorganisms and fungi in other kingdoms are keratin reducers.

Fabric pests -- carpet beetles and clothes moths -- developed as scavengers, consuming feathers, fur, and hide of dead birds and mammals. Many species feed on dead insects, the molted skins and pupal cases of moths, silkworms, tent caterpillars, mud daubers, yellowjackets, wasps, hornets, dead bees and pollen.

Textile pests are generally secretive and develop on food that decomposes slowly. As populations of textile pests increase, individual adults and mature larvae migrate away from the infestation to mate or pupate in protected solitude. This activity often is the only signal that a pest infestation is present. The four groups of carpet beetles and two species of clothes moths can be identified from specimens of either adults or larvae.

CARPET BEETLES

All species of hide and carpet beetles belong in the beetle family Dermestidae. Adult beetles have short, clubbed antennae, are black in color or with yellow-white or orange scales (observable only with a good hand lens), or covered with fine smooth hair. The females can lay eggs throughout the year; the adults tend to be cyclical and most active in spring. Adults commonly feed on flowers and flower pollen. The larvae are responsible for most textile damage. They can be long lived; when food is scarce, larvae continue to molt for longer periods, waiting out a food supply.

HIDE AND CARPET BEETLE

Adults:

- the **Larder beetle *(Dermesfes lardarius)*** is large, oblong, and will grow from 1/4 to 3/8 inch long; it has a dull, dark or black head and thorax, and its wing covers behind the thorax are half dull-yellow, and the latter half, black.
- the **Hide beetle *(Dermestes macularus)*** is large, oblong l/4 to 3/8 inch long. Its dorsal or top surface is dark-brown or black, sometimes with white scales on

margin of thorax; the under-surface is also covered with white scales.

- Some other species of ***Dermestes*** resemble the hide beetle with similar habits (e.g., the Incinerator beetle and the Leather beetle).
- the **Black Carpet beetle, *(Attagenus unicolor*** (also called ***A. megatoma*** and ***A. piceus),*** is oblong to oval in shape; it is 1/8 inch in length, dark brown or black, and is not shiny.
- the **Common Carpet beetle *(Anthrenus scrophulariae),*** the **Furniture Carpet beetle *(Anthrenus flavipes),*** and the **Varied Carpet beetle *(Anthrenus verbasci)*** are about l/8 inch long or less. They are mottled, and are covered with yellow, white, orange, and black small flat scales (visible with a good hand lens).
- **Warehouse and Cabinet beetles *(Trogoderma)*** are small, about l/8 inch long or longer, and are dull dark-brown or black-mottled with tan markings.

Larvae:

Dermestid larvae are hairy beetle grubs from less than l/8 inch long to about l/2 inch long. Larvae can be separated into the same groups as the adults:

- the **Larder beetle** is long, about l/2 inch, hairy, dark brown in color with two teeth on the sides of the end segment pointing rearward.
- the **Hide beetle** has the same characteristics as the Larder beetle, except the end segment teeth are curved upward.
- the **Black Carpet beetle** is carrot-shaped; its body extends from about l/4 to about l/2 inch. The front end is widest and tapers to the rear. It is covered with dark-brown to golden-red hair. It has a long twisted tuft of hairs at the narrow tail end which may be worn down or broken off.
- the **Common Carpet beetle, the Furniture Carpet beetle, and the Varied Carpet beetle** are dark, short and less than l/4 inch. They are wider in the middle than at front or rear end, with dark hair bristles that extend out from body. The tail end is darker with short brushes of bristles.
- **Warehouse and Cabinet beetles** usually are small but they may reach l/4 inch. They are long, capsule-shaped, a light cream color, with a dark row of hairs across each segment, and reddish-brown bristles of short hairs on the segments of the blunt tail end.

HIDE AND LARDER BEETLES

Dermestes

These beetles (from which the entire family takes its name) are larger than other Dermestids, but rather than feeding on fabrics or grain, their larvae commonly eat bird and mammal flesh. They feed in remote dark places preferring their food dry rather than spoiled. These beetles will attack cured meats, like ham, and they are often found infesting dead birds caught in a chimney or wall void, or mice that were caught in traps or succumbed to poison. Larvae consume all the flesh and the heavier hairs, leaving a perfectly-cleaned skeleton in a small pile of fluffy undercoat hair. The **Hide beetle,** in particular, is used in museums to clean vertebrate skeletons. Both beetles eat leather, but the larder beetle is found more in homes, cabins and curing sheds.

THE INCINERATOR BEETLE

Another species that resembles the hide beetle is the **Incinerator beetle.** This beetle infests the wettest, unburned portions of garbage found in corners of open incinerators. Adults fly to lights and enter buildings from these incinerators.

THE BLACK CARPET BEETLE

Attagenus

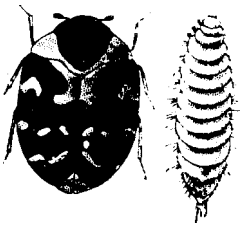
Black carpet beetle adults are frequently found near the larval infestation inside buildings. In the spring, they will, on occasion, fly inside from feeding outside on flowers. Black carpet beetles also infest grain in elevators and mills; in homes and other buildings, they most commonly infest woolen fabrics. Black carpet beetles build-up in stored woolen clothes such as suits, uniforms, skirts, blankets, felt and wool yarn.

COMMON, FURNITURE, AND VARIED CARPET BEETLES

Anthrenus

These very small, somewhat brightly-colored beetles are responsible for infesting woolens, furs,

feathers, hair-stuffed antique furniture, woolen carpets, and blankets; they are known to destroy insect collections, reducing individual specimens to piles of tiny fecal pellets.



WAREHOUSE AND CABINET BEETLES

Trogoderma

The several common ***Trogodema*** species are most often found on high-protein plant material processed into dry pet food, wheat germ and other less starchy grain commodities (see Chapter 4, Stored Product Pests).

CONTROL AND MANAGEMENT OF CARPET BEETLES

Inspection

Inspections for Dermestid beetle infestations depends first on the type or kind of beetle identified.

- Look for accumulations of cast skins and large amounts of fecal pellets as well as irregular holes and loose patchy fur.
- Advise clients to take all woolen clothing and furs out of closets and brush them. [Brushing helps to dislodge eggs and larvae; infestations are discovered in the process.]
- Look in every storage box, under all furniture setting on wool rugs and carpets. Inspect tapestries, insect collections and grain products. Inspect every closet, attic and basement into their far reaches.
- Use pheromone traps in museums etc. as part of the pest management plan.

Habitat Alteration

- Advocate discarding or cleaning any wool or fur product that has not been cleaned since wearing.
- Recommend moving furniture and cleaning wool carpets in infested rooms. Insist on thorough vacuuming of all rooms for pet hair that can support small beetle populations.
- Clothes should be separated into uninfested, cleaned woolens or stained and dirty articles that need to be dry cleaned. Dry cleaning kills all stages of the beetle, and cleaned woolen fabrics retard the growth of the beetle larvae. There is a greater likelihood that furs or woolens in long-term home storage will be infested than those that are used seasonally,
- Have all cleaned fur, feather, and woolen products stored in tight chests or good plastic garment bags. Furs are best kept safely in refrigerated vaults at furriers.

Pesticide Application

- Where infestations are found, spot applications of registered pesticides can be applied to storeroom or closet baseboards and corners.
- Apply pesticides in cracks and crevices of infested rooms after the infestation is eliminated.
- Use naphthalene flakes in tight chests where vapors and odor will not be breathed by occupants. Naphthalene is not as volatile as paradichlorobenzene (PDB) crystals and gives longer protection. Use only amounts recommended on the label. [These two chemicals are sold in department stores as mothballs or moth crystals.]

Follow-up

Conduct a pest management plan emphasizing routine monitoring in high risk areas such as museums, woolen or fur storage facilities, etc. Use pheromone traps for effective monitoring. Museum staff should reinspect annually, and pest management personnel should monitor records regularly. Emphasize educational programs for curatorial staff and storage management personnel in critical facilities.

CLOTHES MOTH SPECIES

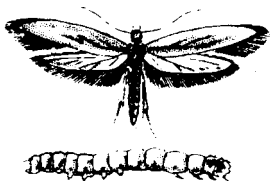
Clothes moths fare better in warm humid climates and so southern regions in the U.S. have historically produced more infestations than northern areas.

Adults:

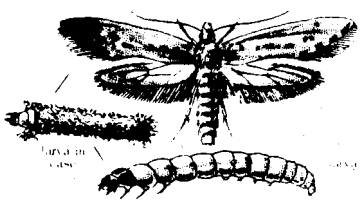
Adult moths are very secretive. They are very small and never fly to lights, choosing instead to

remain in dark areas or not to fly at all. They scuttle down into dark folds of textiles or fur. Clothes moths need humidity.

- the **Webbing Clothes moth** ***(Tineola bisselliella)*** has a length at rest of l/4 to l/3 inch with a wing span of less than l/2 inch from tip to tip. Its head and front wings are a golden buff. Larvae spin fine silk over the area of their infestation. Fecal pellets, pupal cases and cast head capsules catch in the silk creating a messy accumulation.



- the **Casemaking Clothes moth** ***(Tinea pellionella)*** is the same size as the Webbing Clothes moth, but its head and front wings are dusty-brown or tan with three small dark spots on each front wing. Casemaking clothes moth larvae feed on woolen yarn but incorporate tiny strands into a silken bag or case that covers their abdomen. They crawl with three pairs of legs and hold the case with hooks on stumpy abdominal legs. The color of their cases give an indication of the color of the infested material.



Larvae:

- the **Webbing Clothes moth** larvae are small, creamy-white caterpillars. The Webbing Clothes moth larvae is between l/4 to less than l/2 inch at most with a white, shiny body. It has a brown head and a brown segment behind the head. It is often found in loose silk webbing.
- the **Casemaking Clothes moth** larvae are slightly longer than larvae of the Webbing Clothes moth. It is very light or white with a dark brown head. The segment behind its head is dark brown. The caterpillar constructs a case about its body which it carries about when feeding. Mature larvae after leaving the infestation attach to ceilings and walls and pupate inside the case.

CONTROL AND MANAGEMENT OF THE CLOTHES MOTH

Inspection

- All woolens should be inspected where clothes moths have been sighted, especially clothing that is stained or has been worn and not cleaned.
- Brush to dislodge eggs.
- Look for woolen-based products introduced from Central and South America.

Habitat Alteration

Clothes moths cannot live on cleaned wool. They are very dependent upon sweat, food or urine-stained wool, fur, silk, and feathers. Without certain vitamins produced by microorganisms growing on the stains, clothes moth larvae will die.

- Recommend dry cleaning of all woolens that are in need of it.
- Advocate that clients inspect all wool products in storage and discard those where use is not projected.
- Where there is sudden activity of flying moths, look for areas where water leaks have brought about increased humidity. Then have all areas with high humidity ventilated or dehumidified.

Pesticide Application

- Clean woolen products.
- Make spot applications in storage areas with approved pesticides.
- Apply naphthalene flakes at the labeled rate to tight chests and storage bags that concentrate and hold vapors.
- Paradichlorobenzene (PDB) crystals vaporize much faster than naphthalene and must be maintained to insure protection. [Do not allow continued breathing of either of these pesticides.]

Follow-up

Develop a pest management program with an emphasis on monitoring for critical museum or stage drama collections. Historical textiles cannot be

cleaned; closely monitor stained tapestries, clothing, furniture coverings, and stuffings. Review records regularly, and provide educational programs to curatorial staff and those in textile storage businesses.

SUMMARY

Fabrics made of wool, furs and feathers, are attacked by a few species of beetles and moths that can consume a protein called keratin. These pests also consume grains, leather, meat, and horn as well as dead insect skeletons.

Originally, these insects were scavengers in mammal and birds nests, dead vertebrate bodies, and seeds. When humans began using these materials as food and clothing, the pests came too. Fabric pests destroy textiles, tapestries, and carpets in museums, clothing in homes, and furs in warehouses and stores; these are often both expensive and unique products. The pests do not thrive in cleaned textiles and wool because they need certain vitamins produced by fungi found along with stains of perspiration, urine, and human food; added to this is a requirement for moisture.

STUDY QUESTIONS FOR MODULE ONE
CHAPTER FIVE
FABRIC PESTS

1. The most important element in a pest management program for fabric pests in a museum would be _____.
   A. fogging
   B. monitoring
   C. dusting
   D. spraying

2. The principal need of fabric pests seems to be _____.
   A. wool
   B. carbohydrates
   C. protein
   D. starches

3. Two groups of insects feed on stored woolens, furs, feathers. They are _____
   A. clothes moths and carpet beetles
   B. carpet moths
   C. blanket beetles
   D. clothes moths, tapestry moths

4. The black carpet beetle does not normally feed on _____
   A. wool
   B. grain
   C. fur
   D. leather

For Answers refer to Appendix A

CHAPTER 6

SILVERFISH & FIREBRATS

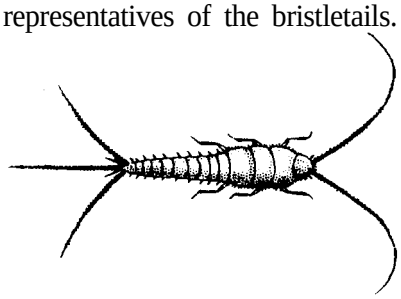
Learning Objectives

After completion of the study of Silverfish & Firebrats, the trainee should be able to:

- Identify key features in the life cycle, habitat and appearance of silverfish and firebrats.
- Understand silverfish and firebrat pest management.

Silverfish and firebrats are among the most ancient of insects; they were on earth before insects developed wings. These pests were among the most common insects in homes and businesses when wallpaper was the usual wall covering and when coal furnaces had glued, taped, insulated pipes.

Pest bristletails are about l/2 inch when adult and, unlike other insects, they continue to molt and may shed their exoskeletons as many as 50 or 60 times when full grown. They have long antennae in front and three antenna like processes behind the "bristles" of the bristle tails. They are slender, broadest in front and gradually taper toward the rear. In general, they shun light and prefer dark, undisturbed sites. Two species, the silverfish, and the firebrat, are the most common representatives of the bristletails.



THE SILVERFISH

Lepisma saccharina

The silverfish is about l/2 inch long when full grown and is covered by a sheen of silvery scales. It prefers temperatures between 70 and 80 F, and requires high humidity. Adults can live from two to three years. They feed on starchy substances like flour, starch, glue, paste and the starch sizing on textiles and papers, but they can also digest cellulose fibers.

Silverfish build up around the materials they are feeding on such as spilled flour in cupboards, corrugated cardboard boxes in damp basements, insulation glue and stored books in unventilated attics. Their feeding leaves irregular yellow-stained holes in sized textiles and paper, surfaces removed from corrugated cardboard, and irregular areas grazed off cloth-bound books. Damaged products will often have a dark fungus growing on them as a result of the humidity and insect fecal deposits.

Large populations of silverfish spread out into other humid areas. Silverfish are often trapped in wash basins and bath tubs in bathrooms to which they migrate from the basement or out of wall voids penetrated by pipes.

Gray Silverfish

The gray silverfish is uniformly gray, sometimes very dark. It is most common in southern California and Hawaii. This species is more a pest of paper and textiles.

Fourlined Silverfish

The fourlined silverfish has four dark lines down its abdomen and is very slightly longer than the common silverfish. It builds up in the mulch of flower beds and under roof shingles, then enters attics and upstairs rooms. They can be common both outdoors and indoors on the east and west coast. High humidity from overhanging trees in summer promotes build-up of this species.

FIREBRATS

Thermobia domestica

Firebrats are not silvery but are mottled dark-gray and dull-yellow. Their cosmopolitan distribution, size, shape and appendages are like silverfish, but firebrats prefer decidedly higher temperatures and surroundings warmed to 90 F or more. Examples of firebrat habitat are bakeries where heat and starches are prevalent, furnace rooms, steam pipe tunnels, hot apartment bathrooms and partition walls of water heater rooms.

CONTROL AND MANAGEMENT

Inspection

- Place silverfish and firebrats in alcohol to preserve them. They are soft and very fragile. When they are captured for identification, scales are usually rubbed off and appendages broken off.
- Check all starch-based materials in the infestation area including glued boxes, wallpaper, books and book bindings, art prints, file boxes, kitchen and bathroom cupboards, glued insulation bats, flour paste, and stored textiles especially those that are starched or sized.
- Inspect rooms connected to infested areas through wall or floor penetrations, or through closet ceilings.
- Note high humidity and high temperatures.

Habitat Alterations

- Locate moisture sources.
- Mend pipe leaks.
- Ventilate closed rooms, attics, and crawl spaces.
- Dehumidify humid spaces.
- Eliminate standing water.
- Make changes in grade and guttering where water runoff causes damp basements and walls.
- Eliminate stored materials that harbor bristletails.
- Dispose of infested storage boxes and relocate stored materials in dry spaces after inspection of materials.
- Trim trees where shade is causing moist conditions on roofs and roof eves.

Pesticide Application

- Use crack and crevice applications of registered pesticides in areas of infestation to kill newly hatched bristletails.
- Use dust as spot treatments where it will not drift. Dusts can also be used in crack and crevice applications.
- Use naphthalene flakes in sealed textile storage for protection of materials.
- Use fogs to eliminate heavy populations and to keep the active, exposed pests from migrating into new areas.
- Treat attics where fourlined silverfish are found.

Follow-up

- Educate the client regarding bristletails' need for starch-based foods, humid conditions, and the firebrats attraction for high temperatures.

SUMMARY

Ancestors of the silverfish and firebrats are among the most ancient insects. Silverfish prefer a moist or humid environment with a moderate temperature. Several species of silverfish live outside and inside. Firebrats, on the other hand, seek very hot places like bakeries, furnace rooms, and hot apartment bathrooms.

Both silverfish and firebrats feed on starchy materials such as flour, paste, glue, textiles and paper sized with starch. Boxes of books, corrugated cardboard, flour or cake mix spills, glued insulation bats, taped heat pipes, etc. They also eat paper.

Removing the infested material is the first step in control of these pests. Ventilating moist or hot spaces, and using pesticides will quickly suppress these pests.

STUDY QUESTIONS FOR MODULE ONE
CHAPTER SIX
SILVERFISH AND FIREBRATS

1. The common silverfish prefers moderate heat and high humidity.
   A. True
   B. False

2. The most common silverfish outside is the _____.
   A. common silverfish
   B. firebrat
   C. fourlined silverfish
   D. gray silverfish

3. The firebrat prefers moderate heat and high humidity.
   A. True
   B. False

4. Silverfish and firebrats prefer to consume _____
   A. carbohydrates
   B. starches
   C. proteins
   D. vitamins

For Answers refer to Appendix A

CHAPTER 7

FLEAS

Learning Objectives

After completion of the study of Fleas, the trainee should be able to:

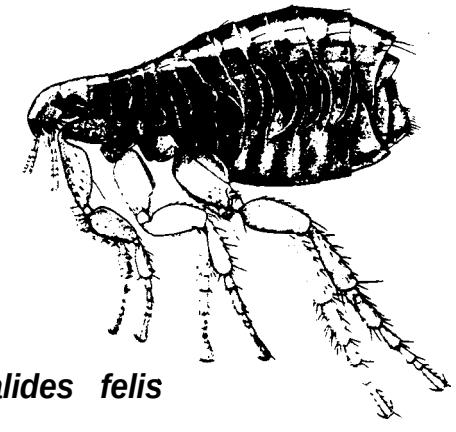
- Understand the cat flea life cycle and how it contributes to flea problems.
- Discuss habitat alterations and why they are needed.
- Identify pesticide application methods for flea control.
- Understand when, how and why IGRs are helpful.

The secret to flea population management is the flea's life cycle; the adult must contribute timely nourishment for larvae under special conditions or the young will not survive. No longer a regional problem, today fleas are common in all parts of the country except very dry areas.

The most important species that pest control technicians must manage is the cat flea which feeds on a variety of hosts, including cats, dogs, rodents, foxes, opossums and humans. This flea prefers pets and will not affect humans unless populations are excessive or the pet is removed from its resting areas. The situation that occurs when families remove the pet, take a vacation, then return home to find ravenous fleas is not uncommon.

An outline of the sequence of events:

- A summertime vacation assures good flea-growing conditions (temperature and humidity).
- Taking the pet removes the main host.
- While the family is away, larvae continue to develop, feeding on dried blood; pupae complete their cycle and are ready to emerge.
- The family returns to the adult fleas emerged and emerging -- ready to feed and accept ALL available warm-blooded hosts.



CAT FLEA
Ctenocephalides felis

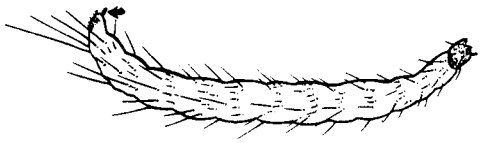
Eggs

After feeding an adult female flea will lay up to several hundred eggs within three weeks. Flea eggs develop in pet resting areas in warm humid climates. The tiny flea eggs are very smooth and rounded. They do not stick to pet hair and are easily scratched or shaken off. When they fall on pet bedding furniture, carpets, etc., they shake down to the same level as the pepper-like dried blood (see larvae and adults). These eggs will hatch in one week to ten days.

Larvae

Larvae are tiny, wormlike, whitish (almost transparent) insects with a small brown head. When larval fleas hatch, they are only l/6 inch long; after

three molts, they grow to near l/4 inch but are still difficult to see. The entire larval stage may take only one week under favorable conditions, or it may be prolonged into several months.



The legless larvae can disappear with remarkable speed (into carpets, pet bedding, etc.) moving by use of a pair of spines at their rear and long (hut nearly invisible) hairs on each segment. Larval fleas are scavengers and do not suck the hosts' blood or live on hosts. Cat flea larvae have chewing mouthparts which they use to eat specks of dried blood (see adults). [when they are full, the blood turns them to a near-purple color.]

Like many insects that live in large populations (e.g., pantry pests), mature flea larvae crawl away from the area where they developed, and work their way into cracks or under the edge of the pet bed, rugs, or carpeting. These mature larvae spin a loose, white, silken cocoon in which to pupate. The cocoon often gets covered with dirt particles and other detritus during its construction.

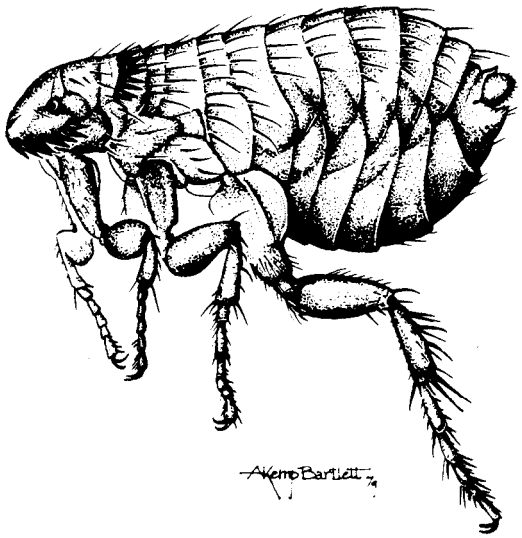
Pupae

Shortly after making the cocoon the larva molts and forms a white pupa. The pupa becomes adult but does not emerge immediately, rather, it remains immobile in a form called the "pre-adult" until stimulated to leave the cocoon. This pupal stage is completed within one week to ten days, but the pre-adult form may remain in the cocoon for months.

Various stimuli guarantee the flea will leave the cocoon only at a favorable time: being stepped on by the pet, carbon dioxide being exhaled by a host, or, encountering a sufficient number of warm, humid days. The adult flea is ready to feed as soon as it leaves the cocoon.

Adults

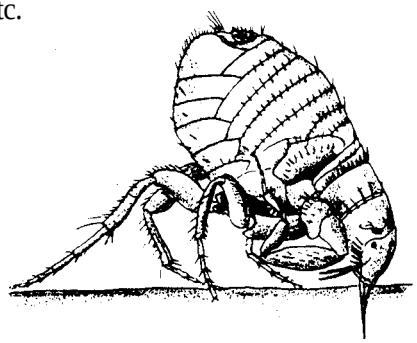
Adult fleas live on the pet and in the pet's sleeping or resting area. Adult fleas are parasites -- they obtain their nourishment from a host animal, usually mammals. They feed by biting and sucking blood, sometimes daily, for two or three weeks. Most feeding takes place while the pet is sleeping or at rest. Cat flea larvae cannot live without dried blood from the adults, therefore fleas are not evenly distributed throughout a home or building.



Fleas inject an irritating saliva when they feed. The bite irritation causes the host to scratch and shake, dislodging the eggs. The females digest the host's blood and excrete a corkscrew shaped string of black, nearly dry blood. This fecal blood breaks up in pepper-like specks that are also scratched off into the pet sleeping or resting areas.

Flea Bite and Flea Allergy

The flea bite is accompanied by secretions of saliva that prevent the host's blood from coagulating [a aspect accompanying the bites of many blood-sucking insects]. The saliva contains several chemicals that cause irritant reactions, sometimes including hypersensitivity to subsequent flea bites. This sensitivity often results in flea allergy dermatitis, expressed by hair loss, excessive scratching, skin inflammation, etc.



The bite distribution pattern in dogs and cats begins across the hips near the tail and narrows along the back. An area between the hind legs and on the belly can also be affected. Cats are less affected on the belly than dogs, but often have problems on the neck or collar. Once the allergy is activated, reaction is sudden with few subsequent bites. Flea allergy also seems to be hereditary.

Range

In the past, flea control in the northern United States consisted of a summer spray inside and treatment of the pet since reinfestations from outside were not common. In the southern states where outside infestations were common, treatment in the yard was also needed. Today flea infestations and reinfestations are common in all parts of the country except very dry areas.

CONTROL AND MANAGEMENT

Inspection

Indoor. A close inspection of a home or building will principally involve finding the "hot spots" or areas of high flea development. Pet bedding or sleeping areas should be identified first. Pets do not sleep or rest indiscriminately or randomly in a building. They have favorite places and move among them throughout the day. Where they habitually stop and rest, flea eggs and dried blood accumulates. These are spots where they habitually scratch, bite, or shake (e.g. immediately after leaving a resting spot). Spots where cats land as they jump down from a high resting or feeding area are places where eggs and dried blood falls.

Outdoor. Kennels and doghouses are obvious places where fleas build up. But there are other places pets prefer to sleep or rest at certain times of the day. Examples are under particular bushes, under porches, or in crawl spaces. If a pet roams the perimeter fence, points of infestation might be located there.

Outdoor flea infestations rely on dependable hosts and warm humid climatic conditions. Flea larvae require moisture because they easily dry out and die. Neither can they tolerate free water (such as rainwater) or they drown. Therefore, infestations are not found in unprotected or undrained situations.

Reinfestation from outside. As do pets, some species of urban wildlife harbor cat flea infestations. When urban neighborhoods mature, their habitat for wildlife increases. Raccoons have long been prominent, and, in fact, have overpopulated some urban areas; they live in chimneys, large trees and storm sewers. Chipmunks, ground squirrels, and domestic rodents have also found habitat in ivy terraces, rock walls, soil berms and underground drainage areas. Another mammal, the opossum, has extended its range or has been introduced over most of the United States; it is one of the most common urban wildlife species found today.

Pets are always aware of the locations of wildlife habitat in their own backyard. As soon as they are released, they run to these places to investigate, even if they can't get at the animals. This behavior ideally facilitates flea reinfestation of clean pets.

Habitat Alteration

Indoor. Flea populations build up in warm humid weather of spring and summer and drop to low levels in cool or dry winter weather. Inside air with a low humidity will hold back the buildup of flea populations.

When focus areas of flea populations are identified, these and other potential harborage sites should be vacuumed as thoroughly as possible. Except for flea allergy dermatitis, which can be initiated with very few flea bites, a moderate flea population can be kept at a tolerable level by vacuuming alone. This vacuuming MUST be performed daily and must always be thorough -- an alternative very few pet owners would choose when other safe and effective options are available. If vacuuming is augmented by use of growth regulators, better success can be predicted.

Reduction of clutter facilitates inspection and permits effective pesticide application and vacuuming. Pets and feral animals should be kept out of crawl spaces, and from under porches and out-buildings. Eliminating the wildlife habitat where fleas are harbored and trapping or killing animals responsible for reinfestations may become essential in stopping difficult flea infestations. Care should be taken, however, not to rely on wild animal elimination alone; these animals are usually replaced by others moving in from adjacent range (see outside treatment). Consult local restrictions when dealing with wild mammals.

Pesticide Application

Treatment of Pets. Pets should be treated by the pet owner or a veterinarian. Where flea allergy dermatitis is involved, pets must be treated by veterinarians or else recovery will be slow at best. Pet bedding should be washed once a week. The pet kennel or pet box should also be cleaned and washed each week. The weekly schedule kills eggs and larvae, and eliminates the dried blood essential for complete larval nourishment. Pet owners can purchase pesticide powders and sprays and they should be used according to label information. "Dipping" pets is done most effectively by veterinarians. Flea collars may help with some flea infestations but they are generally the least effective treatment.

Treatment of puppies and kittens with dusts and sprays can be hazardous. These small pets should be moved out of infested areas into clean bedding and their mothers carefully treated. Children should not

fondle pets treated with pesticides. Medicated ointments can be used on pets, especially dogs, with severe flea allergy dermatitis.

Indoor. Never apply pesticides until thorough vacuuming has been completed.

Insect growth regulators (IGR) have proven very efficacious in flea control. Growth regulators interfere with or replace natural hormones essential for the flea larvae to change into pupae. IGRs have long residues and leave a good margin of safety for humans. Since IGRs do not affect the pupa or adults, fleas that have reached those stages complete their development. The "pre-adult" under adverse conditions (cool or dry weather) may not leave the pupal cocoon for a period of weeks, even months. This means that some fleas will be able to "dodge" treatments and expose themselves after pesticides have lost their effectiveness.

Spot treatments with pesticides are applied to kill flea larvae and adults that come in contact with the sprays. These pesticides (e.g., microencapsulated pesticides, emulsifiable concentrates, dusts, and space sprays) have varied residual periods. Carpet staining or color alteration can occur and should be considered. The sprays should be applied as even, fine overlapping fan sprays under low pressure. Overwetting carpets must be avoided. During very humid weather, carpets dry slowly and ventilation or dehumidifying is necessary. Sprays will not reach larvae or adults deep down in the carpet, but they will come into contact with the pesticide residue when they move up or out of the nap. Some fumigant action may kill pests as the pesticide dries. Do not allow pets or children on the treated carpet while it is wet. Contact with the treated carpet will also help kill adult fleas on an infested pet.

Preventive treatment. Preventive treatment is helpful: where flea infestations were particularly severe the previous year, where flea allergy dermatitis must be avoided, where animals are in poor health, and where outside infestations can be predicted. If IGRs are to be used alone, they should be applied before spring flea activity gets underway -- at least one month before flea problems even begin to be noticed (depending on the local climate). IGR application can be repeated according to predicted need.

When summer visitors bring their infested pets, a flea infestation can be anticipated. Thorough vacuuming should be recommended, but where previously uninfested pets are involved, preventive treatment with an IGR might be indicated.

Outside. Where pet reinfestation brings on repeated inside infestations, the outside environment should be treated. Random outside treatment or full lawn cover sprays are not as effective as careful treatment of pet resting areas and wild animal habitat.

Kennels, dog runs and dog houses are also obvious areas to treat. Perimeter fences where pets and wild hosts roam may be the pest interface between one yard and another. Crawl spaces, areas under porches, and openings into basements and attics where pets or wild animals nest should not be closed off until the animals are removed and the area adequately treated.

Emulsifiable concentrates or microencapsulated insecticides can be applied as spot treatments where labels permit. Emulsifiable concentrates of many pesticides have a short residual when exposed to outside light and weather fluctuations.

Dusts where they can be applied are often more effective. Take care not to overapply dusts. Dusting burrows or the protected nesting areas of reinfesting wild animals can be very effective and might eliminate the need for trapping or killing these animals.

Pesticides should be reapplied when rainy weather follows pesticide application.

Ultrasonic devices. Clients have been led to believe that ultrasonic devices are effective flea deterrents. Cat fleas have **NOT** been shown to react to a broad spectrum of ultrasound; consequently, there is no utility for ultrasonic devices in a flea management program.

Follow-up

Thorough client education is essential both before and after flea pest management programs are conducted. Clients must be well informed or they will not be motivated to carry through with the steps they alone can do. Flea infestations, often bring about emotionally charged situations -- especially when anxieties prevail, such as when children are involved or the infestation is long term.

Pest management technicians must be able to clearly and patiently explain the flea life cycle and how each stage is important. They must clarify how infestations can persist and that there may be no easy or quick solution. Where infestations are severe or where management procedures may not be completely carried out, a reinspection and possible retreatment should be scheduled before a rebounding population cancels out all of the previous work and cooperative effort.

SUMMARY

Fleas are mainly parasites of mammals and birds. They undergo a complete metamorphosis. The eggs drop off of the host where they are deposited by the female during feeding periods. The larvae with

chewing mouthparts hatch and feed on dried host blood -- provided by the feeding female flea. Prior to pupating, the larva spins a small, loose white silk cocoon. The pupa molts to an adult inside the cocoon. Adults emerge from the pupal cocoon find the host, feed by sucking blood, mate, and produce eggs. The cat flea is the most common flea infesting dogs and cats in the United States.

Understanding the life cycle of the flea, the dependence of this pest on its host, and the importance of the dried host blood, is essential to flea control.

Removing dried blood and adult fleas by vacuuming, killing the adult fleas, and using an insect growth regulator to keep the larvae from pupating will control flea populations.

STUDY QUESTIONS FOR MODULE ONE
CHAPTER SEVEN
FLEAS

1. The food of flea larvae is principally _____
   A. blood they suck from the host
   B. dried blood from the female flea
   C. fur from the host
   D. starch

2. Adult fleas obtain blood by _____
   A. sucking
   B. chewing
   C. Absorbing
   D. lapping

3. Pets that are flea hosts sleep and loaf in particular places rather than randomly lying down when they are tired.
   A. True
   B. False

4. For control of fleas, it is not important for the pet owner to:
   A. remove the pet
   B. vacuum pest resting spots
   C. treat the pet
   D. clean pet bedding

5. Application of an IGR will _____.
   A. kill adults
   B. immunize the pet
   C. keep pupae from developing
   D. keep eggs from hatching

6. Dogs can become allergic to flea bites.
   A. True
   B. False

For Answers refer to Appendix A

United States
Environmental Protection
Agency

Pesticides And
Toxic Substances
(H7506C)

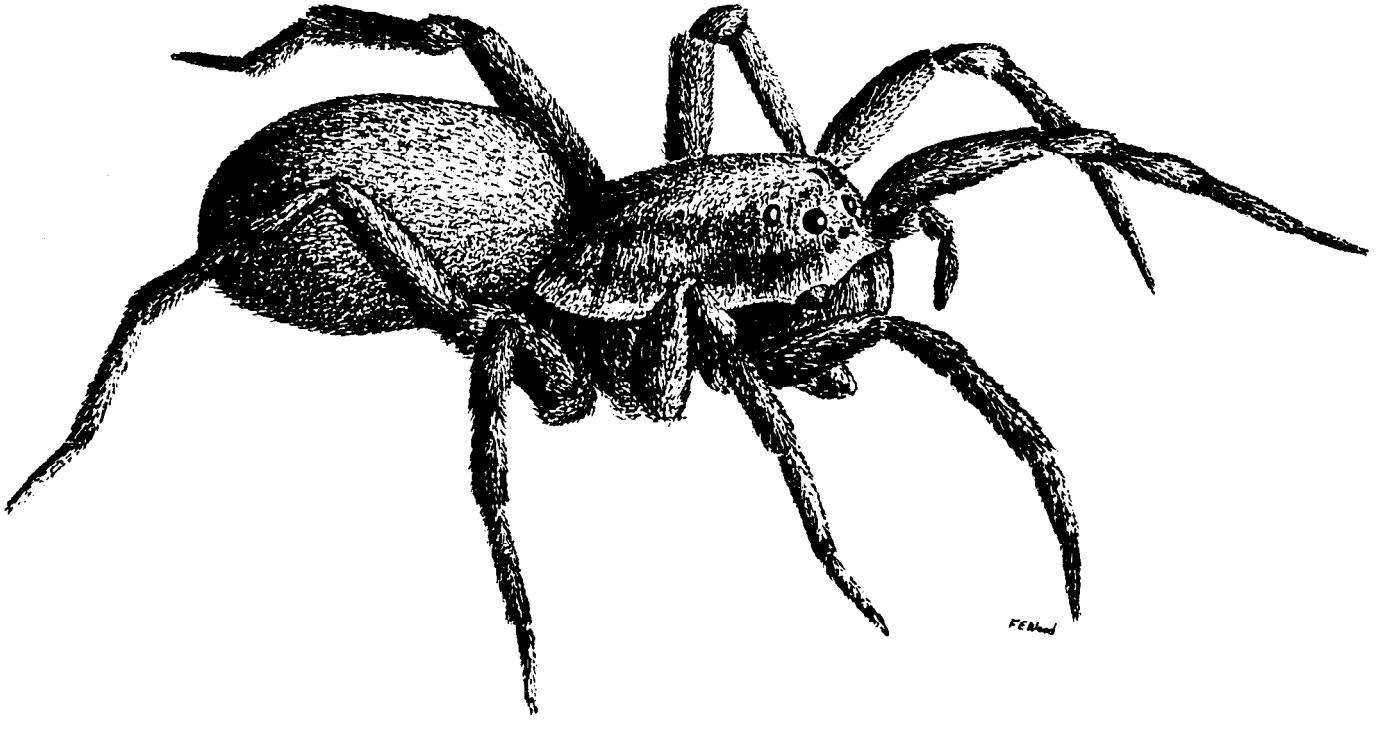
EPA 735-B-92-001
July 1992

EPA

Urban Integrated Pest Management

A Guide For Commercial Applicators

Invading Pests



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INVADING PESTS

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INTRODUCTION

The pests discussed in Module One consisted principally of those that infest structures and for the main part remain inside -- generations producing generations as long as the necessities of food moisture and harborage hold out. Many of those species are cosmopolitan. They have been carried over much of the world by human migrations of trade or conquest. A few (some of the cockroaches, for example), have adapted so well to human habits, that their origin cannot be identified with assurance. Ants are the possible exception to this grouping. They could be placed in either module, since some species can persist indoors, in colonies, they have been included in Module One. Module Two covers arthropod species that primarily live outside, individuals from the local fauna, that invade human habitat but do not reproduce inside. Exceptions to this are spiders, who with encouragement produce egg sacs that develop, honey bees that inhabit building wall voids, and human lice whose unique habitat is difficult to designate as outside nor inside. A final group, the imaginary pests, are neither outside or inside.

Pest species in Module Two also tend to be regionally distributed. Many occur in the southern states but not in northern ones. Likewise, eastern pest species usually do not persist much west of Kansas (around the 100th meridian) where related western ones take over. Module Two pest populations are often cyclic. They may verge on the epidemic for several years and be rare in others. Some pests -- enough to keep things interesting -- occasionally enlarge their ranges by expanding into new territories, and from time to time, new ones are introduced from other countries.

Finally, most of the pests in Module Two must be managed by treatment inside and outside, using either habitat alterations, cultural changes, pesticide applications, or all of the pest management components. Urban pest management technicians are certain to find the pests in both modules interesting and their management challenging.

CHAPTER 1

HOUSEFLIES AND THEIR RELATIVES

Learning Objectives

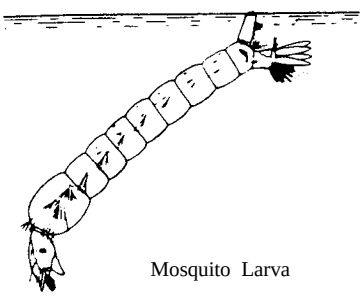
After completion of the study of House Flies and Their Relatives, the trainee should be able to:

- Describe the life cycle and habits of common urban flies.
- Given a specimen of a common urban pest fly species, identify its common name or group.
- Given a fly management problem, describe pest management procedures needed to suppress it.

Of the five most serious diseases in the world, flies, including mosquitoes, spread the organisms that are responsible for four: Malaria, sleeping sickness, Leishmaniasis and filariasis. They also are responsible for yellow fever, typhoid, and various diarrheal illnesses. In the United States, the toll of the worst afflictions -- heart attacks, cancer and strokes -- is annually numbered in the thousands; in the tropics, the dead and disabled from fly borne diseases are counted by the ***millions.*** In the United States, flies are considered more annoying than dangerous; as recently as the turn of the 20th century, however, malaria and typhoid were major health problems.

Flies, the order Diptera, are one of the largest and most dynamic orders of insects. This vast order is characterized by having ***only one pair of wings.*** Most flies are also small, soft bodied; often, two large eyes that cover the front of the head.

Flies can be divided into two groups; distinguishing differences center around the appearance of the larvae and adults.



Mosquito Larva

In Group 1:

- The adults are small -- gnat or mosquito-like with long antennae and slender legs.
- Larvae have head capsules and most live in water or moist soil.

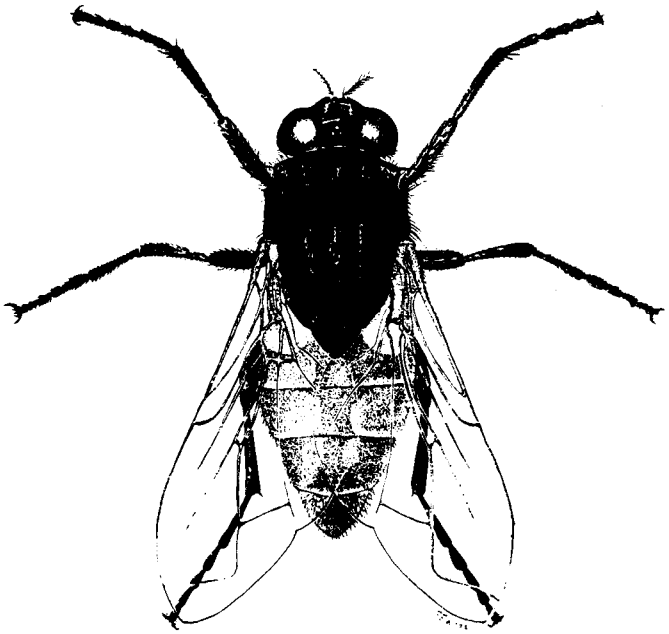
Fly Maggot

In Group 2:

- The adults have stout bodies; their antennae are short or not visible; some are relatively large but usually not long legged.
- Larvae do not have discernible heads and are often maggot-like. Their harborage varies -- they live in water, filth, soil, carcasses, plant tissues or animal tissues.

All dull gray flies about l/4 inch long found inside or even near structures will likely be called House flies. If the identification is incorrect, it probably is not far wrong.

Flies often tell the same story: they frequent garbage, dead animals and manure. Their larvae live in that material. To enter a house, they have flown inside through an open door or window, or they have moved from a dead bird or rodent in a wall.



House Fly

Appearance

Both the House fly, ***(Musca domestica)*** that lives on garbage or manure, and its close relative, the Face fly ***(Musca autumnalis)*** that lives on fresh cattle manure, are about l/4 inch long. They have a dull-gray thorax with dark stripes and a dark, dull abdomen with yellow sides.

Flesh flies (the family Sarcophagidae) live on meat scraps, dead animals and dog excrement; they are more than l/4 inch long, have a dull-gray thorax with three distinct dark stripes and a gray checkerboard abdomen.

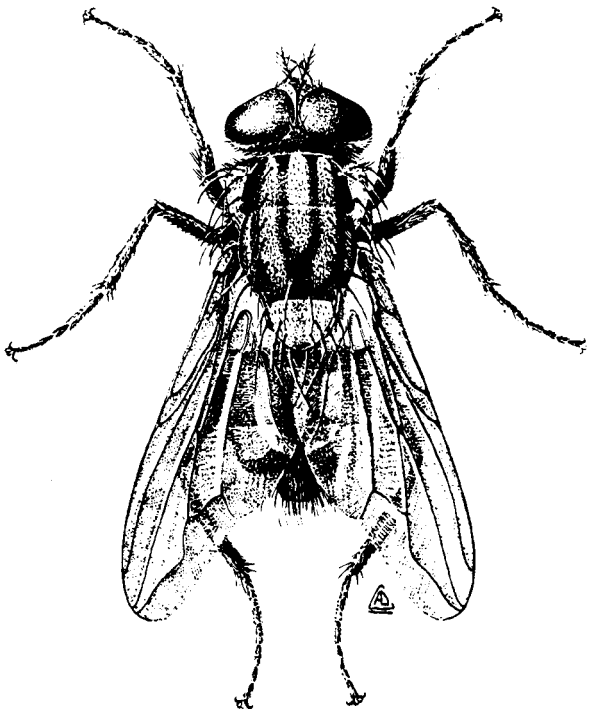
Blow flies (the family Calliphoridae) are about l/4 inch long. Their thorax and abdomen are shiny black, metallic green or bronze, or they have a metallic blue abdomen with a dull thorax. They live on dead animals, meat scraps in garbage, and wet mixed garbage.

The Cluster fly ***(Pollenia rudis)*** is also in the family Calliphoridae. It is slightly more than l/4 inch long. Its thorax is covered with gray or yellowish hairs; it has no stripes, Its abdomen is dark gray with light patches.

Inspection

When any of these flies become problems inside, their breeding site and their larvae will usually be close by. If animals are nearby, investigate for manure concentrations. Garbage cans and dumpsters are often the problem source; even soil where garbage has decomposed will support infestations.

- House flies infest most garbage, manure (horses, cattle, poultry, pet), filth accumulations.



Face Fly

- Face flies need fresh cattle manure for egg laying.
- Flesh flies, like blow flies, live in pet manure, meat scraps in garbage, and dead animals.
- Blow flies are scavengers and live in manure, carrion, dead birds and rodents in wall voids and chimneys. One Blow fly, called the Cluster fly, parasitizes earthworms.

Look for fly sources where buildings are infested. Observe sanitation in the areas where flies are problems.

- The most common means of fly entry is through open doors. Look for door props, and hooks, as well as gaps where broom handles are stuck over hinges to hold the door open.

Evaluate garbage management.

- Garbage left in the building or on loading docks is an attractant.

Garbage should be removed from the premises ***twice*** a week.

In favorable weather, House fly larvae mature in 6-10 days and Blow flies in 3-9 days. They live in refuse only from the egg laying to the mature larval stage. Then the mature larvae crawl away to pupate, emerging as adults later.

Habitat Alteration

- Caulk and tighten around all openings such as screens, doors, windows, ventilators, and eves.

Emphasize sanitation: Make the following recommendations to clients. [If sanitation cannot be improved, other methods of control will not be effective.]

- Remove breeding materials such as garbage and manure.
- Clean garbage cans and dumpsters regularly, and any fresh overflow immediately.
- Clean food delivery spills immediately.
- Drain wet areas around garbage collection sites.
- Keep loading docks clean.
- Install air curtains where doors remain open for deliveries, etc.
- Install automatic door closers.
- Replace white security lights inside and outside with yellow lights.

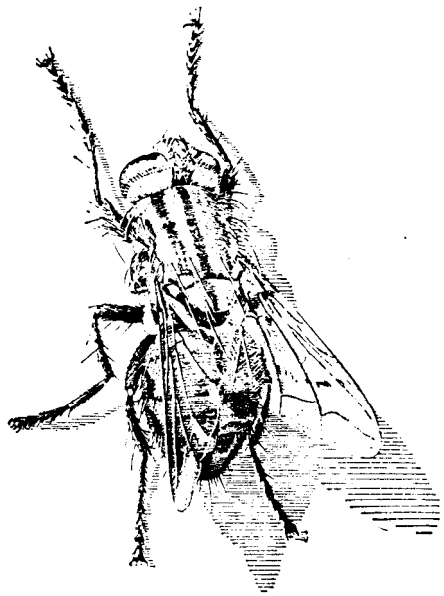
Pesticide Application

- Fly strips can be placed in low access rooms, such as attics and storerooms.
- Fly bait can eliminate adult flies when methods are in place that reduce breeding sites.
- Electric fly traps will control only a low level of adult flies. [Watch these traps to see what kinds of flies are being caught.]
- Do not place blacklight fly traps where they will attract insects from outside; Do not put them in competition with other lights such as those from vending machines, etc.
- Aerosol contact sprays can be used to knock down adult flies -- after elimination of breeding sites and exclusion methods are in effect.
- Ultra-low dosage applications of nonresidual pesticides can be used if an adult infestation must be quickly reduced outside.

Follow up

Regularly check sanitation and exclusion methods to see that they are being maintained. Observe client and worker habits that run counter to the pest management program (sanitation, habitat alteration, and so forth). Hold training clinics for workers about fly pest management.

ATTIC FLIES, CLUSTER FLIES



Flesh Fly

The same flies that enter structures: House flies, Face flies, some Blow flies, Flesh flies and Cluster flies, normally overwinter as adults. In nature, these locations are under bark, in hollow parts of trees or under the bark of logs. They begin seeking shelter at the end of the hot part of summer.

If they begin investigating structure walls in this search for winter harborage, their upward movement often brings them to openings under siding, ventilators and weep holes in masonry, cracks around windows, wire penetrations, wall voids, and openings around the roof. Unused attics are good overwintering sites.

Flies, Elm Leaf beetles, Boxelder bugs and female Paper wasps (all hidden in attic cracks) will begin flying to windows on warm winter days. They often make their way down through closets and chimney cracks into living spaces of the house. This same behavior takes place in office buildings, hospitals, and other structures.

Inspection

Frequently finding flies dead at windows may indicate an Attic fly infestation.

Habitat Alteration

- Caulk cracks and crevices as much as possible.
- Tighten up and caulk around windows and screen ventilating spaces under the roof.

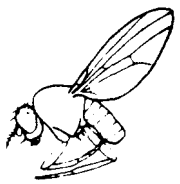
Pesticide Application

- Use liquid pressurized sprays or dusts where flies have collected in wall voids. Likewise, treat around window and door frames and other cracks and crevices.
- Use aerosols or space sprays where large numbers of flies are active; these formulations will control exposed individuals.
- Hang sticky fly strips in front of attic windows, especially east windows.
- Apply residual pesticides labeled for fly control to surfaces where flies rest, provided those surfaces are not used by people.

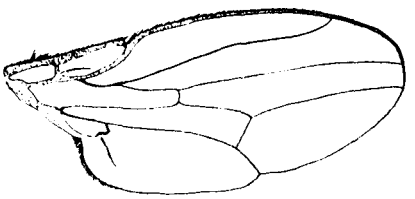
STRUCTURE INFESTING SMALL FLIES
Fruit Flies and Phorid Flies
Drosophila and the family Phoridae

These small flies (from two different fly families) often are mistaken for each other. They are about l/8 in long and somewhat similar looking, but their biology and management are very different. Treatment of these fly infestations are a good example of the site specific nature of successful pest management.

FRUIT FLIES



Drosophilidae



Wing

Several species of ***Drosophila*** have been immensely beneficial to mankind because of their use in the study of genetics and heredity. Fruit flies are attracted to nearly any material that is fermented by yeast. These small flies commonly have bright red eyes, although some species' eyes are dull-dark red. The head and thorax are yellowish to brown, and the abdomen is light brown to dark with yellow bands.

The wing vein structure is important and can be seen with a hand lens. It consists of a thickened vein bordering the front margin of the wing from the attachment at the thorax to the wing tip. Four other long veins can be seen on the rest of the wing.

In a common Fruit fly infestation, flies are attracted to the sweet odor of fermentation in ripe fruit, like bananas; they lay their eggs in the cracks of the peel. Fruit fly larvae hatch, then feed on yeast cells in the fruit. The life cycle can be completed in not much more than a week.

Newly-emerged adults are attracted to lights, but egg laying females will not leave fermenting materials. Fruits, vegetables, beer, fermenting water from refrigerators, humidifiers, sink drains, sour mops and rags, and fermenting pet food are good examples of fermenting material. Infestations are common in orchards, breweries, restaurants, canneries, hospitals, and homes.

Inspection

When certain the infesting insect is a fruit fly, look for fermenting materials. Begin with ripe fruit and vegetables, then proceed to less obvious possibilities.

- Use fly traps baited with bananas to find the most heavily infested areas when the source is very obscure.
- Be sure to inspect outside of the building near windows.

Habitat Alteration

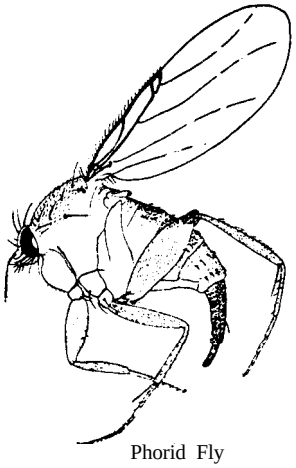
- Tighten up gaps where flies can enter.
- Use small mesh screening to exclude these small flies.
- Discard or clean infested material.
- Use precautions to remove flies before fruit is brought to terminal points when the infestation originates in the field or orchard. Infestations in canneries and fruit markets are particularly difficult to manage.

PHORID FLIES

Phorids or humpbacked flies are about the same size as fruit flies or a little smaller. They are dark brown and have a humpbacked appearance -- a visual effect caused by a small head located low on the front bulge of the thorax.

Wing venation consists of several short, thickened veins on the foremargin of the wing near the attachment to the thorax. These veins do not extend to

the wing tip, and other veins are weak or nearly invisible. Phorids run in short jerks.



Phorid Fly

These flies become problems when they infest decomposing plant or animal matter. Buried animals, garbage, or broken sewer lines support large numbers of phorids. Phorids also infest bodies in mausoleums.

Adults are able to emerge from the underground infestation site upwards through several feet of soil. If broken sewer lines are under buildings, phorids can come up through cracks in concrete floors or around floor drains. When water and sewage wash out cavities in the soil around the pipe, immense numbers of flies are produced.

Inspection

Carefully identify the infesting fly as a phorid. Locate the area where most flies appear. Ask clients if there have been sewer problems, buried garbage, decaying vegetable, or animal matter close by.

Habitat Alteration

- Remove decaying matter and soil contaminated by it.
- Where sewer lines must be repaired, insist that sewage contaminated soil also be removed.
- Caulk all floor and wall cracks where flies may enter.

MOTH FLIES OR DRAIN FLIES
The family Psychodidae

Moth flies are about l/8 inch long. Their dark color comes from tiny hairs that cover the wings which are held in roof-like fashion over the body. Moth flies have long, drooping antennae.

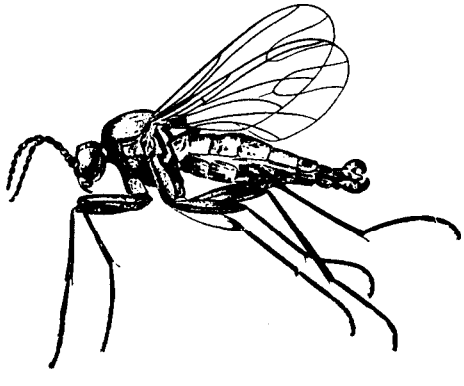
Larvae live in the gelatinous material in sink drains traps and sewers. Where. sinks regularly overflow, these flies build up in the overflow pipe. When drain traps of sinks, commodes, and floor drains dry out, large numbers can enter dwellings from the sewer.

Drain traps should be cleaned mechanically or with drain cleaners. Without larval control, adults will continuously emerge.

In sewage treatment plants, drain flies feed on the gelatinous material that collects on stones in trickling filter beds. Over time, however, cast skins from these filter flies can slow down water drainage. When sewage treatment plant filter beds malfunction or become "out of balance," the moth flies can become problems in nearby neighborhoods. The filter bed should be cleaned by reverse or back flushing.

FUNGUS GNATS
The families Mycetophilidae and Sciaridae

Fungus gnats are slender, delicate mosquito-like insects. Their larvae infest moist soil and feed on fungi associated with decaying vegetation. Indoors, fungus gnats infest flower pots. They also build up in pigeon droppings on outside ledges, then enter dwellings through nearby windows.



Fungus Gnat

MIDGES
The family Chironomidae

Midges look very much like mosquitoes but do not bite. Midge larvae live in water, especially in quiet, still water.

Adult midges are the driving force behind some spider infestations on buildings and monuments (see Orb Web spiders, Chapter 3). The adults fly to lights and enter dwellings through gaps.

Management is site specific; pesticides are generally not useful. Manipulating lights will reduce midge attraction. As part of the pest management plan, note flight periods and times. The larvae of some species of midges indicate a larger pollution problem.

SUMMARY

Flies, insects with complete metamorphosis, in the great order Diptera are characterized by having only one pair of wings. These insects carry diseases and are responsible for millions of deaths each year because of their disease vectoring ability -- particularly in less developed countries. In urban areas, flies contaminate food and people in restaurants, hospitals, homes. They are annoying indicators of sanitation, structural, and cultural problems.

STUDY QUESTIONS FOR MODULE TWO
CHAPTER ONE
HOUSEFLIES AND THEIR RELATIVES

1. Distinguish between ***Drosophila*** or fruit flies and phorid flies.

2. Briefly distinguish between house flies, flesh flies, blow flies and cluster flies.

3. Briefly describe the two major divisions of the order Diptera characterized by form.

4. Describe the life cycle of the cluster fly.

5. List at least three pest management procedures for house fly and blow fly infestations.

6. List at least three pest management procedures for fruit fly or ***Drosophila*** infestations.

For Answers refer to Appendix A

CHAPTER 2

STINGING PESTS

Learning Objectives

After completion of the study of Stinging Insects, the trainee should be able to:

- Identify common urban stinging insect pests.
- Describe the life cycles of yellowjackets, paper wasps, mud daubers, honeybees, and carpenter bees.
- Given an urban stinging insect problem, describe integrated pest management procedures to suppress it.

The insects most beneficial to humans are found in the large insect order Hymenoptera. Not only are the bees and many of their relatives pollinators of flowering plants, including fruits and vegetables, but thousands of species of small wasps are parasites of other arthropods including pest insects. Without these parasites that limit the growth of insect populations, pests would overtake most crops.

The urban pests of the order Hymenoptera are the stinging insects. Although the first image to come to mind implies danger to humans, these yellowjackets, hornets, and wasps sometimes serve our interest: They feed their young largely on flies and caterpillars.

Many of these stinging insects are social. They live in colonies with a caste system or a division of labor and overlapping generations -- all offspring of one individual reproductive. Some of these colonies persist for many years (ants, honey bees) and others, like stinging wasps, start anew each year.

WASPS, YELLOWJACKETS, AND HORNETS

In parts of the United States, particularly in the eastern states, yellowjackets, wasps, hornets and bees are all called bees by the general public. Of course the general public is principally focused on one attribute these insects have in common -- their stingers.

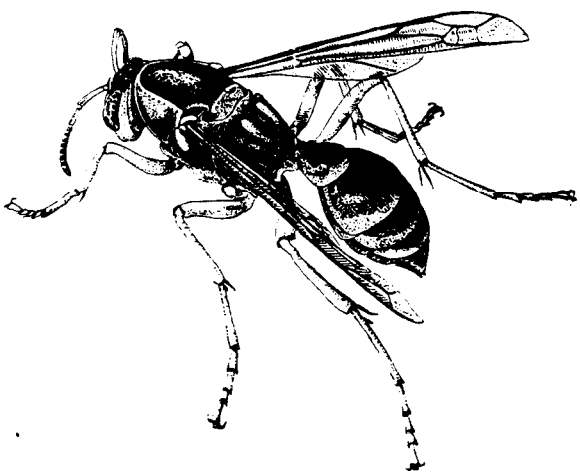
Knowledge of the behavior of these pests is essential to their management; effective communication with frightened or, at best, fearful clients is an important skill technicians must develop.

Nests of stinging pests are usually the target for control. Understanding nesting and the make-up of the colony is essential.

NESTS AND COLONIES

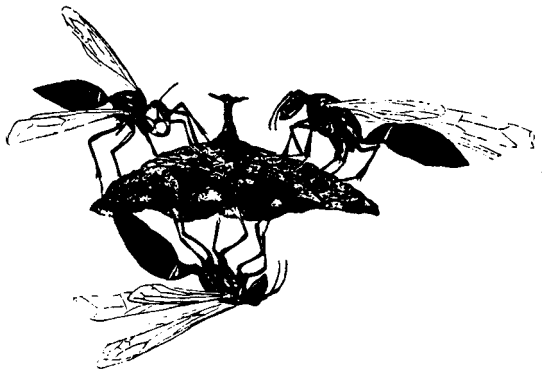
Yellowjackets, hornets and paper wasps are all in the same insect family, Vespidae. The common Paper wasp with its umbrella shaped nest or single comb best demonstrates the basic building pattern of a colony.

PAPER WASPS



Paper Wasp

Paper wasp queens, like other Vespid nest mothers, is the lone female reproductive, who begins her nest by attaching a thick paper strand to an overhanging structure. She then builds hollow paper cells by chewing wood or plant fibers (cellulose) mixed with water and shaped with her mouthparts.



Paper Wasp Nest

When a half dozen cells or so are hanging together, the Queen lays an egg near the bottom of each one. The little white grubs that hatch from the egg glue their rear ends in the cell and begin receiving nourishment in the form of chewed up bits of caterpillars provided by their mother. When they grow large enough to fill the cell cavity, they break the glued spot and hold on their own by their stuffed fat bodies, hanging head down.

Mature larvae, then, spin silk caps, closing off the cell, and molt into pupae. This same larval behavior pattern is followed by yellowjackets and hornets also. All are females. Other than their white color, these Vespid pupae look like adults; they develop adult systems, then shed their pupal skins, chew through their silk cell cap, pump out their wings, and take their place as worker assistants to their mother. (Paper wasp queens and workers are the same size; yellowjacket and hornet queens are larger than their daughters.)

From Spring on, the queen lays eggs and the daughter workers feed larvae and expand the comb or nest. They do not eat the protein (insect) food they gather for the larvae but get their energy from flower nectar. Later in the season, some of the larvae develop into males and others will become next year's queens.

The new males and females mate with those of other colonies, and the fertilized females find hiding places under tree bark or in logs and wait out the winter until they can begin their new colony in the spring.

The male Vespids die in winter, likewise the nest disintegrates and will not be used again.

MANAGEMENT AND CONTROL OF PAPER WASPS *(Polistes)*

Paper wasps nests are often found near doorways and other human activity areas without occupants being stung. Colonies can become problems, but when they do, Paper wasps can be controlled easily:

When attracted to fallen ripe fruit, these wasps sting people who venture into the same area. Colonies in trees, out buildings, hollow fence posts and other protected places are not as easy to control as those from nests on structures.

Habitat Alteration

- Remove old nests and scrape the point of attachment. [This spot is often selected by new queens for attachment of new combs.]
- Remove ripe fallen fruit as often as possible.
- Caulk openings in attics, window frames, and around wall penetrations to keep overwintering females out of unused rooms and spaces.

Pesticide Application

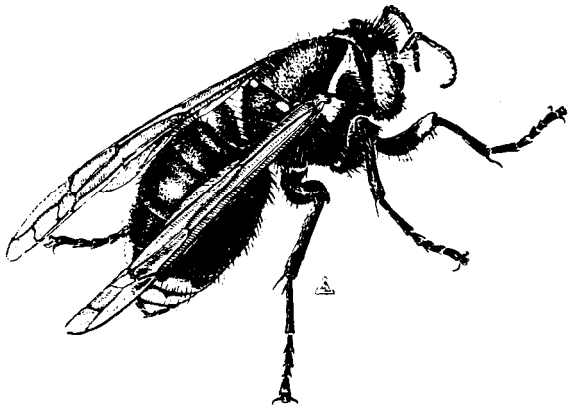
- Use pressurized sprays that propel spray for 8-12 feet or use aerosols on extension poles especially manufactured for aerosol cans.
- If a ladder is needed wear a bee suit and veil. Proceed cautiously.

YELLOWJACKETS

Yellowjacket (with eighteen species in North America) colonies begin with a large fertilized queen; she develops smaller daughter workers and later reproductives just as the Paper wasps, but the nest structure is not the same. Some yellowjacket nests hang in trees and shrubs, and some are developed underground.

Aerial Nesters

Several yellowjackets make the aerial football-shaped paper nests, commonly called hornets nests. Two of these yellowjackets are common: the Aerial yellowjacket, ***Dolichovespula arenaria,*** and the Bald Faced hornet, ***Dolichovespula maculata.***



Bald Faced hornet

The Aerial yellowjacket is found in the west, Canada, and east (but not in the central and southern states). This species begins its nest in March or April and is finished and no longer active by the end of July. Their nests, usually attached to building overhangs are smaller and more round than those of other species.

The Bald Faced hornet is larger than the other yellowjackets and is black and white -- not black and yellow. It lives along the west coast, across Canada, and in all of the states in the eastern half of the country.

Bald faced Hornet Nest

On warm spring days, the large Aerial nesting queen develops a small comb, like the Paper wasp with a dozen or so cells, but she encloses it in a round gray paper envelope. The daughter workers later take over the nest duties, and by mid summer, when the worker population is growing and food is plentiful, the nest is expanded to full size. A full-sized Bald Faced hornet nest consists not of a single umbrella comb like the Paper wasp, but four to six wide circular combs -- one hanging below the other and all enclosed with an oval paper envelope consisting of several insulating layers. Bald faced hornets not only gather flies, but are large enough to kill and use other species of yellowjackets for larval food. They attach their nests to low shrubs or high in trees or on buildings. Although Aerial colonies can have four to seven hundred workers at one time, their food gathering habits do not routinely bring them in contact with humans. Large nests are often discovered only after leaves have fallen and the nests are exposed -- both to view and to nature's elements that finally bring about their disintegration.

Underground Nesters

The stinging wasp, often identified as a yellowjacket, is black and yellow. Primarily yellow bands cover a dark abdomen. These species are in the genus ***Vespula.***

They begin their nests like the aerial nesters -- with an enveloped small comb made of wood fiber paper. Only these nests are started in soil depressions, rodent burrows, or in any small hole in the ground that will give protection until workers can develop.

Once workers begin nest care, they enlarge the entrance hole and expand the nest. Combs are placed in tiers, one below the other. They can be very large; they have firm support from the soil surrounding the external envelope. Several species of ***Vespula*** make their nests in building wall voids, attics, hollow trees and other enclosed spaces as well as the ground.

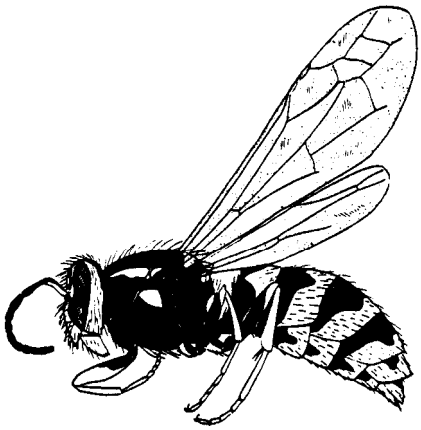
Both Aerial and Ground Nesters

Of the thirteen species in North America, only a few require pest management. These few species have certain characteristics and habits that put them on a collision course with people:

- They can live in what might be called disturbed environments (areas that have been changed to suit human activities in urban settings) such as yards, golf courses, parks, and other recreation areas.
- They have large colonies -- some will develop thousands of workers.
- Their habits do not restrict them to a specific kind of prey. Foraging workers capture insects for their larvae and nectar and other sweet carbohydrates for themselves where they can find it. Essentially, they are scavengers and work over garbage cans and dumpsters. They especially enjoy picnics and football games.

One can easily see that these habits put a large number of foraging ***stinging*** insects into close association with large populations of humans.

THE WESTERN YELLOWJACKET
Vespula pensylvanica



This is the primary pest yellowjacket in the west and is found from Washington to California. It often builds its nests in rodent burrows, clearing the ground around the entrance and producing a colony of around 5,000 workers. This yellowjacket preys on a wide variety of arthropods but also scavenges. It has been known to drive out loggers, fruit pickers, and campers, as well as food facility customers.

THE COMMON YELLOWJACKET
Vespula vulgaris

Second in importance in the western states, ***V. vulgaris*** also ranges across Canada and the northeastern United States. Common in higher elevations, it nests in shady evergreen forests around parks and camps in the western mountains and the eastern Appalachians. This species also is one of the most important stinging insects in Europe.

THE EASTERN YELLOWJACKET
Vespula maculifrons

This common ground nesting yellowjacket is distributed over the eastern half of the United States. Its western border is from eastern Texas north to eastern North Dakota. Workers are slightly smaller than most yellowjackets, but colony size can number around 5,000 or more individuals. The nest of ***V. maculifrons*** is dark tan, made of partially decomposed wood and is quite brittle. The Eastern yellowjacket sometimes nests in building wall voids.

Most yellowjackets have very slightly barbed stingers but the sting will not set in the victim's tissue like the barbed stinger of the honey bee. The stinger of ***V. maculifrons,*** however, often sticks and when the insect is slapped off, the stinger may remain. [When stingers are retained, it cannot always be assumed to be a honey bee.]

THE SOUTHERN YELLOWJACKET
Vespula squamosa

Distributed from Texas, north to Iowa, and east to the Atlantic coast, this yellowjacket is particularly common in the southeastern quarter of the United States. In Florida, colonies are known to be active for more than one year; these southern colonies remain active later in the summer. and build up large numbers of workers and reproductives. The Southern yellowjacket sometimes nests in building wall voids.

THE GERMAN YELLOWJACKET
Vespula germanica

In Europe, German yellowjacket nests are subterranean, but in North America the vast majority of reported nests are in structures. This yellowjacket is distributed throughout the northeastern quarter of the United States. Nests in attics and wall voids are large, and workers can chew through ceilings and walls into adjacent rooms. The nest and nest envelope of this yellowjacket is made of strong light gray paper much like that of the Western yellowjacket. Colonies of this yellowjacket may be active in protected voids into November and December when outside temperatures are not severe.

THE GIANT HORNET
Vespa crabro

The last Vespid to be discussed is the Giant hornet (sometimes called the European hornet or the German hornet). Technically, this wasp is the only hornet in North America, but it did not originate here; it was introduced from Europe. It is found in the northeastern quarter of the United States; it ranges as far south as North Carolina and Tennessee with scattered sightings extending west of the Mississippi River.

The Giant hornet is reddish-brown and yellow and almost an inch long. It builds its nest mainly in hollow trees, and in wall voids of barns, sheds and sometimes houses. An open window or door is an invitation to hornet workers, and they frequent buildings under construction. Their large combs and envelope are constructed of partially decomposed wood and, like the Eastern yellowjacket, are very brittle. Workers of the Giant hornet capture a variety of insects including bees and yellowjackets to feed their young. Workers also have a habit of stripping bark back from some shrubs

-- especially lilac. As they girdle the branches, they lick the sap from the torn edge. They will sting humans, and the sting is painful.

MANAGEMENT OF YELLOWJACKETS

Problems with yellowjackets occur mainly when:

- humans step on or jar a colony entrance
- a colony has infested a wall void or attic and has either chewed through the wall into the house or the entrance hole is located in a place that threatens occupants as they enter or leave the building
- worker yellowjackets are no longer driven to feed larvae in the late summer months, and they wander, searching for nectar and juices -- finding ripe, fallen back yard fruit, beer, soft drinks and sweets at picnics, weddings, recreation areas, sporting events and other human gatherings.

Yellowjackets are sometimes responsible for injections of anerobic bacteria (organisms that cause blood poisoning). When yellowjackets frequent wet manure and sewage they pick up the bacteria on their abdomens and stingers. In essence, the stinger becomes a hypodermic needle. A contaminated stinger can inject the bacteria beneath the victim's skin. Blood poisoning should be kept in mind when yellowjacket stings are encountered.

Inspection

Sting victims often can identify the location of yellowjacket nests. Where the nest has not been located look in shrubbery, hedges, and low tree limbs for the Bald Faced hornet. Soil nests are often located under shrubs, logs, piles of rocks and other protected sites. Entrance holes sometimes have bare earth around them. Entrance holes in structures are usually marked by fast flying workers entering and leaving. Nests high in trees should not be problems. ***Be sure to wear a bee suit or tape trouser cuffs tight to shoes.***

Habitat Alteration

Management of outdoor food is very important.

- Clean garbage cans regularly and fit them with tight lids.
- Empty cans and dumpsters daily prior to periods of heavy human traffic at zoos, amusement parks, fairs and sporting events.
- Remove attractive refuse, such as bakery sweets, soft drink cans, and candy wrappers, several times a day during periods of wasp and yellowjacket activity.
- Locate food facilities strategically at late summer activities so that yellowjackets are not lured to dense crowds and events. [The National Park Service in their IPM programs, found that stings were dramatically reduced when drinks are served in cups with lids.]
- Clean drink dispensing machines; screen food dispensing stations, and locate trash cans ***away*** from food dispensing windows.
- To limit yellowjacket infestations in wall voids and attics, keep holes and entry spaces in siding caulked; screen ventilation openings.

Pesticide Application

When possible, treat ground and aerial nests after dark [Workers are in the nest at that time]. More often than not, because of traditional work schedules, treatment will be scheduled for the daytime.

Begin with the entrance hole in view and a good plan in mind.

- Wear a protective bee suit. Unless these insects can hold on with their tarsal claws, they cannot get the leverage to sting. Bee suits are made with smooth rip-stop nylon which does not allow wasps and bees to hold on. A bee veil and gloves are part of the uniform. Wrist and ankle cuffs must be taped or tied to keep the insects out of sleeves and pant legs.
- Move slowly and with caution. Quick movements will be met with aggressive behavior. Move cautiously to prevent stumbling or falling onto the colony.
- Have equipment handy so one trip will suffice.

Application

- Insert the plastic extension tube from a pressurized liquid spray or aerosol generator in the entrance hole; release the pesticide for 10 to 30 seconds. Resmethrin is most effective.
- If the pressurized liquid spray includes chemicals that rapidly lower nest temperature (freeze products), be aware that it will damage shrubbery.

- Plug the entrance hole with dusted steel wool or copper gauze. Dust the plug and area immediately around the entrance. [Returning yellowjackets cue on entrance holes using surrounding landmarks and seeing the shadowed opening. They will land at the entrance and pull at the plug picking up toxic dust. Any still alive inside will also work at the dusted plug.

Aerial Nests

- Cut aerial nests down and seal them in a plastic bag. [The queen and workers inside will be dead, and larvae will fall out of their cells and die from either insecticide poisoning or starvation. Pupae in capped cells may escape the treatment, however, and emerge later.]
- Be especially cautious when using ladders to get at aerial nests or wall void nests. Set the ladder carefully and move slowly.

Wall Voids

- Approach the entrance hole cautiously; stay out of the normal flight pattern.
- Watch first. Observe whether yellowjackets entering the nest go straight in or to one side or the other.
- Insert the narrow diameter plastic tube in the hole in the observed direction of entrance and release pesticide for 10-30 seconds.
- Dust inside the entrance and plug it as with underground nests.
- Remember, German yellowjacket nests may remain active into December.
- Use care not to contaminate food surfaces.

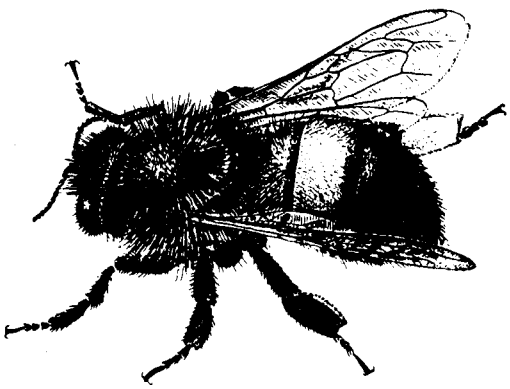
Spraying trash cans and the outside of food stands will reduce or repel yellowjackets at sporting events; the treatment will not last more than one day. Honey bees are also killed with this control measure. Remember, do not contaminate food surfaces.

A synthetic chemical lure (composed of 2,3-hexadienyl butyrate) is attractive to the Western yellowjacket. Traps with this lure were found to depress wasp populations successfully in a peach orchard and in some western campsites. They are ineffective with eastern species.

Follow-up

Ongoing monitoring throughout the active yellowjacket season is essential when a pest management program is in place at parks, recreational areas, zoos and other outdoor activity areas.

HONEY BEES
Apis mellifera



The honey bee was introduced into the United States in Colonial America. Honey bees are highly social insects and communicate with each other, relaying direction and distance of nectar and pollen sources. Bees make combs of waxen cells placed side by side that provide spaces to rear young and to store honey. The bee colony lives on the stored honey throughout winters, and therefore, can persist for years.

When colony populations are high, the queen may move part of the colony to new harborage. Bees swarm at this time, usually finding hollow trees to begin their new colony, but they occasionally work their way into building wall voids.

A honey bee colony in a house wall can cause major problems. The bees can chew through the wall and fly inside. Their storage of large amounts of honey invites other bees and wasps. Their detritus (e.g., dead bees, shedded larval skins, wax caps from combs and other material) attracts beetles and moths.

When a bee colony is found in a building wall, it must be killed. Killing can be accomplished in the same way as killing yellowjackets in wall voids is done. Listen to the bee noise from inside rooms to locate the exact position of the nest in the wall to assure that the whole colony is treated.

After the colony is dead, remove the nest. If the nest is not removed, the wax combs -- normally cooled by the bees -- will melt and allow honey to flow down through the walls. Honey stain can never be removed; the walls will have to be replaced. As well, the freed honey attracts robber bees and wasps. The comb wax will attract wax moths that may persist for several years. The dead bees attract carpet beetles.

After the colony is killed the entrance hole should be caulked or repaired to prevent further bee infestation.

THE AFRICANIZED BEE

The Africanized bee is the same species as the European honey bee kept by beekeepers all over the United States. Introduced into Brazil from southern Africa, it is adapted to longer warm seasons than are northern honey bees.

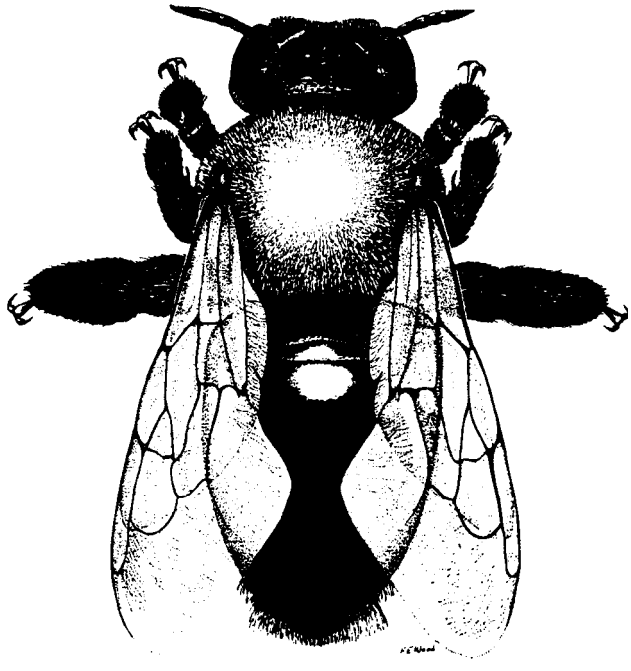
It is thought that this bee will advance as far into the northern temperate region as it has into the southern temperate region. If this is true, Africanized bees will be distributed north in a line that will reach from southern Pennsylvania, west to Seattle, Washington.

Africanized bees do not store as much honey to take them through the winter as honey bees do. They have smaller colonies and tend to swarm more often. Smaller swarms allow colony development in smaller cavities. In South and Central America, Africanized swarms settle in hollow trees like northern honey bees; they also colonize in rubber tires, crates and boxes, wall voids, abandoned vehicles and other protected places that abound in urban areas. Worker bees tend to mob intruders. The urbanized Africanized honey bee presents a new management challenge not only to beekeepers but to urban pest management technicians.

CARPENTER BEES
Xylocopa

Carpenter Bees are not social insects; they live only one year. The most common Carpenter Bee, ***Xylocopa virginica,*** is distributed throughout the eastern half of North America. This bee is a large insect with a hairy yellow thorax and a shiny black abdomen. Superficially, it resembles yellow and black female bumble bees, which are social and more closely related to honey bees. Western Carpenter bees are also large, shiny, sometimes metallic, and are shaped like bumble bees.

Carpenter bees bore in wood and make a long tunnel provisioned with pollen and eggs. They prefer to enter unpainted wood and commonly tunnel in redwood and unpainted deck timber. They will also go into painted wood especially if any type of start hole is present. New females reuse old tunnels year after year; they are also attracted to areas where other females are tunneling. Egg laying and tunnel provisioning occurs in the spring. Males hover around the tunnel entrance while the female provisions the nest and lays eggs.



Males dart at intruders belligerently but they can do no harm; they have no stingers. Since these bees are not social, there is no worker caste to protect the nest. Stings of females are rare.

New adults emerge after the middle of summer and can be seen feeding at flowers until they seek overwintering sites, sometimes in the tunnels.

Habitat Alteration and Pesticide Application

Carpenter bees drill into the end grain of structural wood or into the face of a wooden member, then turn and tunnel with the grain.

Dust tunnels or inject with pressurized liquid insecticide. Insert a dusted plug of steel wool or copper gauze in the tunnel; fill the opening with caulk, wood filler, or a wooden dowel. [A dusted plug stops new adults who otherwise would emerge through shallow caulking.] Caution should be taken, especially if technicians are working on ladders and if they are not experienced with these rather harmless bee?.

MUD DAUBER WASPS
Family Sphecidae

Mud Dauber wasps are not social wasps like Paper wasps. They are in a different family. Many paralyze spiders to provision mud cells built to enclose eggs, larvae and pupae. The mud cells form long clay tubes or large lumps. The wasps are slender; they are

shiny black or brown, orange or yellow, with black markings. Many have long slender thread waists.

Like Carpenter bees there is no protective worker caste; these wasps are not aggressive; they will not sting unless pressed or handled. Mud Daubers place their mud nests in protected places like electric motors, sheds, attics, against house siding and under porch ceilings. So many wasps congregate at the same site to construct the mud nests that later removal of the nests and repainting is often expensive.

Habitat Alteration and Pesticide Application

Mud daubers are killed easily with aerosol contact sprays. Scrape away mud nests, and cover problem areas with a good quality smooth paint. Nesting should be discouraged on porticos and high porches of historically important buildings.

CICADA KILLER WASPS

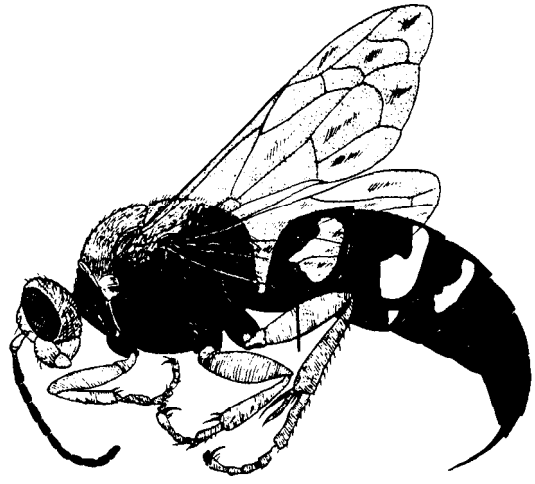
Family Sphecidae

Sphecius speciosus

Cicada killers are very large yellow and black relatives of mud daubers, however they do not look like mud daubers. More than one inch long, they look like "monster" yellowjackets.

Pest Management

Cicada killers can be ignored by those who accept an explanation of their harmless nature. Each wasp, being a female, has a stinger; each can sting. Due to their size and fierce looks, however, stings are extremely uncommon. When there is undue worry about these huge wasps, open soil burrows can be dusted individually; the female will be killed when she returns.



SUMMARY

Stinging insects are included in the very large order Hymenoptera. Hymenoptera undergo complete metamorphosis and thousands of species are parasites of other insects. When they parasitize pest insects, man lists them as beneficial insects; in many instances they are encouraged, protected or reared and released for their pest suppression qualities. Many species of Hymenoptera are social, including stinging insects such as yellowjackets, paper wasps and honey bees as well as the ants. Stinging social insects (with the single queen) can be very aggressive because there are many workers that can be used to protect the hive and even expend their life doing it. Stinging, non-social hymenoptera such as mud daubers, cicada killers and carpenter bees tend to be non-aggressive and are usually single, fertile females or queens that do not have a colony or a protective caste with the individuals that can be expended.

STUDY QUESTIONS FOR MODULE TWO
CHAPTER TWO
STINGING INSECTS

1. Describe the two types of nesting habits of yellowjackets.

_____
_____
_____

2. Describe the nesting habits of the paper wasps, ***Polistes.***

_____
_____
_____

3. Describe the nesting habits of mud dauber wasps.

_____
_____
_____

4. What makes an insect a "social insect?"

_____
_____
_____

5. Describe pest management procedures for a stinging insect problem where stings and specimens were the only clues provided by the client.

_____
_____
_____

For Answers refer to Appendix A

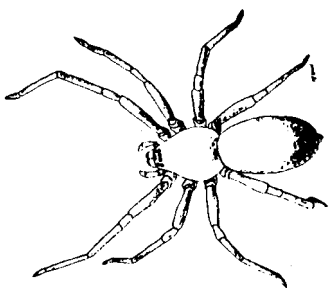
CHAPTER 3

SPIDERS

Learning Objectives

After completion of the study of Spiders, the trainee should be able to:

- Describe the habitat and life cycles of common types of spiders that cause problems in urban areas.
- List the appearance or characteristics of harmful spiders.
- Understand pest management procedures for urban spider problems.



Spiders are seldom ignored. Their distinctive appearance, habits, and intricate webs command attention and evoke strong emotions. Given their due, spiders would be prized for their role as predators and natural regulators of insect populations, but because of their appearance and human cultural fears, when one is found to be potentially dangerous, sensationalizing it is irresistible.

There are 3,000 kinds of spiders in the U.S.; they are categorized in the order Araneae. Like their arachnid relatives the mites, spiders live in all parts of the world where they quietly make their way, snaring food in their webs or ambushing insect prey in episodes acted out in minute jungles and deserts.

The two-part spider shape is well known. Its head and thorax are combined to make the cephalothorax. Four legs are attached to each side of the cephalothorax. Spider eyes are in front -- some have very large eyes. Like all arachnids, spiders have no antennae.

While all spiders are poisonous to some extent, few bite humans. Spider mouthparts, located in front below the eyes, have two short needle-tipped appendages, called chelicerae. These needles, or central fangs, are connected internally to poison sacs. The fangs are used to bite prey (mostly other arthropods) and inject poison to immobilize it. Two short leglike mouthparts help hold their paralyzed prey, while the chelicerae work back and forth tearing the exoskeleton. As blood wells out, it is sucked into the mouth cavity and ingested. Spiders keep working their prey in this way until all the juices are gone and the remainder is a dry crumbled lump.

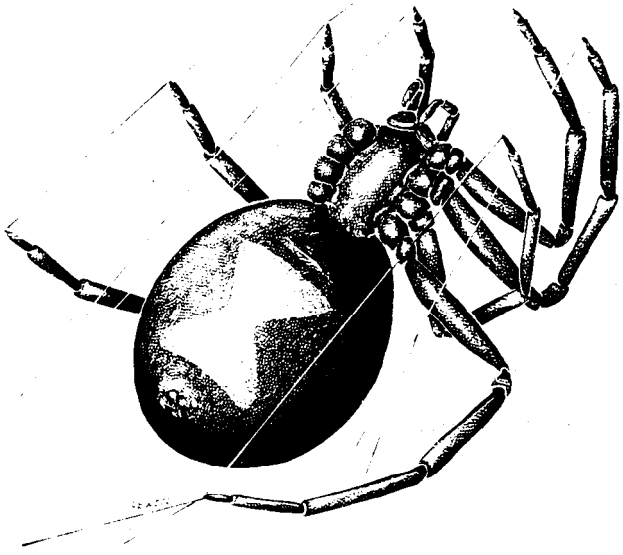
The abdomen is located behind the cephalothorax; it is saclike, usually globular. The anal opening is located near the end of the abdomen and close by are some short appendages called the spinnerets. Silk webbing threads out from these spinnerets.

All spiders produce silk, and they use silk in more interesting ways than most other silk producers. Spiders make silk retreats such as tubes and funnels, they make irregular cobwebs as well as the evenly spaced, spiraled great orb webs. Most spiders feed out a dragline wherever they walk and never fall off edges without catching themselves.

While spiders don't have wings, they "fly" nonetheless, by releasing a thread of silk until it is long enough for the wind to catch it and carry them off -- the process is known as ballooning. Newly-hatched spiderlings use this method to leave the hatching area.

Two spiders are considered dangerous to humans in the United States: the Black Widow and the Brown Recluse. In reality, these two names each represent several species.

BLACK WIDOW
Latrodectus mactans



The Black Widow spider, the species ***Latrodectus mactans,*** is distributed over the eastern and southern United States. Two very similar species overlap that range and extend into the western and northwestern states.

Female Black Widows have large, round, shiny black abdomens usually decorated with two touching red triangles on the belly. They hang upside down in the web, and the red hourglass is obvious. Sometimes dull red dots appear on the back, and occasionally the triangles don't touch, but this l/2 inch or larger, shiny black spider is unmistakably unique and eye catching. Male Black Widows are small, white and streaked with yellow and red; they are not dangerous.

Black Widow females are not aggressive but will give full attention to anything that disturbs the web. They weave tangled webs of coarse silk in dark, quiet locations. Mature females are so large they can hardly crawl. While pest management technicians are not commonly called on for Black Widow spider control, they may well run into these spiders when inspecting crawl spaces, porches, garages, and sheds for other pests. Black Widow spiders can be found in stacked pots or baskets, firewood piles, rodent burrows, water meters, stacked boards, under bricks and stones. Usually the spiders are outside, but they may be brought inside, or the young may move inside on ground floors, Western Black Widows are likely to be found outside in bird nests, on low plants and in grape arbors. Move cautiously when treating any potential spider harborage.

Black Widow bites are immediately painful. The pain at the site of the bite increases during the first half hour following a bite. Two small red marks from the fangs will be noticeable on the skin. After the first half hour other symptoms such as headache, dizziness, shortness of breath, abdominal and back pain set in. Death seldom results from Black Widow bites to healthy adults; children and the elderly, however, are vulnerable. Victims should receive hospital treatment as soon as possible.

Habitat Alteration

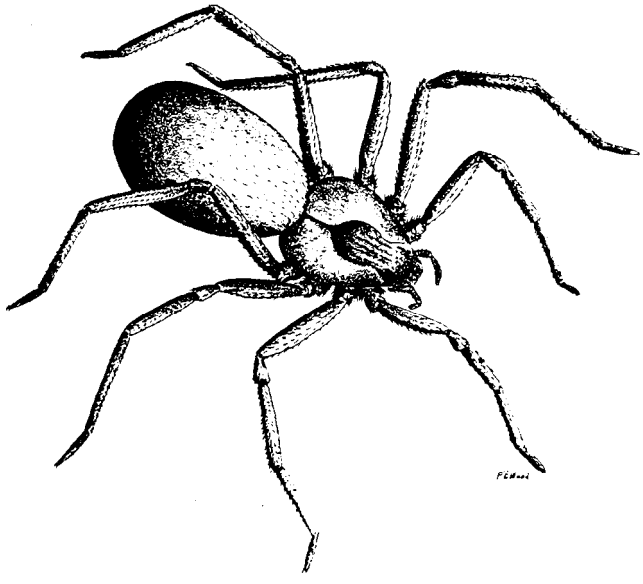
Eliminate harborage sites carefully.

Pesticide Application

Pesticides must come directly into contact with the spiders since they do not leave their webs or wander after they have become established in the summer.

A control method found in nature is employed by Mud Dauber wasps; they paralyze spiders and store them in their mud cells for their larvae to devour. One spider wasp family is known to provision its burrows with spiders. These predators are particularly active in the western states.

BROWN RECLUSE SPIDER
Loxosceles reclusa



Loxosceles reclusa is a dusky-tan or brown spider with the widest range of any recluse spider in the United States. It ranges from central Texas, north to Oklahoma, Kansas, Iowa, and south through Illinois, North and South Carolina, northwestern Georgia, and Alabama, with a few collections in adjacent states and

where they have been transported in luggage and household furnishings. Other species of recluse spiders live in the southwestern states particularly in desert areas. This spider lives outdoors in the southern part of its range and primarily indoors throughout the rest of its distribution. It is commonly found in older homes in the Midwest. The Brown Recluse is smaller than the Black Widow; it has an oval abdomen rather than a round one. The abdomen is uniformly tan to brown without marking. A dark fiddle-shaped mark is obvious on the cephalothorax -- the broad base of the fiddle begins at the eyes and the narrow fiddle neck ends just above the attachment of the abdomen. Legs are long, the second pair longer than the first. The Brown Recluse makes a fine, irregular web. It commonly wanders in the evening in indoor infestations.

Bites. Recluse spiders avoid parts of rooms where human activity is prevalent, remaining where there is no activity and in closed or unused rooms. Even though indoor infestations can be large, household inhabitants are seldom bitten. Bites can be expected when guest rooms are suddenly put into use or when stored clothing is brought out for use. Brown Recluse bites are sharp but not initially painful like those of the Black Widow, but a blister is quickly raised, broken, and surrounded by a red welt. The depressed center of this raised, red circle (the size of a dime to a quarter) turns dark within a day. The dead tissue regularly sloughs away, and the bite area scars over in one to eight weeks. Death seldom occurs, but the bite is debilitating and psychologically traumatic.

The spider is delicate. After biting, it frequently can be found lying where it was slapped by the victim. It should be killed and taken to the physician along with the victim for positive identification. Other biting arthropods can produce lesions resembling the bite of the Brown Recluse spider.

A foreign species of recluse spider, ***Loxosceles rufescens,*** is imported from Mediterranean Europe and North Africa. While this spider closely resembles ***L. reclusa*** and has successfully infested several locations in the middle Atlantic states at least for short periods, its bites do not result in trauma like those of ***L. reclusa*** and have been noted to be far less venomous.

Inspection

Recluse spiders should be sought near places where bites occur.

- Look along walls in uninhabited rooms, under and behind furniture, in the far reaches of storerooms, in unused closets, under stairs and in hanging clothing that has not been used during the current season.
- Concentrate on areas outside daily human traffic patterns. Homes and buildings that have been unoccupied for months or longer are particularly susceptible to increased spider populations.
- Outdoors, in the southern and western part of its range, these spiders may be found in cracks between the soil and structure foundations, door stoops, and in window wells.
- Outside of their range, inspect around luggage, trunks, and furniture brought from southern Europe, the Mediterranean, or North Africa. American personnel, who have, lived overseas in these areas, sometimes introduce ***L. rufescens*** in returning household goods.

Habitat Alteration

- Recommend careful mopping or dusting of seldom-used rooms and closets.
- Inspect winter clothing that has hung in hallways or unused closets through the spring and summer. Store them in plastic bags.
- In the evening, reinspect spaces disturbed by dusting and mopping. Kill moving spiders.

Pesticide Application

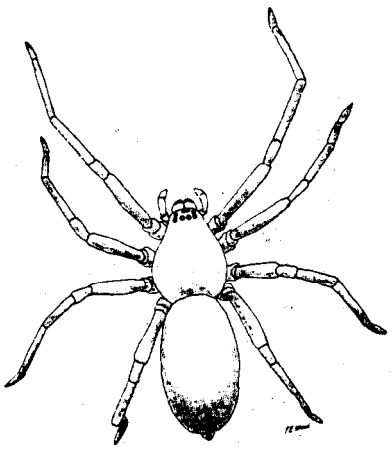
Residual pesticides labeled for spiders, should be used carefully to control the Brown Recluse spider.

- Carefully use residual pesticides labeled for spiders.
- Apply the pesticide in all cracks and crevices -- particularly in spaces outside daily human traffic patterns.
- Spot treatments will be less effective than crack and crevice treatments because spiders touch spot residues only with hairs at the tips of their legs.

Follow up

Spiders not killed by the pesticide treatment will wander. Warn clients to be wary of immediate use of rooms not normally in use. They should watch carefully for spiders one or two days following treatment. Monitor and, if indicated, retreat the structure in one or two weeks.

YELLOW HOUSE SPIDER
Chirocanthium mildei



The Yellow House spider was introduced into the United States in the late 1940s and is now common. A native species is common outdoors, and a third, introduced into Hawaii, is now common inside buildings there. These spiders are about l/4 inch long, with legs and cephalothorax darker than the abdomen. It has been reported as being yellow, white, or greenish.

In late summer and early fall, Yellow House spiders migrate into structures and automobiles. At this time, they have not reached the adult stage, and they weave protective, white, silken cocoon-like webs in which to overwinter and molt into the adult stage in spring. The Yellow House spider will bite if pressed or accidently confined (e.g. during the victim's sleep). The venom has been described as causing pain and reddening at the site of the bite. In some instances a deadening of the tissue will occur, but much less severe than that caused by the Brown Recluse spider. Children that show symptoms of spider bites (the two fang marks) may have been bitten by the Yellow House spider. This spider, however, cannot pierce the skin of everyone; there is a very large margin of safety.

Inspection

Inspect rooms, particularly bedrooms of suspected Yellow House spider bite victims. Inspect obvious webbing sites in the fall as a part of ongoing monitoring activities for other pests.

- Look at the angles of the wall and ceiling, door and window facings, in furniture joints, in larger cracks and crevices, in thermostats, and in other protected places.
- Look for webs inside jets and burner trains of gas appliances that are inactive during the summer-winter transition period. Other sites are gas stoves and refrigerators in recreational vehicles, gas air conditioners and through-the-wall gas furnaces. [The silken obstructions interfere with gas flow; operational failure can be an indication of their presence.]

Habitat Alterations

- Close gaps around outside entry doors and ground floor windows that may be entry points for the spider.
- Keep grass low next to building foundations to discourage wandering spiders.

Pesticide Application

- Where biting is a problem, apply a residual pesticide labeled for spiders in cracks and crevices, including closets and furniture joints.
- Apply pesticides carefully, in small amounts and at low pressure to suppress drift and noxious odors.
- Ventilate the rooms after treatment.

THE AGGRESSIVE HOUSE SPIDER
Tegenaria agrestis

This common funnel-weaving spider is found in the northwestern United States. Its body is about l/2 inch long; it has a dull tan color with darker markings on its oval abdomen. This spider makes thick webs with the funnel neck back in a wall crevice and the wider mouth opening into a room. They are found only in moist areas of basements or cellars, in ground level window wells, and so forth. The spider has been given its name because it readily bites when touched or pressed. The bite, not initially painful, resembles the bite of the Brown Recluse spider (not found in the Northwest) and other bites that result in ulcerating lesions. A close relative is distributed in the northeastern United States but is not aggressive. These cellar-dwelling, funnel-weaving spiders were introduced from Europe where they are very commonly found in structures.

Inspection

The funnel web is easy to see in moist basement areas.

Habitat Alteration

Tighten and close up spaces around entrances.

Pesticide Application

Apply contact spray into the funnel. Vacuum webs and spiders.

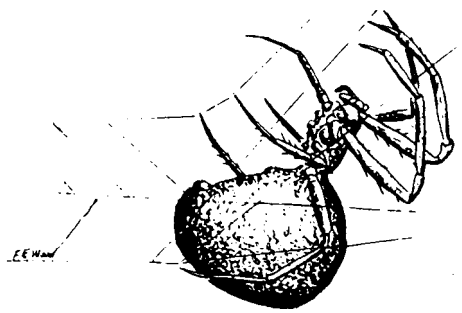
WEB WEAVING SPIDERS

Orb Weaving Spiders

Several hundred species of orb weavers are distributed in the United States. Usually only the large, conspicuous orange and yellow, or black and yellow, species are noticed in late summer when they build webs that extend one foot or so across on porches or small trees and shrubs. These large flat webs have many straight strands radiating out from the center and are connected with spiral thread winding around and around from the middle out to the perimeter. The spiders, often with bodies one inch long and very long legs, sit in the center of the web waiting for flying insects to be trapped. The large orb weavers are not aggressive towards people; if the client's fear is great, the webs can be knocked down.

Smaller orb weaving spiders build webs across paths in the woods. Another web builder, the Barn spider, ***Araneus cavaticus,*** is the prominent, nonaggressive character in the children's book, ***Charlotte's Web.***

Cobweb Spiders



Cobweb weaving spiders make small irregular webs. These webs are characteristically found indoors in the upper inside corners of window frames. There are many species of cobweb spiders and the Black Widow is one of them. Most all of them are smaller than the Black Widow. They have the same type of globular abdomen, but it is always dull in color and not as eye catching. These quiet spiders hang in the web and wait for small insects to blunder onto their snares.

The problem with cobweb spiders inside buildings is that when they feed, they defecate drops of feces that dry and discolor anything they fall on. These spots are difficult to remove from painted wooden trim. Regular dusting eliminates cobweb spider problems. In historically significant buildings and museums their presence should be called to the attention of building supervisors.

Spiders in Boathouses

A unique but not uncommon spider habitat is in the rafter area of boathouses. Ballooning spiderlings trailing their silk threads are taken up by the wind and deposited on boathouse uprights and piers. When they crawl up into sheltered spaces, they find it is also a refuge for flying insects like flies and gnats. When they feed, their feces falls on the painted roughened decks of pleasure boats. As with the housebound Cobweb spider, these spots are extremely difficult to remove.

Habitat alteration

This perplexing problem is abated somewhat if the spiders food source is eliminated. Locate lights so they will not attract flying insects to the boathouse. Flies and gnats do not rest in breezy areas, so fans activated at night may also help.

Pesticide Application

- Careful placement of electric fly grids outside the roof area may reduce gnats. Avoid placement that draws flies or attracts midges from distances.
- Fogging inside the roof only causes the spiders to drop out of the fogged area on their webs and return when the fog is ventilated.
- Do not use residual pesticide spray applications; they are almost certain to drop on the water and cause contamination. Spray applications also degrade rapidly in heat.
- Sticky tapes or papers for fly control will liquify in the heat of these shelters and also drop on boats below.

SPIDERS ON MONUMENTS

Spider buildup on buildings and monuments can cause major problems for structural maintenance.

Where structures are lighted near aquatic areas in certain seasons, midges are attracted to the light and drive the increase in spider populations. Large spider populations harm limestone and marble structures and statuary with feces and webbing.

When this occurs:

- Pesticide use is not effective. Explore habitat alteration.
- Locate the source of midge populations and identify their habits of emergence, laying, etc.
- Recording flight times and periods. Time lights to turn off during the main flight period. Alternative placement for lighting should be considered as required for public safety.

WANDERING SPIDERS

Wolf Spiders

The hairy, fleet, wolf spiders are very common outdoors under leaf litter, rocks, and logs. When they come inside, they normally stay on the ground floor and are active in dim light. Large Wolf spiders often frighten people. If handled, they give a painful bite, but it is not dangerous.

Jumping Spiders

Jumping spiders are active during the day and are common around windows where they feed on insects attracted to natural light. Jumping spiders are usually small, up to l/2 inch in length. They have husky cephalothoraxes and are brightly colored, sometimes iridescent. They hold their front legs up in front of them when approached and move in quick rushes, jerks or jumps. They often enter buildings from shrubs near windows, or ride in on plant blossoms.

Crab Spiders

Small Crab spiders are dark or tan; some are lightly colored orange, yellow, or creamy white. Their legs extend out from their sides causing them to scuttle back and forth in a crablike fashion. These spiders hide in flower blossoms and ambush insects. Some can even change their color to more closely align with the flower's color. Crab spiders, like Jumping spiders, are often brought inside in cut flowers which they abandon when food becomes unavailable. They can be pests wherever flowers are introduced.

Pest Management of Wandering Spiders

If called on to eliminate wandering or nomadic spiders, the best action is to locate specimens, identify them, assure clients that they are not poisonous, and tell clients on how they got inside.

- Tighten under doors and around window screens.
- Caulk door and window frames and all wall penetrations.
- Remove vegetation and litter from the foundation, doorways, and window wells.
- Turn off house, building, or area lights that attract flying insects, especially midges.
- Advise clients to look carefully at flowers brought in from the garden and from commercial greenhouses.
- Assure clients that they can swat or vacuum spiders without harm.

Pesticide application is very difficult; indoor treatment is usually effective only if the pesticide contacts the spider directly. This means the technician must have clear access to all spider habitats. Unless efforts are made to exclude spiders (e.g., tighten gaps around entrances, and observe material being brought into the facility), spiders will reenter.

SUMMARY

Spiders are distinctive arthropods in the class Arachnida. They have two regions to their body -- the front one is the cephalothorax on which are located eyes, mouthparts and four pairs (8) of legs. The rear region is the abdomen at the tip of which is located silk spinning organs. Spiders, for the most part, live outside; some enter structures and dwellings. A few can deliver bites that are debilitating or even fatal. They spin webs in which to live or capture prey; these webs are considered unsightly indoors. For the most part spiders are beneficial to humans, capturing and eating many insect pests.

STUDY QUESTIONS FOR MODULE TWO
CHAPTER THREE
SPIDERS

1. Describe three distinguishing characteristics of the black widow spider.

_____
_____
_____

2. Describe three distinguishing characteristics of the brown recluse spider.

_____
_____
_____

3. Describe inspection procedures for black widow spiders.

_____
_____
_____

4. Describe inspection procedures for the brown recluse spiders.

_____
_____
_____

5. How do spiders enter structures? _____

   A. Under doors.
   B. Through window wells.
   C. With flowers brought inside.
   D. All of these.
   E. A and B only.

6. Discuss pest management methods for controlling spiders indoors.

_____
_____
_____

For Answers refer to Appendix A

CHAPTER 4

TICKS, MITES, BEDBUGS & LICE

Learning Objectives

After completion of the study of Biting Pests, the trainee should be able to:

- Identify common biting pests.
- Understand the biology and habits of biting pests.
- Cite integrated pest management options for biting pests.

More than 30,000 species of mites have been identified. They are placed in the Arachnid order Acarina. Many new mite species (which includes ticks), are found and described every year. They have sack-like bodies, rather than segmented bodies like scorpions. Unlike spiders, which have a combined head and thorax where the legs attach and an abdomen that is connected behind, mites have only a single (one part), oval body with legs attached to its sides. All first stage mite larvae have only six legs; both later stages, nymphs and adults, have eight.

Mites are more diverse than spiders; they are found all over the world from deserts to rainforests, mountaintops to tundra, salt water ocean floors to freshwater lakes. They suck plant juices and animal blood, make tumors (galls) in plants, and transmit diseases.

Mouthparts are attached at the very front end of a mite's body. These mouthparts consist of a group of small appendages that sometimes looks like a head but the brain actually is located behind the mouthparts and eyes. The mouthparts of mites form a tube that ingest plant or animal juices. Very short appendages on either side of the mouthparts guide other mouthparts as they are inserted into food tissues. As the mite sucks, digestive juices gush out of the front of the body, mix with the food juices in the mouth, and are sucked back through the mouth tube. The mite's genital opening is found underneath and between the attachments of the first two pairs of legs.

Mites walk by using body muscles to press blood into individual legs. The movement of blood extends a leg out or forward. Little muscles in each leg segment, then pull the segment back, and the mite moves forward. Many mites use their first pair of legs like antennae, feeling in front as they walk along. Leg hairs have diverse purpose: some sense touch; others pick up odors; not uncommonly, some hairs have light-sensing cells which allow the mite to distinguish light from dark.

TICKS

Ticks, the largest mites, feed only on the blood of mammals, birds, reptiles, and amphibians. Ticks differ from other mites; ticks are larger and have recurved teeth or ridges on the central mouthparts (called the holdfast organ).

They also have a sensory pit on each of the first pair of legs. This pit 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, coop, and so forth. Hard ticks are round on pets, cattle, wildlife and people. In the United States, all campers, hikers and hunters are sometimes hosts for hard ticks. Worldwide, there are over 650 species in this group.

Some ticks live their life on one host, other species spend only their larval and nymphal stages on one host; then the adult drops off to find another host. Most ticks, however, have three hosts -- one for each stage.

Life Cycle

Seed Ticks. Normally, thousands of tiny larvae hatch from a batch of eggs and crawl randomly in the surrounding area; fortunate ones attach to a small mammal or lizard. These ticks, called ***seed ticks,*** suck blood. Being small, their feeding (or ***engorgement)*** time lasts only hours or a day or so. While feeding, the host wanders and seed ticks are distributed 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.

Nymph. After molting, the engorged nymph climbs grass leaves or a plant stem. Ticks climb progressively higher as they develop; different stages reach different layers of vegetation. Because of this, developing ticks usually find a larger host than they had during the previous stage. After several days feeding, the engorged nymph drops off its host and molts.

Adult. The adult climbs vegetation; stretches its front pair of legs, and waits for vibrations or a shadow announcing a nearby host. Ticks sometimes wait for months or more than a year for a suitable host. According to one report, a soft tick lived for eleven years without feeding!

If heat or carbon dioxide is detected (e.g., 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; the tick moves in the fur (or feathers) to a place where it can engorge.

Attachment and Feeding

Adult female hard ticks will feed from several days to more than a week. (Anyone who removes an engorged tick gains, at least, a grudging respect for the parasitic tenacity of this pest.) Since ticks cannot fly or jump and do not crawl up high shrubs or trees, they grasp human hosts from a point relatively close to the ground: on the shoe, ankle, or lower leg and crawl upwards until constricted by tight clothing or until they reach the head. On wild mammals or pets, they often 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.

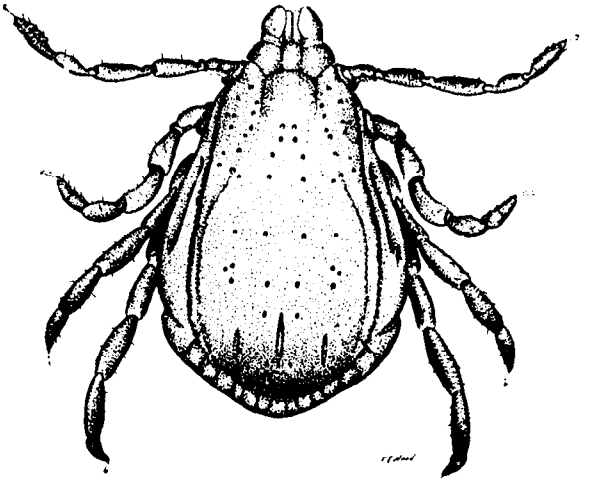
The tick slides its pair of slender teeth painlessly into the host's skin, and feeding attachment begins. The central holdfast organ, covered with recurved teeth or ridges, is inserted. Blood sucking begins. Secretions from the tick's salivary glands are injected into the wound; these secretions form around the holdfast organ and glue it in place. At this point, the tick cannot voluntarily detach until feeding ceases and the secretions stop.

The strength of the holdfast organ helps the tick resist scratching. The organ's importance increases as feeding proceeds; as the female tick engorges, she cannot hold on the host with her legs alone.

Female feeding may take from several days to 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 to mate. They do not enlarge greatly or feed much. In fact, they sometimes pierce and feed on the engorged females [In one species, this is the only way males feed.]

BROWN DOG TICK
Rhipicephalus sanguineus



The brown dog tick is the most urban of the pest ticks in the United States. It has been introduced around the world on dogs and other animals, but in the United States its only host is dogs. In the southern United States, the brown dog tick lives outdoors year round, but in most of the country it cannot live outdoors in winter.

Adult ticks are about l/8 inch long and uniformly 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.

Up to 4,000 eggs can be deposited by the female. When the eggs hatch, larvae outdoors climb vegetation; inside, walls and furniture. The larvae, nymphs, and adults return to the dog to feed; they do not bite humans. 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 the temperature.

Infestation. Homes and yards can be infested by the visit of an infested dog who drops mated, engorged female ticks. Other dogs can become infested when they are taken to an infested kennel or a home where ticks successfully attach.

When outside, dogs encounter ticks that live outside. When the dog spends more time indoors in late summer or fall, female ticks will drop off indoors, lay eggs, and their larvae will emerge late that fall -- indoors. In fall, winter, and spring, tick infestations indoors are likely to be brown dog ticks.

Ticks at each developmental stage drop from the host and seek cracks to hide in and molt. Brown dog ticks usually drop off when the dog is sleeping; these areas will most likely have the most severe infestations.

MANAGEMENT AND CONTROL OF TICKS

Inspection

- Look in rooms where dogs sleep, under the edge of rugs, under furniture, in cracks around baseboards, window, and door frames, in dog boxes.

Habitat Alteration and Pesticide Application

Advise clients 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.
- Evaluate flea and tick collars. Effectiveness is variable.
- Keep grass cut short around buildings and fences. Mow on both sides of fences.
- Keep stray dogs out of the yard.

Pest control technicians:

Inside:

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

Outside:

- Spray or dust kennels and resting areas using pesticides labeled for that treatment.
- ***Do not allow pets or children in the sprayed area until it is dry.***

Follow up

It is important that clients know that dogs should be protected even after treatment since eggs can take thirty days to hatch. Take time to assure clients 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.

TICKS AND DISEASES

Several species of hard ticks are significant human disease vectors (or carriers) and are responsible for the spread and increase of Lyme disease and the persistence of Rocky Mountain Spotted Fever (RMSF). All technicians should be familiar with Lyme disease and the ***Ixodes*** ticks that transmit it.

The large urban population in the United States is becoming increasingly at risk from tick-borne diseases. Humans are closer to diseased ticks due to

- reversion of farmland to scrub vegetation
- continuous incorporation of rural land into urban population centers, and
- frequent travel to rural areas for recreation and vacations.

Wildlife populations, hosts for tick-borne disease, are increasing in both rural and urban areas. As well, urban tick populations do not lend themselves to classical agricultural pesticide cover applications.

There are many reasons why ticks are successful parasites and successful at transmitting diseases.

- They are persistent bloodsuckers, they attach and hold on.
- Long feeding periods give time for infection and extends the distribution time.
- Many species have a wide host range. Initially ticks feed on small hosts, later on larger hosts. Most can take three different hosts; they primarily find mammals, but accept 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.

Lyme Disease

Lyme disease is caused by a spirochaete (a spiral shaped bacteria). Symptoms vary and may mimic other diseases; many cases go undiagnosed. 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 (in 60 to 75 percent of all cases). The rash looks like a red, expanding ring with a clear center; this center often is the site of the bite. The rash may burn or itch. Technically. this rash is called erythema cronicum migrans (ECM); it is not uncommon to find ECM at multiple sites. It disappears within three weeks but can recur.

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, e.g., 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 untreated victims experience an arthritis of the large joints (primarily the knees, elbows, and wrists) intermittently or chronically.

A few (10-27 percent) experience neurological effects including severe headache, stiff neck, facial paralysis, weakness, and possibly, pain of the chest or extremities; these symptoms may persist for weeks. In 6-10 percent of the cases, heart block may occur.

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

Responses to Lyme Disease: Education

This serious disease can be expected to increase. Technicians should clearly instruct their clients that there are no easy or effective control measures that state or federal agencies can perform.

- Children are at highest risk; they encounter infected ticks in camps, parks, on hikes, or at play in areas where deer and mice abound. Children are not as sensitive to finding ticks on themselves as are adults.
- The second risk group are adults whose occupations place them in tick habitat: farmers, outdoor maintenance workers, park and forestry personnel, and military personnel.
- The general public who hikes, camps, participates in outdoor recreational sports, or lives in areas of preferred tick and host habitat is the third risk group.
- Hunters, depending on the amount of time spent out of doors, fit into either of the last two groups.

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.

A 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°F. Less obvious symptoms may not be noticed.

Laboratory blood tests can be done to assist diagnosis in questionable cases. Early treatment using antibiotics is most successful.

Ticks That Carry Disease

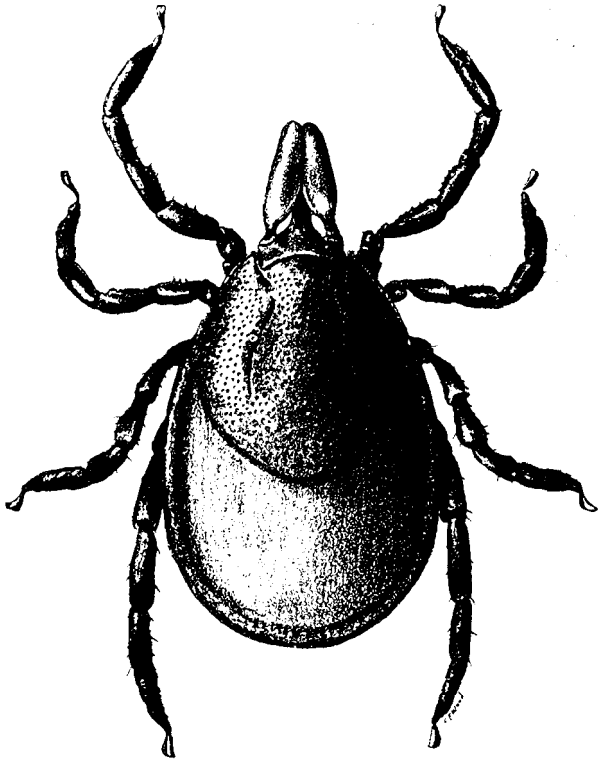
Deer ticks, or ***Ixodes,*** carry Lyme disease. This genus of ticks contains the greatest number of species of the hard ticks and they transmit diseases around the world. The northern deer tick, ***Ixodes dammini,*** is the carrier (called a vector) of Lyme disease in the eastern United States. Its counterpart in the South is called the blacklegged tick. In the West, the common vector is ***I. pacificus.*** There are many other ***Ixodes*** in the United States and what part they will play in Lyme disease transmission is not yet known.

The American dog tick, ***Dermacentor variabilis*** is the eastern, central United States, and Pacific coast vector of Rocky Mountain Spotted Fever. 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. When settlers reached

the west, their dogs contracted RMSF from the wood tick and transmitted it to the American dog tick. The American dog tick then became the principal vector of the disease and has carried it around the world.

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 an RMSF vector as the previous two species of ***Dermacentor.***

DEER TICKS
Ixodes



The deer tick is unlike the larger Lone Star Tick, American Dog Tick, and Rocky Mountain Spotted Fever Tick (see below). Larvae are no larger than the period at the end of this sentence. Nymphs are close in size to the adult -- a little less than 1/6 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.

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 humans but will not transmit Lyme disease.*** Larvae overwinter, and in the following spring, they molt into the nymphal stage.

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, migrating birds and humans as well as mice.

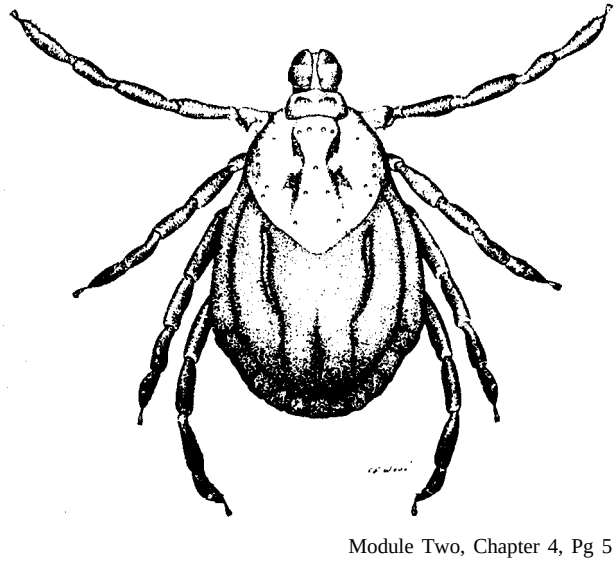
Nymphs live in what is classically called the "white-footed mouse habitat," where larvae fed the previous late summer. This habitat is best described as woodlands: bushy, low shrub woodland edge regions and grassy areas that border woodlands. This is also deer habitat. The mice travel in trails and nest almost anywhere they can find a sheltered depression. Nymphal tick activity coincides with human outdoor activity, and peak human infection symptoms occur in early July. ***Ninety percent of the 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; they sometimes overwinter and molt in the spring.

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 on deer which are unaffected by the Lyme disease. Where these deer move while hosts of egg-laying females determines the distribution pattern of the next generation. Adults feed in late fall or spring. Deer ticks also bite on warm days in winter. Hosts of the western blacklegged tick are dogs, cats, sheep, horses, cattle, and deer.

AMERICAN DOG TICK
Dermacentor variabilis

The American dog tick larvae and nymphs attack small mammals and the adults attack larger mammals -- dogs, horses, and humans. Larval and nymphal stages prefer small rodents especially ***Microtus,*** the short tailed voles, called meadow mice.



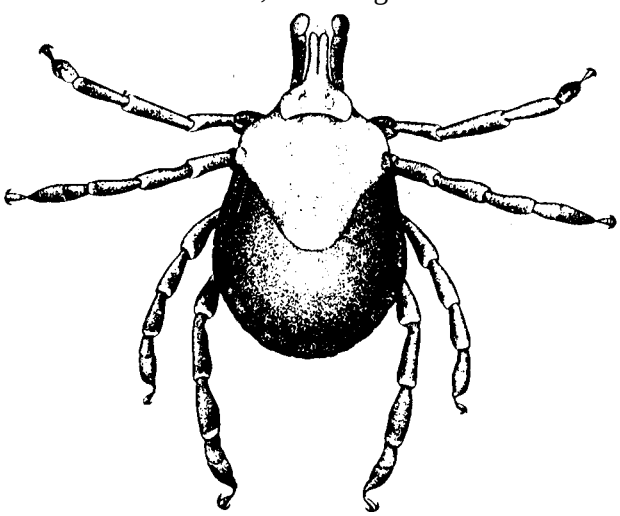
Only the adults which are slightly over l/8 inch long are found on dogs and humans. The adult female is brown with a pearly-light anterior dorsal shield. Males are brown-backed with pearly streaks. Both sexes have eyes, or unpigmented light receiving areas, at the edges of the shield.

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 worn by children allows ticks to proceed as far as the head hair. [This is probably the basis for the false idea that ticks drop out of trees.] Because of possible communication of RMSF, any tick attachment should be noted and the victim observed for symptoms.

LONE STAR TICK
Amblyomma americanum

The Lone Star tick lives in the southeastern quarter of the United States from Texas to Missouri and east to New Jersey. It attacks birds and both wild and domestic mammals, including man.



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 are prolific, often producing more than 6,000 eggs.

While it is rare to find larval ticks on humans, all three stages of the Lone Star tick will attack man. When the solid brown larval tick infests humans, it is usually the result of an unwitting person sitting or laying on an aggregation of larvae; frequently, the infestation amounts to many -- perhaps hundreds of ticks. These infestations of larval ticks are easily noticed and easily removed. Usually the larvae wander but do not attach; they can be showered off.

Lone Star ticks are associated with cattle and deer, therefore there is increased human risk around large cattle and deer herds. When found on humans, the ticks certainly should be removed and noted in case RMSF symptoms develop.

TICK PEST MANAGEMENT

Where pest management services are being provided to an area such as a neighborhood, camp, park, zoo, government installation, or similar facility, 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.***

Inspection

- Drag a flannel rectangle, 2x3 feet, using a rope on a board at the front and a strip of wood at the back for weight. All stages of ticks attach to the flannel. Collect them and take them to a University Extension Service office for identification. An office is located in each county in the United States. Small pieces of dry ice (CO,) placed in the middle of cloth squares have also been successful in attracting ticks.
- Visit deer checking stations during hunting season; trap mice and count ticks. If governmental agencies or regional health associations are interested, they will test collected live ticks to ascertain their level of infection.
- Consult local veterinarians; they 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.
- Interview game conservation agents to learn host (mice, deer) prevalence. They also have information concerning disease prevalence in hunters and hunting dogs.

Habitat Alteration

Talk with game conservation personnel about game management practices and game habitat modification. Make recommendations.

- Encourage hunting or other game management practices to reduce the deer population in infested areas. [Previously restricted areas may need to be opened to hunting.]
- Reduce the rodent habitat to reduce hosts for larval and nymphal ticks.
- Open up woodland edges to provide observation perches for hawks (mouse predators) and reduce edge browse for deer.
- Protect owls and hawks from hunters.
- Advocate cleaning up corn left in the edge rows of fields and grain spills around storage bins and roads.
- Widen paths in camps and parks to keep walkers away from plants from which ticks can make contact with humans.
- Keep vegetation short to eliminate rodent habitat in areas where people congregate.
- Advise that uncontrolled areas with high tick density be kept off limits to the public.

Pesticide Application

A novel control measure using ***permethrin-treated cotton balls in cardboard cylinders*** has been reported to reduce tick populations. The white-footed mice use the pesticide-treated cotton as nesting material. The pesticide does not harm the mice but kills their tick parasites. This device, marketed as Damminix, must be placed early enough to catch larvae and nymphs; it must be placed close enough to reach all the female mice.

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. [Remember, 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.

Follow up

Continued monitoring and recordkeeping 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.***

Precautions for At-Risk Group Members

- Wear long pants tucked in 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.
- Sulfur powder dusted on socks repels chiggers. It also may be effective against ticks.

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.

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.

HUMAN ITCH MITE OR SCABIES MITE
Sarcoptes scabiei

Urban pest management technicians are sometimes asked to treat homes where scabies mite infestations have occurred. Pesticides should not be applied. Scabies mites are parasites of humans, dogs, pigs, horses and sheep; the species of one host does not parasitize other hosts.

Scabies mites are microscopic. The only way to be certain of an infestation is to have skin scrapings made and inspected under a microscope. However, physicians with experience can usually make accurate diagnoses without laboratory procedures.

Infestation. Scabies are transmitted by direct contact only. Crowded conditions, particularly where children sleep together, spread scabies infestations most quickly. A scabies mite infestation begins when a fertilized female cuts into the skin and burrows in the upper layer of skin. She lays eggs in the burrows. Larvae hatch in the burrows and come to the surface to molt. Two nymphal stages and the adult stage are spent on the skin surface; only fertilized females burrow beneath the skin surface.

Favored places of infestation include the skin between fingers, at the bend of elbows and knees and under breasts. Though the idea of mite burrowing, even if it is only in the epidermis, might bring on itching, these sensations do not develop for a month after the initial infestation; it takes two or three generations with subsequent secretions and excretions to bring about sensitivity to burrowing.

Treatment. Treatment is relatively simple. Pesticide ointments or creams prescribed by physicians are applied from the neck down to every member of the family; bedding and underwear is laundered. ***No pesticide application to rooms or objects is indicated under any circumstances.***

HOUSE DUST MITES
Dermataphagoides

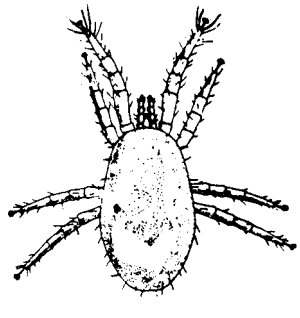
While these microscopic mites are found in the United States, they are much more prevalent in England where humidity is very high.

House dust mites sometimes cause allergic reactions. Cast skins and body parts of house dust mites accumulate with other dust and small household allergenic disintegrated matter. Vacuum intensely. A new and effective management method is to spray carpet with tannic acid solutions obtained from carpet cleaning suppliers.

BIRD MITES

Urban pest problems ranging from imaginary itches to pubic lice have been diagnosed as bird mites. Several species of mites bite and suck blood from birds. Smaller than a period, these rapidly moving mites are difficult to find. They may be very light colored, red, or dark, depending on their last blood meal. Their bites resemble small skin pricks. Hungry mites are not reluctant to bite.

Bird nests are occupied by several populations of arthropods; they make up their own community with physical and biological supporting factors. For this reason, bird mite control is a simple example of integrated pest management. Management is required of this entire, but small, ecosystem.



Applicators will find predatory species that feed on mites: beetles that feed on feathers, textile pests that infest woolens, and beetles and mites that feed on fungus. This community of organisms is supported by the blood, feathers, down, and moist droppings of the birds.

When the young birds fledge (grow flight feathers and leave the nest), the food supply stops and the arthropod community leaves in search of other harborage. Often, bird mite migration can be tied to a particular bird species (usually one of the pest birds that nest on structures).

In the middle Atlantic states, bird mites become problems when fledgling starlings leave the nest the last weeks of May and the first weeks of June. Suspected bird mite infestations at other times of the year, more often than not, turn out to be caused by other problems.

Inspection

Always collect mites for identification.

- Use a small watercolor brush to pick them up.
- Store them in alcohol.

Often mite activity is close to their point of entry into a structure. When this is the case:

- Look for bird nests on the outside of the structure on ledges, air conditioners, etc.
- Identify ways they can enter buildings.

Habitat Alteration

In this case habitat alteration also refers to the host birds habitat.

- Remove nests.
- Screen or net nest areas.
- Install inclined ramps to prevent nest attachment.
- Prevent nesting.
- Caulk mite entrance points into structures.

Technicians should always protect their eyes and respiratory system from dust of the nest, bird droppings, and fungal spores when cleaning roost areas. Wear rubber gloves to keep mites from crawling on hands and arms.

Pesticide Application

Use pesticides labeled for mite control. Without food, and with pesticide applications, mite activity should cease within one day. Activity for extended periods means that nests and entrances have been missed (or the pest misidentified).

- Apply pesticides indoors to cracks and crevices in the area of mite activity.
- Apply sprays or dusts in the cracks that might communicate with the nest area.
- Outside, spray or dust pesticides at the nest area to kill wandering mites.

Poultry mites, the same species or close relative of bird mites, can be problems. These mite infestations are treated in poultry houses or coops.

- Obtain and follow recommendations from University County Agricultural Extension Service agents.

Follow up

Record nest sites and control methods; if later infestations appear, new nests can be identified. Note the dates when identified bird mite infestations are reported. Keep records for several years; pinpoint times and seasons when these pests can be expected. Conduct annual monitoring of nesting sites before birds fledge.

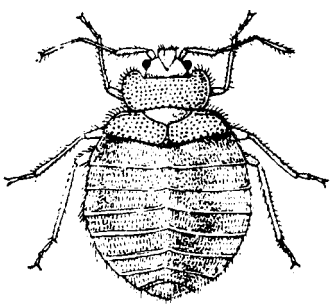
BITING BUGS

The term, bug, is slang for insect. Used technically, however, it refers to the thousands of species of the order Hemiptera, true bugs. Most species of true bugs feed on plants; many feed on animals, other insects in particular; some are aquatic. Feeding is accomplished when the bugs pierce tissues with slender thread-like stylets (located in a "beak" on the front of the insect's head) and suck up liquids. Bedbugs are indeed true bugs that suck blood, but a larger family of predatory bugs, the Reduviids (over 2,500 species) also suck blood from mammals, birds, and some reptiles, as well as many species of insects.

BED BUGS
The Family Cimicidae

THE COMMON BED BUG
Cimex lectularius

This wingless bed bug, a notable blood sucking parasite of man throughout written history, has moved with him all over the world. The bed bug's adaptation to humans is so complete their bites are nearly painless. In the United States bed bugs have been one of the most important urban human pests; they were disliked more than cockroaches, but DDT so effectively controlled bed bugs in the late 1940s that they are of minor importance today.



Bed bugs are dark reddish brown, oval and very flat. Adults are almost l/4 inch long and become mature in about four weeks when host blood is available and temperature, humidity, and harborage is favorable. If hosts are scarce, bed bugs can survive for a year without feeding.

Hosts include many species of vertebrates besides man, including poultry, rodents, dogs, and cats. They infest shelters along hiking trails and cabins of summer camps and parks. The surprise occurrence of bed bugs in urban homes often can be traced to these recreation facilities.

Eggs. Eggs are deposited several times each day in protected places near the host's sleeping area;

several hundred might be deposited. Hatching occurs in one to two weeks, depending on temperature -- the warmer the weather, the shorter the incubation time.

Nymphs. Nymphs, tiny and colorless at first, go through five molts taking a blood meal between each one. This nymphal period can last from several weeks under favorable conditions to as long as a year when hosts are unavailable and temperatures are low.

Adults. Undergoing gradual metamorphosis, the bed bugs mate soon after becoming adults. Adult bed bugs prefer humans as hosts; while they have been known to harbor several human diseases, ***there has been no record of disease transmission.***

Harborage

Under normal conditions, bed bugs feed at night. Flat bodies allow them to hide in cracks in beds, bedside furniture, dressers, wall boards, door and window frames, behind pictures, under loose wall paper and in rooms near host sleeping areas.

Inspection

The bedroom is usually the center of infestation. All dark cracks and crevices are potential harborage.

- Inspect camping sleeping equipment.
- Inspect outdoor animal sheds and coops even though not recently occupied.

Habitat Alteration

Since bed bugs have alternative hosts besides humans (e.g., rodents, some birds, etc.), excluding these animals is very important. While it is difficult, infested woodland cabins must be vermin-proofed.

Inside

- Tighten, caulk, and screen routes of entry.
- Store mattresses in protected areas.
- When not in use, do not fold mattresses on cots to prevent mouse nesting.
- Open protective harborage inside, such as wall voids, or tighten it up completely.
- Open cabinets. [This discourages rodent nesting.]
- Make crawlspaces accessible to predators and light.

Outside

- Move wood piles away from the structure.
- Keep weeds and shrubs away from the foundation.
- Eliminate garbage.

Pesticide Application

There is no tolerable number of bed bugs in occupied structures. Camps and hiking shelters should be treated only when there is evidence of an active bed bug infestation. Rodents found inside should be trapped or baited. Several general application pesticides labeled for bed bug, are available.

- Dust or spray desiccating dusts, pyrethrin, malathion, etc.
- Use crack and crevice application methods to treat harborage thoroughly.
- Treat furniture joints.
- Ensure that treated tufted mattresses or depressed seams dry and are covered with bedding before they are used.
- Leave time for drift or droplets to settle before bedtime.
- Do not use space treatments or fogs; they are not effective.
- Check state regulations. Some laws allow the use of appropriately labeled residual pesticides for cracks and crevices; this reduces repeated applications.

Follow up

If treated infestations recur, evaluate to determine whether some harborage was missed or if the structure is being reinfested; revise the management plan. Monitor structures where periodic reinfestation occurs. Remember, camps used only seasonally should have a pest management plan too. Keep good records on pesticide use and application methods. Educate clients and maintain communications. Emphasize that bed bugs do not transmit diseases. Remove rodent baits when recreational buildings are occupied.

BAT BUGS

Two species of bed bugs can be found in bat colonies. These bugs are very similar in appearance to the common bed bug; they do not build up in structures as intensely as the common bed bug. Their host is the bat, but bat bugs wander when hosts leave during migrations. They are also disturbed by reconstruction and bat proofing. An occasional bat bug appears in rooms usually just below attics. Locate infested bat nesting sites and dust after the bats and detritus have been removed.

Endangered Species

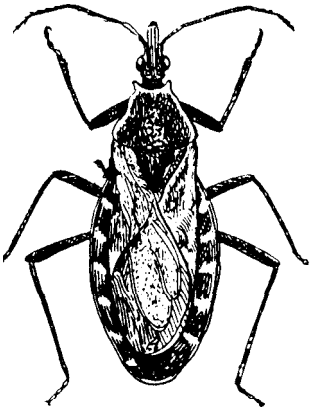
Be aware of endangered species of bats and other animals when treating bed bug infestations. Outside, treat rodent burrows only.

BITING BUGS

Family Reduviidae

This family contains some species that bite humans and even transmit diseases in tropical

America. They are known by many names: conenose bugs, masked hunters, black corsairs and kissing bugs. One species feeds on bed bugs. The insect-eating species of the family are very important predators of plant pests but normally only enter structures accidentally; many are attracted by lights; if they are handled they inflict painful bites.



From Mexico to Argentina, a very serious disease called Chagas disease, is transmitted by the stealthy and painless nocturnal bites of several species of Reduviids. Bugs feed and the blood they defecate is contaminated by disease organisms that are later rubbed into bite areas. Relatives of these bugs that live in the United States have a very painful bite; they are knocked off before they can feed and defecate. These bugs do, however, take blood from wood rats or pack rats, especially in the western United States. While they do not bite humans, they should be eliminated from homes, cabins and other structures; this requires the exclusion of the wood rats.

Habitat Alteration

- Never leave bird seed or stored products that are attractive to rodents in intermittently occupied structures, unless they are kept in rodent-proof containers.
- Close entrance holes and reinforce potential openings in structures.
- Remove rat nests and detritus.
- Vacuum the area.
- Wear dust masks when performing any procedures involving dust from fecal droppings, guano, etc.
- Alter or eliminate any rodent harborage outside near the structure.
- Use light bulbs that do not attract insects in outside light fixtures, or relocate them.

Pesticide Application

- Apply a light application of a pesticidal dust laid down in nest areas to kill bugs that may hatch out later.
- Keep the dust from infiltrating into lower floors.

HUMAN LICE

There are three species of human lice: head lice, body lice, and crab or pubic lice. They all suck human blood and are not found on birds, dogs, cats, farm animals or other hosts.

Historically, the disease typhus, transmitted by body lice, was common where people were confined together and could not wash or delouse their clothing. This disease became epidemic within confined populations such as cities under siege or armies limited to trenches or on the move and unable to delouse their clothes. Typhus is a fatal disease and was so pervasive it, more than wounds of war, determined who was victorious and who was defeated in wartime.

Widespread louse epidemics ceased being a problem when DDT dust became available in World War II. Although body lice became resistant to DDT when it was intensively and repeatedly used, other synthetic pesticides were found to work as well. [Typhus epidemics are not caused by either head louse or crab louse infestations.]

With the elimination of the large infestations, modern societies are puzzled and alarmed when small, persistent louse outbreaks occur. Common examples of small infestations are head louse infestations among elementary school aged children, body louse infestations on people who are unable to care for themselves, and pubic louse infestations resulting from sexual intercourse with an infested partner.

Informed pest control technicians can be very helpful as consultants with louse infestations and can provide a great service by discouraging pesticidal use other than for hair treatment. Leaving directions on lousicide choices with parents, school medical personnel, physicians, or the infested individual strengthens the clients confidence in the technician's technical understanding and discourages the application or spraying of pesticides.

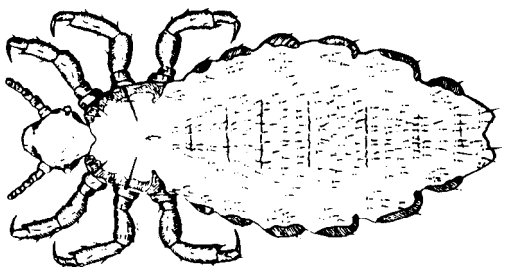
HEAD LICE

Pediculus capitus

Adult head lice are gray and about l/8 inch long. Hatching occurs about one week after attachment. Since lice go through a gradual metamorphosis, the tiny nymphs resemble adults. They grow to maturity in about 10 days. Adult lice mate and the female can lay about 100 eggs, but often falls short of that in her life of only several weeks.

In the United States, lice live in the head hair of children of elementary school age (only rarely on

adolescents or adults). They scuttle about on the scalp between hairs with much more speed than expected of a small, soft, wingless insect with slender hair grasping claws on the end of blunt legs.



Close adaptation locks head lice into the human scalp in several ways. First, louse claws grasp human hair so firmly that they do not fall or wander out of it. Second, head lice suck blood by grasping the scalp with tiny hooks that surround their mouth, and painlessly pierce the skin with slender stylets. [Head lice feed several times a day but do not engorge themselves.] Most importantly, head lice neatly glue their eggs (called nits) to the hair shaft, always within l/4 inch of the scalp. The tiny, pearl-like eggs stick alongside the hair so tightly that they can be dislodged only by being torn from the neat sleeve of biological glue by fingernails or a fine toothed comb. Nits found further away from the scalp than l/4 inch will have already hatched; what is found is the empty shell which remains attached.

The spread of head lice is not well known, but lice do not roam from child to child. Neither do they wander onto coat collars or hats, since they are so restricted to human hair and the scalp surface temperature of around 80°F or a little more. Temperature preference and perhaps humidity is so critical that lice die at elevated temperatures and from excess perspiration. Conversely at lower surface temperatures (about 50°F) lice become torpid and do not move or feed. A reasonable speculation is that head louse nymphs hatch from nits on hair snatched by brushes and knit hats. The tiny nymphs then move toward the warmth of the next head covered by the cap or brushed by the brush. This normally limits ***transmission to siblings that have their hair brushed with a "family brush" or children who use knit hats and brushes of friends.*** Louse infestations are often discovered by school teachers who are watching for the signs of itching heads, but classroom neighbors are not as likely to be infested as are brothers and sisters or close friends that sleep over and share brushes. Head lice have been shown by surveys in several large eastern cities to infest the heads of Caucasian and oriental children but they very seldom infest those of black children.

Head Louse Control

Several over-the-counter and prescription preparations are used to eliminate louse infestations; they are all equally effective when used according to label directions. Prescription preparations are applied only once and have a high probability of killing the eggs as well as live lice. The preparations from drugstores need to be used twice. The first application kills all of the live lice. Viable nits hatch in 6-10 days and the second application kills that population. These lousicides are applied to wet hair and after a short waiting period they are shampooed out. Advise clients to

- Treat ***all members of the family who are infested*** at the same time.
- Wash bedding and knit caps in hot water to be sure any nits on fallen hairs are killed.
- Vacuum all surfaces where children lie or play (including stuffed toys). [In day care centers and kindergartens, napping mats should be wiped or vacuumed.]
- Clean rugs or simply quarantine them for 10 days after vacuuming.
- Remember, do not apply pesticides to rooms, toys, or furniture surfaces.

Decisions on the formulation of lousicide, treatment of head infections from extensive infestations, and so forth, are decisions to be made by parents and physicians.

Reported louse infestations of adolescents and adults should be investigated by a physician; if live lice are not seen, the nits should be examined through a microscope to assure that they are not symptoms of scalp conditions.

BODY LICE
Pediculus humanus

Head and body lice are indistinguishable in appearance and life cycle, however, their behavior is very different: Both suck blood, but body lice engorge themselves, feeding to the point that their abdomens become purple and distended. Body lice are easily reared on rabbit blood after a period of assimilation but head lice can only be successfully reared on humans. Body lice harbor on clothes, hiding along seams and moving to the body to engorge. They do not deposit their eggs on body hair or head hair but on clothing. While body louse epidemics are controlled on

humans by emergency applications of pesticides (dusts usually), control is maintained by cleaning and washing clothes.

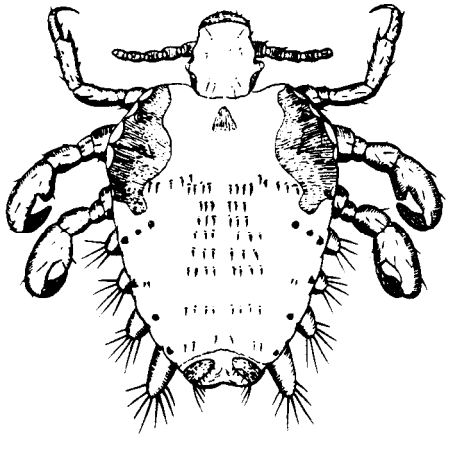
For these reasons body lice, historically the most common human louse, are now rare in the United States. Infestations appear on those who cannot take care of themselves like homeless individuals who do not remove clothes for cleaning and older, incapacitated individuals. Infested clothing passed from one individual to another is a common method of transmission.

Body Louse Control

Some general application pesticide formulations are labeled for spraying but are of little value.

- Clean or wash clothing, bedding, etc., with hot water and detergents to kill lice.
- Bathe to detach and kill moving lice on the body.
- Use detergents and disinfectants to clean bed frames, bedside furniture, ambulances, ambulance and hospital equipment.
- Counsel clients carefully to control emotionally-charged situations and prevent louse reinfestations.

CRAB OR PUBIC LICE
Phthirus pubis



Adult crab lice are only a little over half the size of body or head lice; their last two pairs of legs terminate in hooked mitts that resemble crab claws. These lice are confined to coarse pubic hair and sometimes eyelashes. Pubic lice move very little in the pubic region and produce few eggs. The most common method of transmission is by sexual intercourse. When infested pubic hair detaches, lice can hatch on underwear, in beds, or on toilet fixtures. If their immediate environment is above 50°F, a pair of pubic lice could infest another person.

Pubic Lice Control

Accurate, calm communications are invaluable in explaining pubic louse infestations and making recommendations for their control.

- Use pubic louse preparations.
- Wash bedding and underwear.
- Use detergents or disinfectants in toilets.
- Vacuum.

IMAGINARY ITCHES

Imagination is the ability to form a mental image to experience something that is not present. Where the source of imaginary itches are attributed to pests, the itch is real, but the pest is not. Everyone experiences an occasional itch that feels like crawling insects. A look confirms that either an insect is present or that the mental image was not real. These unreal feelings can be troubling. Concern that the cause of an itch cannot be seen, and may be a microscopic parasite can be overwhelming. This idea affects some people so strongly that it inhibits their ability to function. Imaginary insect-related problems can be separated into three groupings: Entomophobia; Contagious Hysteria; and Delusions of Parasitism.

ENTOMOPHOBIA

Taken alone, entomophobia can be defined as an admitted fear of insects. This is not to mean a fear of imaginary insects, but an exaggerated, illogical, unexplained fear of actual insects. A fear of insects occurs to a minor extent with a majority of people. In an extreme form, when the fear inhibits normal functioning, help from counseling professionals is needed. Group treatment has been found to be very successful.

Entomophobes rarely are problems for pest control technicians. However, their excessive desire for preventive pesticide applications may be encountered when clients attempt to coerce technicians to use pesticides unwisely. Such pressure should be resisted; technicians should remain firm and apply controls only as professionally indicated by pest infestations. [The term, entomophobia, is used sometimes generically to include all imaginary insect-related categories.]

CONTAGIOUS HYSTERIA

As the name implies, imaginary pest infestations

sometimes upset a group of people. This hysteria can be passed along or accepted by others. Contagious hysteria often occurs in an office work force. Factors usually connected with the hysteria include:

- crowded conditions
- overtime work
- excessively detailed or boring tasks
- changing climate
- changing seasons
- paper handling
- perceived unfairness of working conditions caused by physical arrangements in the work space.

Classically, a few individuals including a leader or spokesperson begin feeling bites and discover rashes and other skin eruptions. These individuals identify certain portions of rooms where the pests are common and demand control. Supervisors usually do not believe there is a pest problem, since they are usually unaffected by the contributing conditions, but they may be recruited as pressure for results mounts.

Inspection

- Look for pest infestations such as mites infesting stored products or populations of psocids and fruit flies that may cause entomophobia.
- Inspect for fiberglass filaments and for insect parts that could cause allergies.
- Do not allow obvious miscellaneous insects to become important for the sake of coming up with an answer.
- Carefully inspect the entire work area -- the nontargeted part as well as the identified part.
- Listen to workers explain the situation fully; arrange for management not to refute or ridicule their statements. Not having a hearing entrenches feelings of unjust treatment. Ask if the pests are ever seen biting; ask to see the pests.
- Leave alcohol vials, tweezers, and a small brush so pests can be collected when seen later.

Notice the differences between the pest-affected and non-affected parts of the work place.

- Check air conditioning, air filtering, work space furniture, amount of window space, carpeting, type of work, proximity to duplicating equipment, availability of refreshments, and compare the two areas. Where there is an apparent discrimination, bring it to the attention of the supervisors. Different conditions influence worker feelings.

Problems with contagious hysteria usually erupt during periods of seasonal change. Changing climate results in changing humidity and the need for the body to acclimatize to different atmospheric conditions.

- Notice static electricity around duplicating machines, and check relative humidity of the office air. Low humidity dries skin and increases static electricity. This results in skin sensitivity, causes paper fibers to jump and electricity discharges that snap and sting as well as cause hair to move on the skin, giving the impression, of crawling insects.
- Periods of changing clothing styles, e.g., winter to spring, summer to fall find people more restive. Changing climate and changes between heating and air cooling results in dry or humid air.

Habitat Alteration

Responses to the problem are needed. By the time responses are carried out, the condition often is rectified. Discuss observations with management. Suggest patience. Request physical changes in the environment.

- Inquire whether a pesticidal lotion has been prescribed by a physician. If this has happened, and it often does, strongly recommend that the lotion use be discontinued if no skin eruptions are seen and substitute a non-pesticidal lotion.
- Inquire about the possibility of fiberglass insulation.
- Recommend that the workers at the center of the affected area be dispersed, that desks and furniture in that area be wiped down with disinfectants, and that intensive vacuuming or carpet cleaning be done. Leave the area empty for a time if possible.
- Balance air cooling or heating. Bring relative humidity to 65 percent.

Pesticide Application

Unless there is real evidence of pest problems, **NEVER** apply pesticides. Do not make false statements relating to control of non-existent pests. Legitimate

pesticide application in label-approved sites should produce clear results that can be seen, otherwise it will be viewed as a control failure and lost credibility will result.

Follow up

Monitor the area periodically with sticky traps. Explain the importance of the appearance of captured objects on the sticky surfaces are (e.g. small flies, dust, lint, cockroaches, etc.). Identify any specimens or objects workers have collected in the alcohol vials. Use hand lens or microscopes, and let the workers view the specimens. After taking the steps outlined above, often simply demonstrating to clients that you are on the job, that you are competent and informed about pest management, will be an adequate solution.

DELUSORY PARASITOSIS

A condition where an individual has delusions of parasitism is an extremely emotional and sensitive situation. An inspection of the problem environment and an examination of specimens alleged to be the pest or parasites will affirm or contradict the occurrence of an infestation to the technician but rarely to the client.

Often people affected by these delusions will have been referred from one or several physician(s), to a dermatologist, to a psychiatrist, to entomologists, to health department sanitarians, pest control companies, ***ad infinitum.*** The amount of time that must be expended by each consultant soon becomes excessive, and the patient experiences repeated rejections of one type or another -- not to mention strain due to expenditure of time and money.

In any of these situations there is a possibility that the complainant has a medically treatable condition. There have been cases in which drug abuse, or conflicting drug prescriptions for patients being treated for several health problems, elicit such manifestations. The fact is there is little that can be done by anyone but a medical diagnostician with experience in the cause of delusions.

Always be honest in answering questions; do not agree to seeing pests that are not there. NEVER apply pesticides in these situations. Remember to communicate with the client that pesticides should only be applied by pest management technicians when active pest infestations have been identified and evaluated.

SUMMARY

Biting pests in this chapter are not as commonly encountered as many other urban ‘pests. When infestations are found or suspected, however, they elicit fear: fear of being parasitized as well as a fear of the unknown. Calm, authoritative and well communicated advice is very important for pest management technicians to use in situations involving biting pests.

STUDY QUESTIONS FOR MODULE TWO
CHAPTER FOUR
MITES, TICKS, BED BUGS AND LICE

1. What procedures should be used when head lice are discovered in schools?

   _____
   _____
   _____

2. What diseases are commonly transmitted by ticks in the United States?
   _____ and _____

3. What species of ticks transmit these diseases? _____
   _____
   _____

4. What diseases are transmitted to dogs or humans by the Brown dog tick in the United States?
   _____

5. What diseases are transmitted by bed bugs in the United States? _____

6. What is the typical method of transmission of crab lice and where are they found?

   _____
   _____
   _____

For Answers refer to Appendix A

CHAPTER 5
MISCELLANEOUS INVADERS

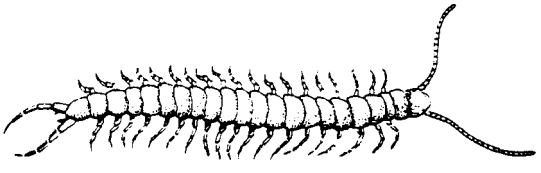
Learning Objectives

After completion of the study of Miscellaneous Invaders, the trainee should be able to:

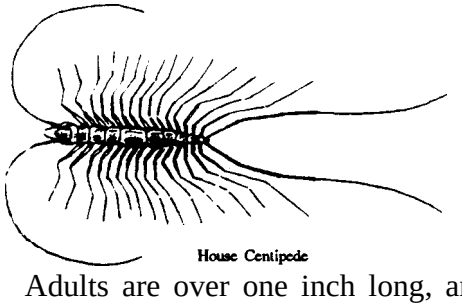
Identify the key features in the life cycle, habitat and appearance of miscellaneous invaders.

Discuss integrated pest management procedures for common miscellaneous invaders.

CENTIPEDES
Class Chilopoda



Centipedes are sometimes combined with millipedes in the large group Myriopoda. Centipedes are many-segmented arthropods with one pair of legs attached to each segment and somewhat long antennae. Except for one group, centipedes live outside under stones and logs. The centipede that lives inside is known as the house centipede, ***Scutigera coleoptera.***

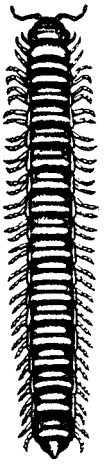


House Centipede

Adults are over one inch long, and run in a graceful manner on many, very long legs. House centipedes are found in small numbers in basements and other rooms that are not continuously occupied. They feed on tiny insects and spiders. Although beneficial, they frighten many people who then insist they be controlled.

House centipedes usually live in places that can be lightly dusted; if the area is damp, apply a light residual spray.

MILLIPEDES
Class Diplopoda



Millipedes are cylindrical, many segmented arthropods with two pairs of legs attached to each segment. They have short antennae. Millipedes live outside in leaf litter; unlike centipedes, they may build up in very large numbers. Millipedes migrate in dry weather and enter basements, ground floors, and window wells. They are a particular problem in houses located near woodlands. One species, the brown millipede, has been known to crawl up forest cabin walls when populations are numerous.

Habitat Alteration

- Remove leaf litter and compost near house foundations.
- Caulk around door and window facings.
- Weatherstrip doors and ground level windows.

Pesticide Application

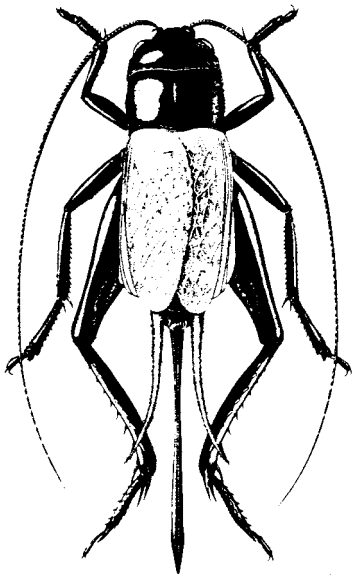
- Apply residual pesticides to cracks and crevices around house foundations.
- If the infestation is particularly persistent, or if the migrating pests have built up in very high numbers, apply a band pesticide application around the house as a barrier.

CRICKETS
Family Gryllidae

Crickets are well-known relatives of cockroaches and katydids. Like katydids, male crickets "sing" in the summer by moving hard parts of their wings together; the males are calling females for mating. They develop with gradual metamorphosis; during some periods, adults and nymphs share the same harborage and food with grasshoppers.

FIELD CRICKETS

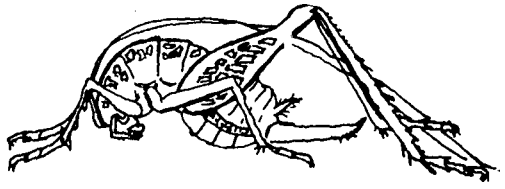
The most commonly-seen crickets in the United States are field crickets; adults are very dark and about one inch long. Eggs are laid toward the end of summer in moist soil of roadside ditches, meadows and fields, along fences; and in dry weather, they are laid in soil cracks, where adult crickets find some moisture for egg laying as well as for themselves. Eggs are injected into soil by the female using a long, straight appendage called an ovipositor. The eggs overwinter and hatch in spring.



Crickets feed on plants, and mature in July and August. When weeds begin to harden and die and rain is sparse, crickets often leave their ditches and fields; they move out in massive invasions. This is the time they come into homes and buildings. Entry into structures is most always under doors and through opened windows.

Field cricket populations are cyclical. Some years great numbers find their way across parking lots and into malls and office buildings. Many years of low cricket populations may follow. Other crickets like the house cricket, and the very small dark brown ***Nemobius,*** also have cycles of build up and movement into structures.

CAMEL OR CAVE CRICKETS
Ceuthophilus



This humpbacked insect is more closely related to katydids than to crickets. It is mottled brown and wingless with very long legs and antennae. Cave crickets are often compared to spiders, but the resemblance is only superficial. Cave crickets prefer dark damp or cool places like basements, crawl spaces, and garages. They seldom cause damage.

Inspection

- Locate the egg laying sites where populations build up, if possible.
- Look near patches of weeds, soil cracks, at the base of plants, or in grass.
- Inspect basements, closets, pantries.

Habitat Alteration

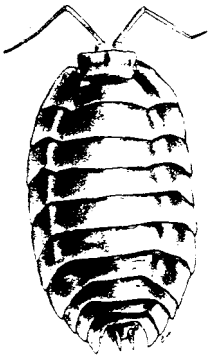
- Caulk, tighten, and weatherstrip basement and ground floor doors and windows to keep crickets out of houses. Thin plantings next to building foundations.
- Keep grass short during cricket activity to discourage the insects and reduce cover in case pesticide sprays are needed.
- Ventilate and remove materials that provide hiding places for cave crickets in crawl spaces and garages.

Pesticide Application

- Direct pesticide spray applications in cracks near the foundation and around door stoops and patios.
- Apply a residual barrier around the building if populations are very high.
- Use granular baits when needed.
- Where very high build-up is detected in breeding areas, particularly in a series of cricket invasion years, spray the weeds and grass in midsummer with pesticides labeled for cricket control on plants.
- Advise clients to swat field and cave crickets indoors or spray them with a general use contact aerosol.

- Use dusts on cave crickets in crawl spaces and garages; however, they are seldom needed.

SOWBUGS AND PILLBUGS
Class Crustacea

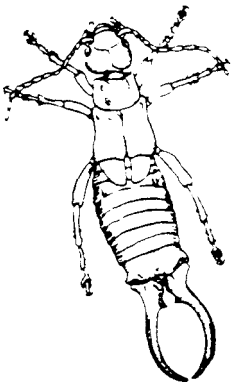


These small, oval land crustaceans, protected by objects on the ground, feed on decaying vegetable matter and fungi. They have been known to clip outside potted plant roots, but very little damage is expected of them. Heavy infestations outside encourages movement that causes individuals to find their way inside. Their generic names, ***Porcellio*** and ***Armadillidum,*** seem to distinguish these small oval arthropods.

Habitat Alterations

- Remove places where sowbugs and pillbugs can develop near the house, such as boards on the ground, flower pots, and flat stones.
- Remove mulch and replace with gravel, if necessary.

EARWIGS
Order Dermaptera



Earwigs are conspicuous and easily recognized relatives of cockroaches, They are flattened insects with forceps or pinchers at the tail end; the forceps grasp insect prey. At first glance, earwigs appear to be wingless; in fact, their wings fold up many times under the small front wing covers; some fly to lights. Earwigs feed on other insects and often scavenge in garbage and moist plant material. They also feed some on plant tissue, and at least one is a pest in greenhouses. They are dependent on high moisture. Earwigs are active at night; they shelter together and are quiet during the day.

Earwig females tend their young. They place their eggs in moist depressions or holes, guard them, groom them until they hatch, and take care of the early stage nymphs. Earwigs grow with gradual metamorphosis; older nymphs and adults harbor together.

The European Earwig
Forficula auricularia

The European earwig was introduced into the United States. This dark brown insect grows to be almost one inch long and is common in the Northeast, Northwest, parts of southern Canada, and now is found in the middle Atlantic states.

Like most earwigs, the European earwig requires high moisture and builds up in shady yards where stones and boards offer protection. These earwigs enter on ground floors and can make their way into other parts of houses. They also hide in wrappings used to trap gypsy moth larvae.

The Striped Earwig
Labidura riparia

The striped earwig, common in the tropics and subtropics, has now extended its range across the southern and southwestern United States. These earwigs burrow in soil, mulch, rubbish, and grass thatch. The striped earwig is about one inch long, and brown or tan with pale stripes on the thorax. The abdomen is darker and slightly banded. This earwig survives well in disturbed areas such as new subdivisions. They are doubly obnoxious when they come inside because they emit a foul odor when crushed.

Inspection

- Look under bark, boards, and stones near house foundations.
- Inspect cracks around foundation and door stoops.
- Check behind bird houses, tree trunk wrappings, and under plant mulch.

Habitat Alteration

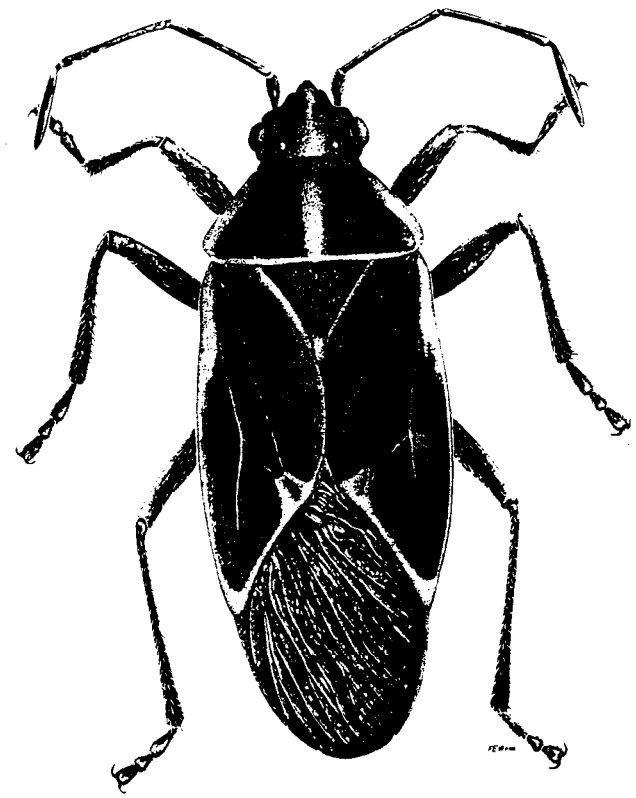
- Caulk ground floor entries, windows, and cracks between door stoops and patios and the building foundation.
- Remove as much harborage as possible.
- Trim hedges and plants away from foundations.
- Ventilate and dehumidify moist basements, porches, and so forth. Lowering the humidity or moisture discourages earwig buildup.

Pesticide Application

- Prepare a band of low mowed grass on which residual pesticidal sprays or granules can be applied where earwig infestations are very high.
- Spray in cracks next to the foundation and under shrubbery.

- Sprays of detergents are known to quickly kill earwigs. Use pesticidal soaps when labeled for this use.
- Dust in dry basement areas to kill earwigs there.

BOXELDER BUG
Letocoris trivittatus (eastern)
Leptocoris rubrolineatus (western)



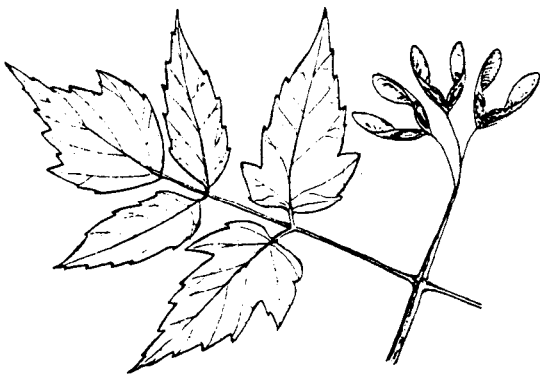
The conspicuous black-and-red Boxelder bugs are divided into two species. Boxelder bugs undergo gradual metamorphosis. The eastern species grows to be about l/2 inch long; it is distributed as far west as Nevada, while the slightly smaller western species ranges in California and Oregon. These bugs lay eggs in the spring on female or pod-bearing Boxelder trees.

The young nymphs are bright red. Dark markings become more apparent on older nymphs. Nymphs feed on Boxelder tree foliage, tender twigs, and winged seed pods. In late summer, mature nymphs and adults crawl down the tree trunk by the hundreds and disperse. Adults also fly directly from the tree to houses. Like attic flies, the bugs find spaces under siding, around window and door facings where they enter wall voids and rooms in houses.

Boxelder bugs seek overwintering shelter outdoors in tree hollows, as well as in sheds, barns, and houses. Those that find harborage indoors move around and fly on warm winter days.

Habitat Alteration

The best management method is to find female Boxelder trees and remove them. These trees are seldom planted as ornamental or shade trees; they grow as weed trees, and are not eliminated mainly because they are difficult to identify.



Their leaves, somewhat like maples, are variably shaped on the same tree. Seed pods are helpful in identification of the female trees. It usually takes a large invasion before tree removal is practiced.

- Caulk around entry points on the house foundation and door and window facings. At times it may be necessary to caulk obvious points of entry indoors.

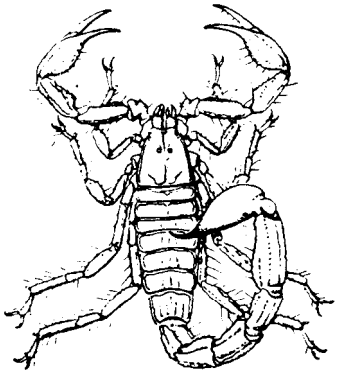
Pesticide Application

- Spray tree trunks and foundations with microencapsulated pesticides when the migrating insects are noticed descending the tree or accumulating on the house sides.
- Vacuum bugs inside or spray with contact aerosols.
- Detergents have been shown to kill these bugs. Use pesticidal soaps when labeled for this use.

SCORPIONS
Class Scorpionida

Although many people outside the southwest United States have never seen a scorpion in nature, its shape is well known. The most common scorpion is the small, striped scorpion, ***Centruroides vittatus.*** This small arachnid is only about 1 l/2 inch long, tan, with two broad dark stripes running lengthwise down the

body. It is distributed across the southern states and can be commonly found under rocks on south hill slopes in Virginia, Kentucky and Missouri. Nonfatal, poisonous species occur in Florida and in the semi-arid southwest.



Two species are known to cause fatalities when they sting: ***Centruroides gertschi*** and ***C. sculpturatus.*** These scorpions are found in southern Arizona and neighboring states of California, New Mexico, and Texas.

Scorpions are nocturnal. They hide under boards, rocks, rubbish and litter during-the day. They forage at night, seeking insects, and sometimes, small mice. Scorpions grab their prey with front, crablike claws and quickly sting, whipping the stinger over their back.

Scorpions find daytime hiding places in crawl spaces, attics and closets. They enter occupied rooms, especially kitchens for water.

Inspection

Conduct a flashlight inspection. Place hands carefully when searching in scorpion habitats.

- Carefully, look under outside harborage and in crawl spaces and attics.
- Inspect kitchen sink cabinets and bedroom closets.
- Scorpions fluoresce under ultraviolet light.

Habitat Alteration

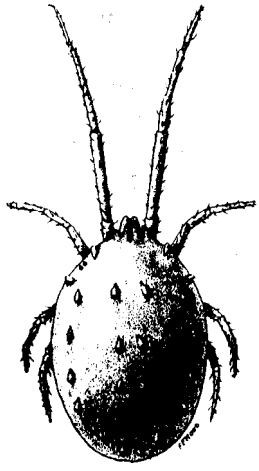
- Tighten and caulk points of entry.
- Remove harborage around buildings and homes.
- Repair plumbing leaks and ventilate moist areas.

Pesticide Application

- Dust or spray dry crawl spaces and attics. [Microencapsulated sprays have a greater residual value than emulsifiable concentrates.]
- Dust under kitchen sinks.
- Spray in closets where scorpions are seen.

CLOVER MITE
Bryobia praetiosa

This fast-moving, harmless mite has a body less than l/16 inch long in its adult stage. It is bright to dark red, and when smashed leaves a red streak. Front legs, as long as the body, move like antennae. [This characteristic distinguishes this mite from other red species].



There are no male clover mites in the United States. Females deposit their red eggs in bark crevices and building cracks during early summer and in the fall. Nymphs develop from summer eggs to invade dwellings in the fall. Eggs laid in the fall hatch the following spring.

Their habitat is grass and low weeds near building foundations, warmed by the sun and sheltered from chill. Mite invasions are influenced by the temperature in their habitat combined with heat reflected from adjacent buildings. Mites build up on the south side of buildings where their habitat optimum temperature reaches above 69°F on sunny, late fall and early, spring days; general air temperatures are lower. As general air temperature increases, the temperature in the mites' habitat grows too high. Both egg and mite development and activity suspend when temperatures exceed 75°F or fall below 45°F in their ground level habitat on grass or house foundations and siding.

When active, mites move from the grass area onto foundations, up under sheathing, or into wall cracks and spaces around windows that lead indoors. Mites that reach interior wall voids in the fall may contribute to the following early spring invasion.

Clover mite populations seem to be highest and most invasive following the installation of new lawns. Clover mite populations reach their height where subdivisions or housing developments are landscaped by seeding and raking bare earth, or more often now, by hydro-seeding. Well-fertilized grass (and other groundcover in the West) contributes to the mites' wellbeing; lack of shade allows uniform temperatures across the sunny lawns and buildings. Scraped, bare soil is devoid of predatory mites and insects; it encourages the free build up of clover mites on new, fertilized grass. As the lawn matures and the plant, shrub, and tree community diversifies, a diversified insect population is supported and clover mite invasions essentially cease.

Habitat Alterations

Whenever infested buildings and yards meet criteria that support clover mites, habitat alteration should be strongly recommended.

Outside

- Place bare earth covered with gravel or gravel over plastic as a barrier strip about two feet wide on the sunny side of buildings to stop clover mite migrations.
- Plant shrubs in front of this strip; shrub mulching will add to the barrier's effectiveness by diversifying the habitat and breaking up the even temperature gradient near the foundation.
- Close-mow the lawn in a 20-foot band to decrease grass protection and temperature insulation.
- Caulk building cracks and the spaces where window and door framing join building siding.

Inside

- Caulk window and door framing and weatherstrip windows on the sunny side of the house.
- Caulk electrical plates.

Pesticide Application

Outside

Use a pesticide labeled for mite control and other lawn pests. Thorough application of the pesticides is needed to reach the soil. Usually mite control is required only when invasions are underway. Placing the pesticides near the building is an effective and immediate treatment, but treatment to the lawn at this time may be too late.

- Apply pesticide to the barrier area and the mowed grass adjacent to it unless mite activity is also obvious elsewhere.
- Place pesticides near the building being invaded. Sulphur is a possible miticide.
- Treat under sheathing, where possible, to kill mites that have accumulated there.

Inside

- Advise clients to place a thin film of cooking oil on window sills to trap mites as a temporary control until pest management technicians arrive.
- Vacuum entering mites to immediately reduce the population. Use caution: sweeping or brushing can smear them.
- Use general use spot treatment on surfaces where activity is very high. [Mites will be killed on contact, and the residue will kill or repel mites for a short period following application.]
- Use crack and crevice applications in structural joints and spaces from which mites emerge.
- Dust voids where mites have assembled.
- Emulsifiable concentrates, wettable powders, dusts and pressurized canned pesticides, labeled for mite control, are effective.

Follow up

- Monitor lawns in new areas or subdivisions with actual or potentially high clover mite populations.

SUMMARY

Miscellaneous invaders are identified as such because they do not regularly occur inside, or because their infestation is less serious to people or structures than those of other pests. However, species in this group are well known -- and disliked. They frequently become newsworthy local topics. Their unscheduled, surprise occurrences are sporadic enough that people forget to guard against them and suddenly find themselves inundated and immediate action must be taken -- leaving little time for thought and planning.

STUDY QUESTIONS FOR MODULE TWO
CHAPTER FIVE
MISCELLANEOUS INVADERS

1. Name and discuss pest management procedures used to suppress late summer invading populations of black and red bugs.

_____
_____
_____

2. Name and discuss pest management procedures used to suppress late winter or early spring populations of small red bodied mites that accumulate on the south side of houses.

_____
_____
_____

3. Describe millipedes and centipedes and discuss their management.

_____
_____
_____

4. Discuss the management of crickets.

_____
_____
_____

For Answers refer to Appendix A

United States
Environmental Protection
Agency

Pesticides And
Toxic Substances
(H7506C)

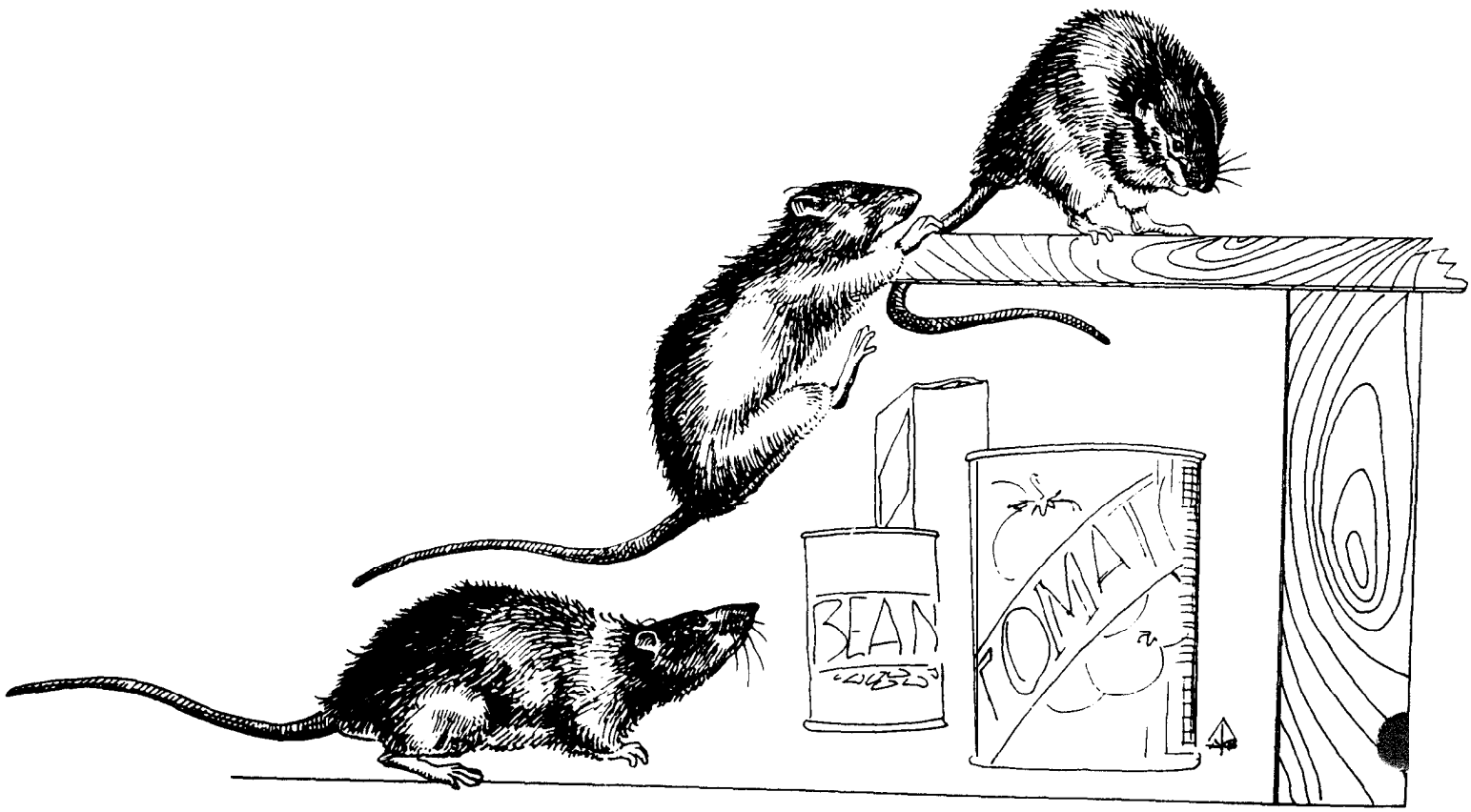
EPA 735-B-92-001
July 1992

EPA

Urban Integrated Pest Management

A Guide For Commercial Applicators

Vertebrates



MODULE THREE
VERTEBRATES

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Rodents: Pictorial Key to Some Common United States Genera

CHAPTER TWO RATS
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Runways.. 4
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Ground Squirrels 5
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Skunks 8
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Opossum 9
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CHAPTER 1

INTRODUCTION TO RODENTS AND OTHER VERTEBRATE PESTS

An animal with a backbone or spinal column is called a vertebrate. Humans, dogs, snakes, and birds are examples of vertebrates, while insects, worms, jellyfish, and snails are not. A few vertebrates, such as rats and mice, are common pests in urban and industrial sites. Others are not pests in their normal habitats, but may occasionally become pests when they conflict with humans. A skunk in the woods is a beneficial part of nature; a skunk nesting in the crawlspace of a home is an entirely different matter.

Some vertebrates that are serious pests in particular situations are never considered to be pests by certain people. Pigeons, for example, can cause human health problems when roosting in large numbers. Commonly, their droppings foul sidewalks, contaminate food, and damage automobile paint. But pigeons are seen as pets and friends by many city dwellers who feed them daily. These constituents react angrily to any attempt to poison or trap pigeons.

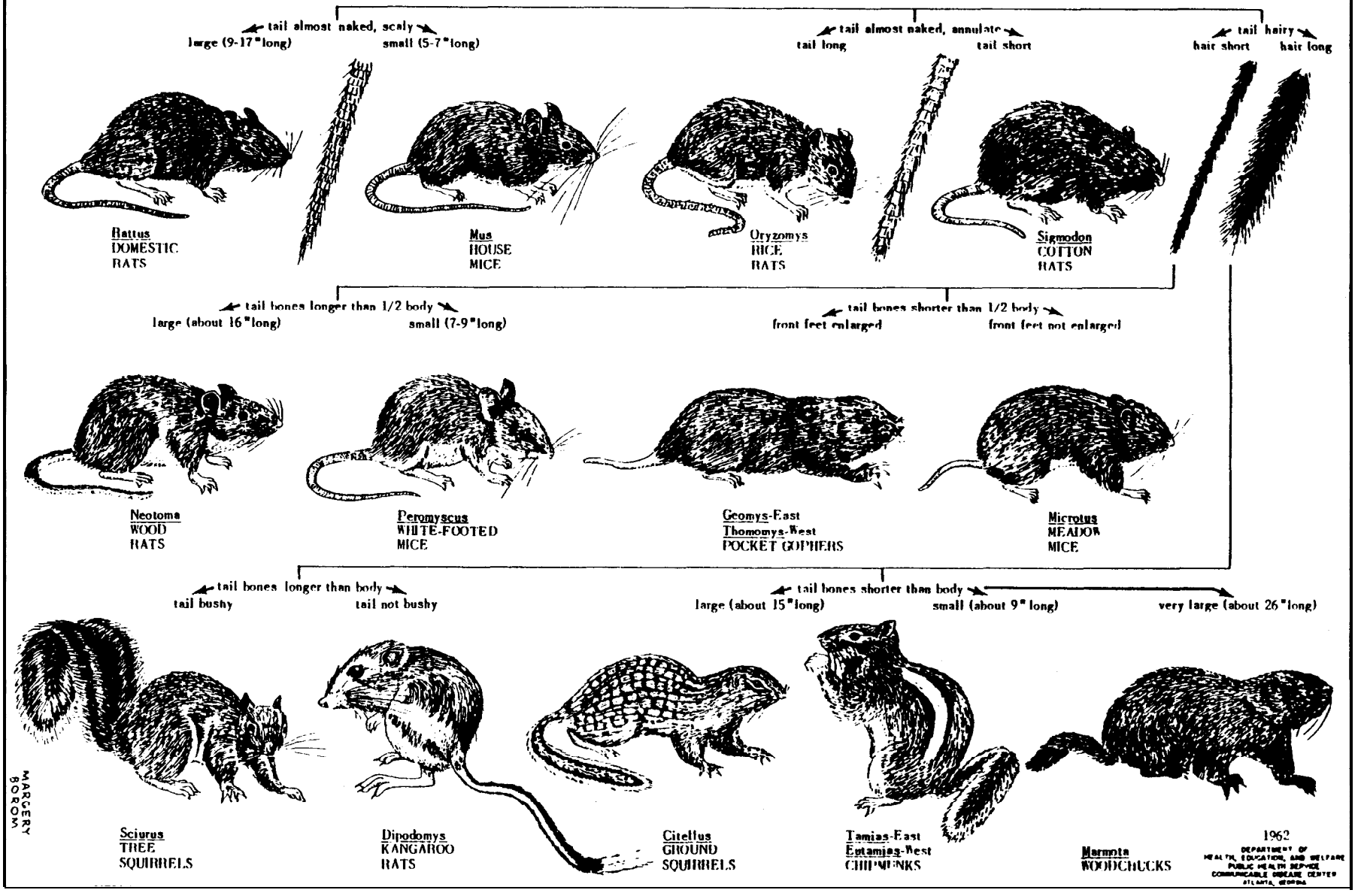
People feel a strong attachment towards vertebrates that they do not feel towards other pests. Children in particular love and cherish them. Many people today are involved emotionally in protecting the welfare of animals, particularly vertebrates. Control of vertebrates other than rats and mice is more of a public relations problem than a pest problem. Killing is the control method of last resort.

Public concern for the welfare of animals and the risk from vertebrate poisons to people, pets, and other nontargets have made rules governing vertebrate pest control particularly strict. Laws and regulations at the state and local level may be much more restrictive than federal regulations. Be sure you understand all the regulations that apply in your geographic area.

RODENTS

PICTORIAL KEY TO SOME COMMON UINITED STATES GENERA

Harold George Scott, Ph.D.



CHAPTER 2
RATS

Learning Objectives

After completion of the study of Rats, the trainee should be able to:

- List the physical characteristics of rats and select those unique to each species.
- Identify the habits and habitat of each.
- Describe the monitoring procedures.
- Describe methods to reduce life support.
- Describe physical control methods.
- Discuss the use of rodenticides.

Rats have caused more human suffering and more economic damage than any other vertebrate pest. From plague epidemics (the "Black Death" of Europe) to rat-bite fever, whether feeding on stored grain or gnawing electric wires, rats are enemies of humankind. Statisticians estimate that rats destroy 20 percent of the world's food supply every year -- directly by feeding and indirectly through contamination.

Yet, rats can be admired. They have adapted to nearly all human environments. They live in granaries, in fields, in city sewers, on ocean-going ships, on roofs, in attics, in basements, in street trees, on top of 30-story buildings, and inside subway tunnels.

Adept athletes, rats can leap three feet straight up and four feet horizontally. They can scramble up the outside of a pipe three inches in diameter, and climb inside pipes one-and-a-half to four inches in diameter. They can walk between buildings on telephone or power lines, and scramble on board a ship on its mooring line. 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; their teeth are extremely hard. They commonly chew through building materials such as cinder 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 an opening only a half-inch high.

In most instances, rats are very wary. Hundreds may be nesting in a city block -- in underground burrows, in sewers, on roofs, inside buildings -- with few people in the area realizing it. Populations are dynamic: rats moving in, rats moving out, rats giving birth, and rats dying. Within a population, some rats will be easy to control, some difficult.

Successful long term rat control is not simple. The key is to control 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. Lethal control often combines the use of rodenticides with nontoxic control measures such as snap traps or glue boards.

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.

Sometimes they transmit disease indirectly, for example, fleas biting first an infected rat, then a person. Following are some of the more important diseases associated with rats:

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 11 million people died in Asia from plague.

The disease is transmitted primarily to man by the oriental rat flea. The flea bites an infected rat, and then, feeding on a human, inoculates them with the bacteria that cause the 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. Humans contacting these rodents could contract the disease. As suburbia expands into undeveloped areas, wild rodents can transmit the disease to urban rats. There is a danger that an outbreak of urban plague can occur in the United States.

Murine Typhus Fever

Murine typhus occurs in California and in southeastern and Gulf Coast states. It is a relatively mild disease in humans. As with plague, murine typhus is transmitted from rats to humans by a rat flea. In this case, however, the disease organism enters the bloodstream when feces of infected fleas are scratched into a flea-bite wound.

Rat-Bite Fever

Rats bite thousands of people each year; most bites occur in inner cities. [In some cases victims, particularly infants and bed-confined elderly, are bitten in the face while sleeping.] A small percentage of those bitten develop rat-bite fever. The bacteria that causes the disease is carried in the teeth and gums of many rats. Although the disease exhibits mild symptoms similar to flu in most cases, it can be fatal. It is of particular risk to infants.

Salmonella Food Poisoning

Rats frequent sewers, rotting garbage, cesspools, and similar sites where ***Salmonella*** bacteria thrive. The bacteria also thrive in the intestinal tracts of rats. If infected rats travel to stored food, or dishes and silverware, or food preparation surfaces, their droppings can transmit ***Salmonella*** food poisoning to humans.

Leptospirosis or Weil's disease

Human cases of this disease are seldom fatal. The disease organisms are spread from rat urine into water or food, and enter humans through mucous membranes or minute cuts and abrasions of the skin.

Trichinosis

Trichinosis results from a nematode, or 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.

About Rabies - Never

Rats have never been found to be infected with rabies in nature. Rabies transmission from rats to humans has never been documented in the United States. The U.S. Public Health Service recommends against anti-rabies treatments in the case of rat or mouse bites.

KINDS OF RATS

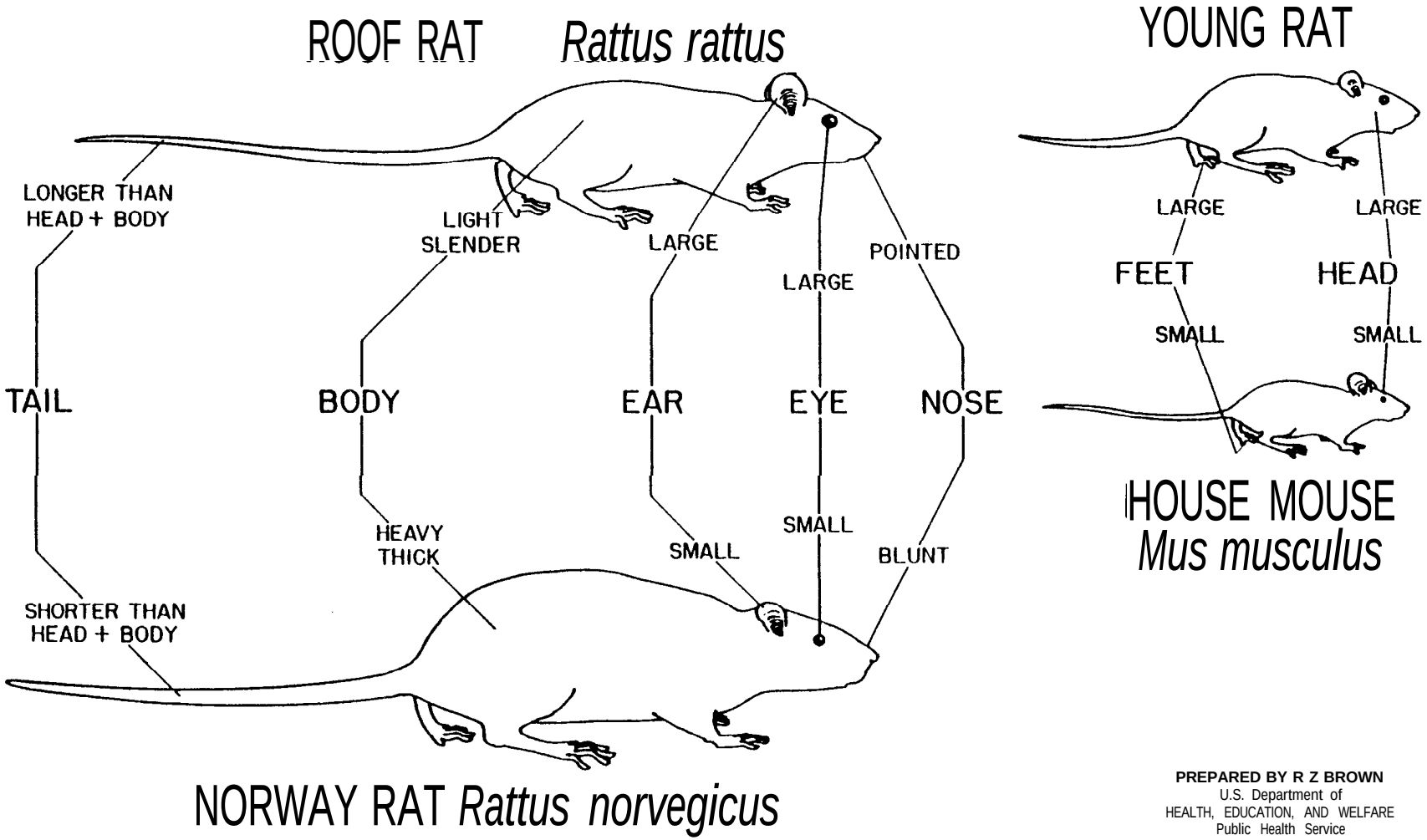
In the United States the two most important pest rats are the Norway rat ***(Rattus norvegicus)*** and the roof rat ***(Rattus rattus).*** The Norway rat is also called the brown rat, house rat, sewer rat, and wharf rat. The Norway rat is generally considered the most important rat in the U.S. It is found in every state.

The roof rat is also called the black rat, ship rat, and Alexandrine rat. Roof rats are found primarily in coastal areas of the United States, including California, Washington, and Oregon, the Southeast and Middle Atlantic States, and the Gulf States.

The two species look much alike but there are noticeable differences. In general: (see field identification chart)

- 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, covered with short hairs, and cannot be pulled over the eyes; a roof rat's ears are large, nearly hairless, and can be pulled over the eyes.

FIELD IDENTIFICATION OF DOMESTIC RODENTS



PREPARED BY R Z BROWN
U.S. Department of
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Communicable Disease Center
Atlanta, Georgia
Sept, 1955

- A Norway rat's snout is blunt; the roof rat's snout is pointed.

HABITS OF RATS

Rats must be understood to be controlled. Knowledge of their life histories, habitat and food requirements, patterns of behavior, range and other factors is essential to their management.

The Norway and Roof rats have similar habits. Most of the discussions below apply to either kind of rat. Where differences are important for control purposes, however, the differences will be highlighted.

Life Cycle

A mature female rat can give birth to about 20 young in a year (4 to 6 at a time), if she lives that long. The average life span of a rat in the field is less than one year; 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 to forage, escape, and watch 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 control programs have been unsuccessful in the past.

Young are totally weaned at four or five weeks old. They then weigh about 1 l/2 ounces. At three months, the young are independent of their mother. They will mate and continue the cycle in the same location or will migrate to a new, unoccupied nest area.

Social Behavior

Rats are social animals and 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.

Senses of Rats

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. Their eyes are adapted to dim light.

Other senses, however, compensate for poor vision. They use their sensitive nose 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.

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 avoid similar baits or stations in the future.

Food & 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. Each rat species, however, will feed on nonpreferred food if nothing else is available.

Rats often cache or hoard food in hidden areas. This food may or may not be eaten when other food supplies run short. Hoarding is important for two reasons. First, rats may be moving a toxic bait into a location where the label does not permit it to be. Second, rats may be hoarding poison bait while feeding on their regular food; thus, a baiting program becomes ineffective.

Rats need water every day. The amount varies, depending on the moisture content of their food, but is usually around 1/2 to one fluid ounce. Rats prefer to nest where water is easily available.

Range

Rats usually begin foraging just 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 of rats that nests outdoors to forage inside a building 100 feet away.

Nests

Outdoors, Norway rats usually nest in burrows dug into the ground. The burrows are shallow (less than 18 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 crawl spaces, 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 to nest in the upper levels of a building in the attic and in ceiling and attic voids near the roof line. But at times they also nest in the lower levels of a building as do Norways.

Both species also nest in sewers and storm drains, and both on occasion can be found in highly unusual nest sites. Both Norway and roof rats 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 20 acres when these secondary nest sites were included in the calculations.

INSPECTION

Rats give many signs that they are infesting an area. Inspection will determine if a site is infested, and will identify where rats are feeding and nesting, their patterns of movement, the size of the population, and the extent of the infestation. This helps the pest control technicians decide what control measures to use, where and how to use them, and how much effort is needed to put the program in place.

Flashlight

An inspection using a powerful flashlight just after dark is the best way to see rats. Dead rats are signs of a current or past infestation. If all that are found are old dried carcasses and skeletons, it may mean an old infestation. Many fresh carcasses are an indication that someone may be baiting the area currently. If rats are actively observed during the day, the rat population is probably high.

Sounds

When a building is quiet, squeaks and fighting noises, clawing and scrambling in walls, or gnawing sounds may be heard.

- Use a stethoscope or electronic listening device to help pinpoint activity.

Droppings

A single rat may produce 50 droppings daily. Roof rat droppings are generally smaller (half-inch) than 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 week later for new droppings.
- Look at the appearance of the droppings to determine if rats are currently active. Fresh rat droppings are black or nearly black, they may glisten and look wet, and they have the consistency of putty. After a few days or a week, 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 and do not feel like soft putty.]

Urine

Both wet and dry urine stains will glow blue-white under an ultraviolet light (blacklight).

- Portable ultraviolet lights are used in the food industry to identify rat urine on food items. Other substances besides rat urine also glow, which can be confusing, so proper use of this inspection method takes practice.

Grease marks

Oil and dirt rub off of a rat's coat as it scrambles along. The grease marks build up in frequented runways and become noticeable.

- Look along wall/floor junctions, on pipes and ceiling joists, and on sill plates where rats swing around obstacles. Grease marks are also found at regularly used openings in walls, floors, and ceilings.

Runways

Outdoors, rats constantly travel the same route; their runways appear as beaten paths on the ground.

- Look next to walls, along fences, under bushes and buildings. Indoor runways (harder to identify) may appear as well-polished trails, free of dust.

Tracks

A rat's foot print is about three-quarter inches 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.]

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 as evidence of a rat infestation. Gnawed holes may be two inches or more in diameter.
- Inspect floor joists, ceiling joists, door corners, kitchen cabinets, and around pipes in floors and walls.

Nest Sites

Roof rats, in particular, often nest or store food in the attics of buildings. Roof rat nests may also be found when dense vegetation is trimmed.

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, often with smooth, hard-packed soil.
- Look for rubmarks 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. If the rats are still using the burrow, they will reopen and clear the hole overnight.

Pet Excitement

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

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.

Estimating Rat Numbers

It's not easy to tell how many rats are infesting a site. As a rough guide, you can use rat signs to characterize the population as low, medium, or high.

- In rat-free or low infestation conditions, no signs are seen. The area either has no rats or was invaded recently by a few.
- With medium infestation, old droppings and gnawing can be observed. 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; rats may be seen in the daytime.

CONTROL AND MANAGEMENT

Most successful rat control programs use a combination of tools and procedures to knock down the rat population, and to keep it down. Methods used combine habitat alteration and pesticide application. Some of the tools, such as baiting and trapping, are lethal to the rat. Some tools are not; rat-proofing, for example. Sometimes applicators recommend changes that their customers need to make, such as increasing the frequency of garbage pickup or making building repairs.

The following sections describe some of the major techniques and tools used in controlling rats:

Sanitation

Food. Like all animals, rats need food to survive. Baiting programs often fail because the bait can't compete with the rats' regular food. The rats simply ignore the baits or cache them. Reducing the rats' normal food encourages them to feed on any rodenticide baits placed in their territory.

- Close or repair dumpsters and garbage containers that are left open or damaged.
- Clean food spills.
- Do not allow food to be left out overnight.
- Outdoors, remove seeds spilled under bird feeders or food around doghouses. In warehouses and food plants, look for spills around railroad tracks and loading docks. Ensure food in storage is rotated properly (first in, first out) and is stored on pallets, not on the ground or against walls. The pallets should be 18-24 inches from side walls and placed so that aisles permit inspection and cleaning around the stored food.

Eliminate hiding places.

Outdoors

- Remove plant ground covers such as ivy near buildings.
- Remove high grass, weeds, wood piles, and construction debris that permit rats to live and hide adjacent to a building.

Indoors

- Reduce clutter in rarely-used rooms -- basements, storage rooms, equipment rooms. Organize storage areas.

Rat-Proofing (Exclusion)

Long term, the most successful form of rat control is to build them out. Also called rat-proofing, this technique makes it impossible for rats to get into a building or an area of a building. Rat-proofing prevents new rats from reinfesting a building once it has been cleared.

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.
- Screen air vents.
- 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.

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 held firmly in place.

Traps

Snap Trap. The snap trap is an effective method of killing rats when used correctly. Trapping is advised for use in places where rodenticides are considered too risky or aren't working well, if the odor of dead rats in wall or ceiling voids would be unacceptable, or when there are only a few rats infesting a limited area.

Trapping has several advantages. There is less nontarget risk than from a toxicant. The technician knows instantly whether or not the trap has been successful. Traps also allow for disposal of the carcass so that there are no odor problems.

Careful attention to detail is necessary to ensure proper placement in adequate numbers or rats will simply pass them by.

The best traps are those with expanded triggers (treadles) set for a light touch.

- 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, or without bait if food is plentiful. Good baits for Norway rats include peanut butter, hot dog slices, bacon, or nut meats. Roof rats respond to dried fruits and nuts, or fresh fruits such as banana or apple.
- Tie moveable bait to the trigger using string or dental floss, or else the rat may simply remove the bait without triggering the trap.
- Sprinkle cereal, such as oatmeal, around traps to make them more attractive.

- Set unbaited traps along runways, along walls, behind objects, in dark corners where the rat is forced through a narrow opening. Place the trigger side of the trap next to the wall. [Rats will step on the trap during their regular travels.]
- When runways are located on rafters and pipes, set expanded trigger traps directly across them, fastening them to pipes with wire, heavy rubber bands, or hose clamps, and to rafters with nails.
- Set traps where droppings, gnawing damage, grease marks and other evidence of activity is found.
- Use enough traps. [A dozen may be needed for a house, a hundred for a small warehouse.] Set five or ten traps in an active corner of a room. Set three traps in a row so 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 10 to 20 feet apart.
- Camouflage traps when left with only a few rats that become very difficult to capture. Set traps in a shallow pan of meal, sawdust, or grain. [Place a small piece of cloth or plastic over the trigger to prevent the meal from jamming the mechanism.]
- In stubborn cases, expose food in shallow pans until the rats readily feed on it. Then add a buried trap.
- Move boxes and objects around to create narrow runways to the traps.
- Avoid spraying insecticide on the trap, or even storing traps with application equipment. The odor of other rats improves a trap's effectiveness. Likewise, the odor of insecticide can make a rat steer clear.
- inspect traps frequently to remove dead rodents and change old bait.

Glue Boards. Another way to trap rats is with glue boards. Glue boards use a sticky material that captures rodents. Although most often used against mice, they are sometimes effective against rats. Be sure to use larger glue boards that have been designed to trap an animal the size of a rat. Be aware that some consider glue boards inhumane, since they often kill the rodents.

- Place glue boards in the same location as you would place snap traps. Place them lengthwise flush along the wall, box, or other object that edges a runway. Overhead runways along pipes, beams, rafters, and ledges are good sites too.
- Do not place glue boards directly over food products 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 bait 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 humanly.
- Adding a dab of bait to the center of the glue board may improve its effectiveness.

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.

Food Baits. Rat baits combine a poison effective against rats with a food bait attractive to rats. At one time, applicators mixed their own baits. Now baits are mostly 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 45-pound bulk tubs, in place packs containing less than one ounce of bait, or anything in between.

Some baits kill rats after a single feeding, some require multiple feedings. Some are anticoagulants [causing rats to bleed to death], some affect respiration, and others have totally different modes of action. Some are only slightly toxic to people or pets, some moderately toxic, and some very toxic.

Many of the old, ancient poisons that were toxic to humans were also used to poison rodents. Experimentation with poisons for killing rodents, produced rodenticides made of arsenic, cyanide, strychnine, etc.: stomach poisons, that were mixed with food and had such extreme toxicity that they killed any animal that ingested them in sufficient amounts. Rats that did not eat a lethal dose, however, recovered, became "bait shy" and communicated their preference -- or revulsion -- to others in the colony. Because of this, these poisons were undependable.

A new type of rodenticide was developed in the 1940's that reduced the clotting ability of the blood. This material became Warfarin, the first anticoagulent rodenticide. Others followed: warfarin, coumafuryl, chlorophacinone, diphacinone, pindone, valone. The anticoagulents were effective and did not cause bait

shyness. Several factors overcame the risks of acutely toxic poisons. While the anticoagulents could be lethal to warm-blooded animals, many species including poultry, farm animals, pets, and humans would have to consume large quantities over several days to cause fatalities. As well an antidote, vitamin K, was developed.

Evidence of resistence to anticoagulents and a desire for quicker results drove the successful search for single dose anticoagulents -- brodifacoum and bromadiolone. In recent years non-anticoagulent rodenticides with different modes of action, such as bromethalin or cholecalciferol, have been proven effective. Zinc phosphide, used as a single dose non-anticoagulent, is somewhat poisonious to all vertebrates. It is often used as a tracking powder and is licked from the fur when rodents groom themselves. It is also incorporated in dry baits. Zinc phosphide should never be mixed with bare hands nor applied without wearing gloves.

Remember, rodenticides must be used very carefully: they are made to kill animal species of the same class as humans.

Several general guidelines should be followed when using a poison bait. First and foremost, protect children, pets, wildlife, and domestic animals from eating the bait. All rodenticides have warnings on the label telling the applicator to place the bait "in locations not accessible to children, pets, wildlife, and domestic animals, or place in tamper-proof bait boxes.' What are safe, inaccessible areas is determined by evaluating each case. Ask questions like these:

- Is it possible for a child to reach under a refrigerator to grab a place pack that you hid underneath?
- Could a guard dog at a warehouse find and eat the bait blocks you placed under a loading dock?

If so, change your placement or put the bait inside a tamper-proof bait box.

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, but they are usually metal or heavy plastic. Rat bait stations are normally 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 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 walls, and at other travel sites, etc.).
- Rut place packs in burrows, in wall voids, 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 attics, trees, and roofs.
- Rut out enough bait and check it often. [Incomplete baiting can lead to bait shyness and make control difficult.]
- Be sure to limit the rats' normal food supply or your baits may be rejected.
- Remember that rats fear new objects at first so that your baits may not be taken for a few days or a week.
- Once bait is taken, leave the box in place for some time; the rats now consider it to be part of their normal surroundings.
- Good bait placements can be effective even when placed 15 to 50 feet apart. Bait placed outdoors around a commercial building can kill rats that are moving in from nearby areas.

Water baits. Rats drink water daily if they can. When rat water supplies are short, water baits -- specially formulated rodenticides that are mixed with water -- can be extremely 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.***

Tracking Powders. Rats groom themselves by licking their fur. Tracking powder makes use of this behavior. This formulation is a rodenticide carried on a talc or powdery clay, applied into areas where rats live and travel. The powder sticks to the rats' feet and fur, and is swallowed when the 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 l/8-inch.] Best application sites are inside wall voids, around rub marks, along pipe and conduit runs, and in dry burrows (when permitted by label). Apply with a hand bulb, bellows duster, or with a (properly labeled)

flour sifter or salt and pepper shaker.

- Do not use tracking powders in suspended ceilings, around air ventilators, or near food or food preparation areas. The powder can become airborne and drift into nontarget areas. [The rodenticide in tracking powders is generally 5 to 40 times more concentrated than that in baits.] Tracking powders can be made with acute poisons or slower acting poisons.

SUMMARY

Rats have adapted to nearly all human environments, Along the way, they have caused more human suffering and economic damage than any other vertebrate pest. But they are marvelous athletes and successful survivors as well. Successful longterm rat control is not simple. The key is to control rat populations, not individual rats.

The two most common pest rats are the Norway rat and the roof rat. To be controled they must be understood. Two of the most important biological factors to help control rats are (1) their fear of new objects and (2) their large foraging range of 100-150 feet or more from their nest.

Successful rat control programs usually use a combination of tools and procedures to knock down a rat population and keep it down. Longterm, the most successful form of rat control is to build them out, also called rat-proofing. Other control tactics include trapping and poisons. When using rodenticide baits and tracking powders, care must be taken to avoid risks to people, children, pets, and nontarget animals.

STUDY QUESTIONS FOR MODULE THREE
CHAPTER TWO
RATS

1. A rat can compress his body and squeeze through an opening as small as:
   A. l/4-inch high
   B. l/2-inch high
   C. l-inch high
   D. 2-inches high

2. Rats are a major carrier of rabies.
   A. True
   B. False

3. Rats will avoid anything new that appears in their territory.
   A. True
   B. False

4. Rats commonly travel a distance of _____ from their nest looking for food and water and patrolling their territory.
   A. 10 to 25 feet
   B. 100 to 150 feet
   C. 1 to 2 miles
   D. None of the above

5. Which of the following is not true about adult rat droppings:
   A. They average 5/16-inch long
   B. Fresh droppings are black or nearly black
   C. The highest number of droppings will be found where rats rest or feed
   D. A single rat can produce 50 droppings in a day

6. Longterm, the most successful form of rat control is rat-proofing ("building them out").
   A. True
   B. False

7. When applying rodenticides, they should be placed:
   A. In locations not accessible to children, pets, wildlife, and domestic animals
   B. In tamper-proof bait boxes
   C. Only outdoors
   D. All of the above
   E. 'A' or 'B'

8. Tracking powder kills rats because:
   A. Rats swallow tracking powder when they groom their fur
   B. Tracking powder is a powdery rodenticide bait
   C. Tracking powder is absorbed dermally through the rats' skin
   D. 'B' and 'C'
   E. none of the above

9. The key to rat control is to control rat populations, not individual rats.
   A. True
   B. False

For Answers refer to Appendix A

CHAPTER 3

HOUSE MICE

Learning Objectives

After completion of the study of Mice, the trainee should be

- Describe the habits and habitat of mice.
- Describe monitoring procedures and tools.
- Describe methods to reduce life support.
- Describe physical control methods.

The house mouse ***(Mus musculus)*** easily adapts to life with 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 subsist throughout the United States. They are found in most areas of human habitation. House mice are also found living in the wild, competing with native fauna. They are common inhabitants of grassy fields and cultivated grain crops. As well, house mice have been captured in open tundra in Alaska, miles away from human settlements.

Technicians will find that the house mouse is the most troublesome and economically important rodent. House mice are a common problem in homes and in all types of businesses. Nearly everyone can remember times when they were irritated by mice. They are a nuisance to rich and poor alike. The continual drain that house mice impose on stored food and fiber, and the damage they cause to personal possessions, are the most serious economic threats. House mice also have the potential to transmit diseases and parasites to people and domestic animals.

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 they are in controlling mice.

LOSSES DUE TO MICE

When mice infest stored food, the greatest loss is not what mice 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 an 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.

So common are mice that the government permits a certain number rodent hairs, and sometimes droppings, to remain in food commodities destined for human consumption. Yet food inspectors often have to condemn food products and fine manufacturers because of house mouse contamination in excess of that permitted.

Losses are not only connected with food. Family bibles or heirlooms stored in a trunk in the attic or garage that are damaged by mice are irreplaceable, as are original paintings and manuscripts stored in museums. Mouse-riddled documents in the bottom file drawer of an office cannot generally be valued in dollars and cents, but these losses can be costly.

Electrical wiring gnawed by rodents start many fires. Many listed as “cause unknown” are probably rodent-related. House mice frequently take up residence in electrical appliances and end up chewing into the power supply. This is particularly costly when computer systems are disrupted.

MICE AS DISEASE CARRIERS

Excluding the spread of food poisoning, house mice are not as important 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.

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.

Rickettsial pox

Rickettsia akari is the causal agent of rickettsialpox, a disease causing a rash of the chickenpox type. Rickettsialpox is transmitted from mouse to mouse, then to man by the bite of the house-mouse mite.

Meningitis

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

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.

Rat-bite Fever, Ray Fungus & Ringworm

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

Dermatitis

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

APPEARANCE

The house mouse is a delicate, agile, little rodent. (See charts, chapter 1, pg 2 and chapter 2, pg 3.) Adult weights vary from region to region and may be linked to the suitability of habitat, but usually range from l/2 to 1 ounce. Adult house mice vary in color from light brown to dark gray but most often are a dusky gray or medium brown over most of their bodies, except the belly, which may be a slightly 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 l/2 to 4 inches). The feet are small in proportion to its body. 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 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.

HABITS OF HOUSE MICE

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 frequency of pregnancies, litter sizes, and survival. Under ideal conditions, females may produce as many as ten litters (about 50 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. Eyes and ears are closed, but by the end of 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.

Social Behavior

While mice primarily are active at night, some day 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.

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 items and to recognize other individuals, especially those of the opposite sex. Taste perception in mice is good also. Mice use their acute hearing to detect and escape danger.

An important sensory factor with mice is touch. Like rats, mice use long, sensitive whiskers near the nose and the 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 quickly carry out actions or movements is governed by constant practice of sequences of muscular movements [sometimes referred to as the kinesthetic sense]: a subconscious recording of a series of movements necessary to go from point A to point B. This activity occurs from stimulation of sensory nerve endings in muscles, tendons, and joints. The result allows mice to quickly escape danger.

Curiosity

Mice do not fear new objects as do rats. As mentioned earlier, they quickly detect new objects in their territory and investigate them. 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 success early [just the opposite of rat programs].

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, with some of the more agile individuals jumping 12 inches (30.5 cm) high from the floor onto an elevated flat surface.
- They can jump against a wall or flat 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 much difficulty if the surface is rough.
- They can run horizontally along insulated electrical type wires, small ropes, and the like, with ease.
- They can squeeze through openings slightly more that l/4 inch (6 mm) high.
- They can easily travel for some distance hanging upside down from l/4-inch (6 mm) 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 8 feet (2.5 meters) to the floor.
- They can survive at a constant 24°F. (-30°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.

Food and Water

House mice prefer cereals over other items, although they will 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 get much of their water from moisture in their food, but they will drink if water is readily available.

Mice are nibblers, feeding 20 or more times during evening rounds. Mice have two main feeding periods, at dusk and just before dawn. In any territory, there will be one or two feeding sites, dark and

protected, where mice will 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 the kernels as they get smaller.

Range

Mice are territorial and seldom travel more than 30 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.

Nests

House mice may nest in any dark, sheltered location. Nests are constructed of fibrous, shredded materials such as paper, cloth, burlap, insulation, or cotton and generally look like a loosely woven ball. They are approximately four inches in diameter.

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. Many failures in mouse control can be blamed on an applicator using rat-control techniques.

INSPECTIQN

Sounds

Sounds are common at night where large numbers of mice are present.

- Listen for squeaks, scrambling and sounds of gnawing.

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 house mice.

- Look along runways, by food near shelters, and in other places mice may frequent.

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.
- Use a blacklight. Urine stains will fluoresce under ultraviolet light.

Grease marks

Like rats, mice produce greasy smears where dirt and oil from their fur mark pipes and beams. House mouse spots are not as easy to detect

- Expect markings to cover a smaller area than those made by rats.

Runways

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

Tracks

- Look for footprints or tail marks on dusty surfaces or on mud.
- Use a nontoxic tracking dust to help to determine the presence of house mice within buildings (see Chapter 2, Rats).

Gnawing damage

Recent gnawings on wood are light in color, turning darker with age.

- Look for enlarged cracks beneath doors.
- Look for small tooth marks. [Such evidence frequently helps to distinguish between mice and rats.]
- Look for wood chips with a consistency like coarse sawdust around baseboards, doors, basement windows and frames, and kitchen cabinets.

Visual sightings

Mice are often active in daylight and this may not indicate a high population as it does with rats.

- Use a powerful flashlight or spotlight at night in warehouses and food plants to confirm house mouse presence.

Nest Sites

- Look in garages, attics, basements, closets, and other storage places.
- Be alert to fine shredded paper or other fibrous materials; these are common nest-building materials.

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 premises only recently.

Mouse Odors

- Smell for the characteristic musky odor produced by mice. It can be easily differentiated from that of rats.

Estimating Numbers of Mice

Estimates are more difficult to get than for rats. The number of mice observed or food consumed is not highly reliable as a census technique with house mice. 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 20- to 30-foot intervals (5 to 10 meters) 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 the local 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.

CONTROL AND MANAGEMENT

Control and prevention of house mice is a three-part process:

- sanitation,
- mouse-proofing, and
- population reduction with traps or toxicants.

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. Applicators that do not take these differences into account will have control failures.

- Sealing mice out of a building is difficult because mice are smaller.
- Range is small. Identify each infested site in order to target control procedures.
- Mice often can produce offspring faster than control methods can work.

Nevertheless, many of the techniques to control and manage rats also apply to mice. In the section. below the differences in procedures between rats and mice are emphasized.

Sanitation

Good sanitation makes it easier to detect signs of mouse infestation. It also increases the effectiveness of baits and traps by reducing competing food. However, the best sanitation will not eliminate house mice; they require very little space and small amounts of food to flourish.

- Store bulk foods in mouse-proof containers or rooms. In warehouses, restaurants, and food plants stack packaged foods in orderly rows on pallets so that they can be inspected easily. A family of mice can happily live in a pallet of food without ever having to leave the immediate area.
- Keep stored materials away from walls and off of the floor. A 12-18 inch yellow or white painted band 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.

Mouse-Proofing

It isn't easy to completely mouse-proof a building since mice are reported to be able to squeeze through an opening as little as l/4-inch high.

- Seal large 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, vents, etc., 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 and glue boards more effective.]

Traps

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.

- Remember that the territory of mice rarely extends further than 30 feet from the nest, and more often is about 10 feet. If mice are sighted throughout a building it means that there are numerous discrete locations where you will have to set traps. Place snap traps not only wherever you see obvious signs of mice, but look for good trap locations in a three-dimensional sphere about ten feet in diameter around those signs.
- 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, crawl spaces, or under coolers and/or processing equipment.
- The best sites are those with large numbers of droppings since that means the 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 the mice into a limited area.
- Good mouse baits increase a traps effectiveness. 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 must be tied securely to the trigger. Food baits must be fresh to be effective.
- Probably the biggest mistake made in mouse trapping is not using enough traps. Use enough to make the trapping campaign short and sweet.

Multiple-Catch Traps. Multiple-catch mouse traps catch up to 15 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. Live mice must be humanely killed.

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.

- Check traps frequently. Mice are captured alive but may die in a day or two. Some traps have a clear plastic end plate or lid so you can see if any mice 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 6-10 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.

Glue Boards. Glue boards are very effective against mice. As with traps, placement is the key. Locations that are good trap sites are good sites for glue boards.

- Do not put glue boards directly above food products 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.
- Place the glue boards 5 to 10 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.

Rodenticides

Food Baits. Observe the same safety guidelines for mouse baits as discussed in the section on rat baits. Children, pets, wildlife, and domestic animals must be protected by putting the bait in inaccessible locations or inside tamper-proof bait boxes.

- Apply many small bait placements rather than a few large placements.
- 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 wall or object to intercept the mice.
- Bait in three dimensions (see earlier discussion on trapping).
- Make bait placements 10 feet apart or closer in infested areas.
- If bait is refused, try switching to a different type, and replace the baits often.
- Use small bait stations which are more attractive to mice than the larger rat-type stations.
- Make sure that sanitation is such that other food is not out-competing the baits.
- Place secured tamper-proof bait boxes in safe locations near doors in late summer to intercept mice entering from the wild.

Liquid Baits. Mice get most of their water from their food; they also drink from a water container. Liquid baits that are labeled for mouse control can be effective in sites that do not have a ready supply of water. The same water bait dispensers used for rats can be used for mice. As with food baits and traps, many water stations will be necessary to put the bait into the territory of all mice infesting a building.

Tracking Powders. Tracking powders are especially effective against mice. Mice groom themselves more than rats, and they investigate enclosed areas which can be dusted with tracking powder.

- Apply inside infested dry wall voids.
- Dust tracking powder into voids in heavily infested apartment or office buildings.
- Use a bait station, PVC tube, cardboard tube, or any small, dark shelter that a mouse could enter in cases where tracking powder cannot be applied. Mice will explore such a shelter. Apply the tracking powder in a layer less than l/16-inch deep.
- Do not allow tracking powder to drift into nontarget areas.

SUMMARY

The house mouse is the most successful rodent in adapting to life with people. It's found most anywhere people are, feeding on human food, sheltering in human structures, and reproducing at a remarkable rate. It's the most troublesome and economically important vertebrate pest, contaminating untold millions of dollars worth of food, damaging possessions, and causing electrical fires with their constant gnawing.

Many control failures against house mice are due to the applicator's lack of understanding of mouse biology and habits, and particularly the major differences between mice and rats. Mice have a remarkable reproductive ability. A mated pair can produce 50 offspring in one year. They also have a foraging range much smaller than a rat's, usually only 10 to 30 feet. Baits, traps, glue boards, and the like, must be placed close to the nest to be effective. Thus, good inspections are critical.

On the plus side, mice are curious and investigate new objects in their territory, so control measure can work fast when done correctly. Control of house mice is best when it is a three part process: sanitation, mouse-proofing, and population reduction with traps or toxicants.

STUDY QUESTIONS FOR MODULE THREE
CHAPTER THREE
HOUSE MOUSE

1. In 6 months, one pair of house mice can eat about 4 pounds of food and deposit about _____ droppings.
   A. 400
   B. 1,800
   C. 4,000
   D. 18,000

2. When mice infest food, the greatest loss is not what mice eat, but what is thrown out because of contamination.
   A. True
   B. False

3. Which of the following is not true about mice:
   A. Mice principly breed in spring
   B. Mice are mostly active at night
   C. Females can produce up to 50 young per year
   D. Mice seldom travel 30 feet from their nest
   E. Mice are nibblers, feeding 20 or more times per night

4. Mice will avoid anything new that appears in their territory.
   A. True
   B. False

5. Mouse control is difficult because:
   A. They can squeeze through openings slightly larger than l/Cinch
   B. There can be many nests in an infested building
   C. They have a very high reproductive potential
   D. All of the above

6. The key difference in baiting mice in contrast to rats is:
   A. You need to apply many small bait placements
   B. You must use water baits
   C. You need to wait weeks for mice to stop avoiding the "new" bait
   D. Baits are not effective against mice

7. Tracking powders should be applied in a layer less than l/16-inch deep for control of mice.
   A. True
   B. False

8. Mouse traps should be placed:
   A. About 6 inches away from a wall
   B. Every 30 feet
   C. Along walls, behind objects, and in dark corners
   D. In the center of infested rooms

For Answers refer to Appendix A

CHAPTER 4

BIRDS

Learning Objectives

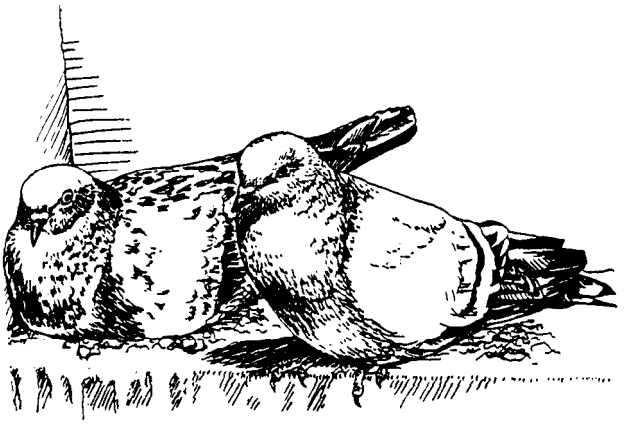
After completion of the study of Birds, the trainee should be able to:

- Describe the habitats and life cycles of birds.
- Discuss the non-chemical and chemical alternatives of bird control and management.

Birds create enjoyment and recreation while greatly enhancing the quality of life. These colorful components of natural ecosystems are studied, viewed, photographed, enjoyed, or hunted by most Americans. Bird watching as a sport and recreational activity involves over 10 million people. For this reason, birds are strongly protected by laws, regulations, and public opinion.

Birds can become pests when they feed on crops, create health hazards, roost in large numbers on buildings, contaminate food, or create a nuisance. Few species can be flatly categorized as good or bad; whether birds are beneficial or harmful, depends on time, location, and activity.

PIGEONS



The domestic pigeon ***(Columba livia)*** developed from the rock doves of Europe and Asia and 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.

Pigeons give pleasure to many people. Along with house sparrows, they may be the only "friendly" wildlife observed by many people living in an inner city. Many park visitors have adopted special pigeons they feed every day. Pigeons are also bred for racing, stunt flying, and meat production. Pigeon racing is a sport in Europe and in some parts of the United States, with birds racing distances of 10 to 1,000 miles (the record is 3,000 miles).

Pigeons are used for scientific research on heart disease in humans and diseases of domestic chickens. They are raised for food; the meat of pigeons is commonly referred by restaurateurs as "squab," to avoid offending their customer's sensibilities; it is considered a delicacy.

Pigeons have become the most serious bird pest associated with buildings; they may congregate in flocks of a hundred or more. Although primarily seed or grain eaters, in urban areas pigeons feed on garbage, spilled grains, insects, food left out by outdoor diners, and food provided by bird lovers who intentionally feed pigeons bread, peanuts, and cookie crumbs.

HABITS OF PIGEONS

Pigeons are gregarious and feed, roost, and loaf in each other's company whenever possible. Feeding, roosting, and loafing sites are usually separate. Roosting sites are protected from the elements and are

used for nesting, congregating at night, and shelter in bad weather. Loafing sites will be nearby to be used by inactive birds during the daytime. 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. Typical roosting and loafing sites are building roofs and ledges, cooling towers, monuments, bridges, and signs. Typical feeding sites are parks, squares, food loading docks, garbage areas, railroad sidings, food plants, and wherever people eat outdoors.

Male pigeons are sexually mature at three to four months of age; females at six months. Pigeons usually mate for life unless separated by death or accident. If one partner of a mated pair is lost, the survivor will re-mate within a few days. 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 and structures. 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 8-12 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 18 days, by the male from mid-morning through afternoon, and the female the rest of the day and evening.

At birth the young pigeons are naked and helpless and 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 10 days, they switch completely to whole grains.

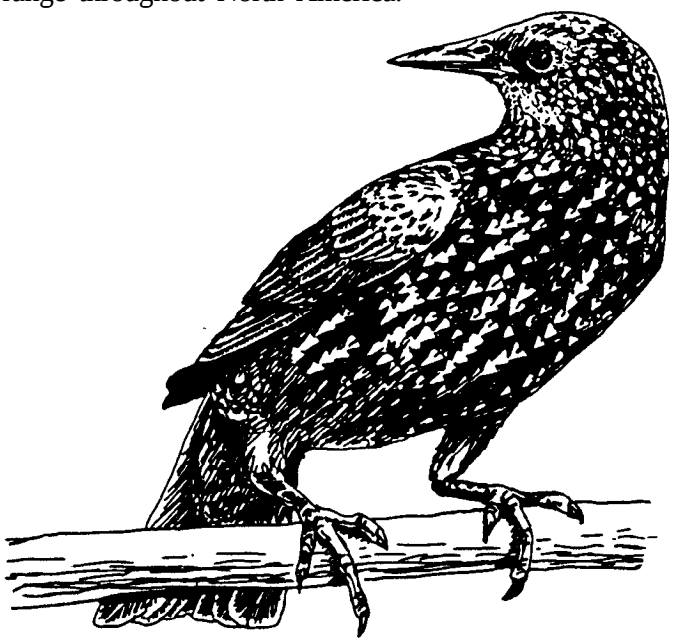
During the first week or so, the young double in size daily and are full grown in less than a month. They are fledged when they are 37 days old. Average flight speed is 36 mph. Adult birds can mate again while the young are still in the nest.

Pigeons nest during all seasons when conditions permit. City pigeons generally remain in one area year-round and produce 10 young per year. Nests that are continually used become solid with droppings, feathers, debris, and sometimes, dead birds.

Life span is highly variable, ranging 3- 15 years in urban roosts. They have lived for 30 years in captivity.

STARLINGS

European starlings ***(Sturnus vulgaris)*** were introduced into the United States in 1890 when 60 were brought to New York City. They rapidly expanded into new areas. Today, 140 million starlings range throughout North America.



Starlings are robin-sized birds that weigh 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 out in flight. Starling flight is direct and swift, not rising and falling like many blackbirds.

Habits of Starlings

Starlings nest in holes or cavities in trees or in rocks, or in urban areas 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 when they are about three weeks old. At this time bird mites sometimes abandon the nest.

Starlings migrate in some parts of the country. As

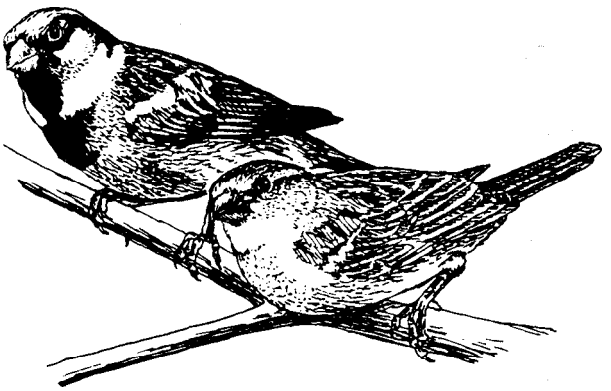
cold weather begins in the fall, they begin forming larger flocks. The major sources of food shift from insects and fruits to grains, seeds, livestock rations, and food in garbage. Roosting areas may shift from rural and suburban into cities and towns. Each day they may fly up to 30 miles to their feeding 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 lines. When they return just before sundown, they do not fly straight in to their roost. They "stage" on high perches such as trees, power lines, bridges, and towers. The birds are quite social at these times and remain on pre-roost sites until after sunset, singing and calling to each other.

Starlings are pests because of their high numbers. Thousands or tens of thousands can roost at one site. Droppings at the roost site damage car finishes, tarnish buildings, drop on 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.

When starlings roost in food processing plants or storage areas, they contaminate food. The birds consume large quantities of livestock feed and contaminate water at stockyards. The noise of a large flock can be irritating.

HOUSE SPARROWS



The house sparrow ***(Passer domesticus),*** also called the English sparrow, was introduced into the United States in the 1850's. 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 1920's when food and waste from horses was unlimited.

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, light eye stripe, and a streaked back.

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 for 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 and social birds and will often outcompete 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 non-breeding adults may sometimes travel four or five miles from nest sites to feeding areas. Sparrows are very tolerant of human activity, and will not hesitate to set up housekeeping in high traffic areas.

House sparrows feed preferentially on grain. They will also feed on fruits, seeds, and garbage.

House sparrows can be pests in many situations. Their droppings contaminate stored grain and bulk food. Droppings and feathers can make hazardous, unsanitary, and smelly wastes inside and outside of buildings, on sidewalks, and under roosting sites. Sparrows can also become a pest when one or a few begin nesting inside a food plant, warehouse, mall, or atrium.

The birds cause damage by pecking at rigid foam insulation in buildings and nesting inside traffic lights. They create a fire hazard by nesting in transformers and power stations.

They are a factor in the transmission of a number of diseases, internal and external parasites. Most significantly, they are thought to be a major reservoir of St. Louis encephalitis.

OTHER BIRDS

The three birds most often pests in the United States in urban areas are pigeons, starlings, and house sparrows. Other birds, from hawks to swallows, may occasionally cause unexpected and unusual pest

problems. When blackbirds and crows roost in suburban areas they become pests. Woodpeckers can "hammer" into house siding looking for insects. Seagulls can feed at food plants.

Many of these birds have more protection by laws and regulations than the three birds discussed previously. Special permits may be required to trap them or to control them by lethal means. The best approach emphasizes exclusion or modification of buildings.

HEALTH HAZARDS ASSOCIATED WITH BIRDS

Health risks from birds are often exaggerated. Nevertheless, large populations of roosting birds may present risks of disease to people nearby and pest management technicians. 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, but this risk is usually limited to food manufacturing or processing plants. When parasite-infested birds leave roosts or nests or invade buildings, their parasites can bite, or irritate people.

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 ***(Hisroplasma 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. Based on histoplasmin skin tests given to large numbers of people throughout the United States, it is thought that about 50 million people have had histoplasmosis or been exposed to it. Each year there are about 500,000 infections, 5,000 people hospitalized, and 800 deaths in the United States due to histoplasmosis.

The National Eye Institute (NEI) at the National Institutes of Health has reported a potentially blinding eye condition, called ocular histoplasmosis syndrome (OHS), that results from infection by the ***Histoplasma cupsulatum.*** 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 NEI estimates that four percent of those exposed to the disease have tiny scars that put them at risk of developing OHS. An estimated 100,000 people have OHS in the rapidly progressive form that can lead to blindness.

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, cupolas, ledges, water towers, and other roosting and nesting sites on structures. It has been found in as many as 84 percent of samples taken from old roosts. Even when old and dry, bird droppings can be a significant source of infection. As many as 50-million colony forming units have been found in a gram of pigeon manure.

The disease is acquired by inhaling the yeast-like vegetative cells (2-3 microns) of the organism. There are two forms of cryptococcosis present 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 man to a lesser degree. Psittacosis, pigeon ornithosis, and toxoplasmosis are normally mild in man, 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 mosquito-borne encephalitis.

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 infest pigeons, but the northern fowl mite and chicken mite are usually the main culprits 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, fungus

gnats, carpet beetles and other insects that may become major problems in the immediate area. These pests may fly or crawl through windows, ventilators, cracks and crevices, etc., and enter buildings.

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, many types of metal trim, electrical equipment, and machinery. Downspouts and vents on buildings also become blocked by droppings, nest materials, and feathers. This accumulation of debris can attract insect pests such as gnats, carpet beetles and other dermestids, spider beetles, and mealworms.

Legal Considerations

With very few exceptions, all birds are protected by one or more federal laws and regulations.

- Pigeons, starlings, and house sparrows are not directly protected at the federal level but applications of toxicants or repellents must be according to the product label and under the restrictions that apply under FIFRA.
- Other birds are regulated in some way at the federal level.
- Nontarget birds in the treatment area are protected, and any actions that kill or damage protected birds or their habitats will be a violation of various federal and state regulations.
- State and local regulations may require permits or restrict the actions taken against pest birds.
- When in doubt, contact your state natural resources agency or the United States Fish and Wildlife Service District office in your area for further information.

TOOLS AND METHODS FOR MANAGING PEST BIRDS

Inspection

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?
- Are they adults, residents, migrants, juveniles?
- Are they nesting, feeding, roosting, loafing?
- Where do they eat and drink?
- What is attracting them to the various sites?
- Are the birds causing a health risk?
- Are the birds causing physical damage?
- If dispersed, where would they go?
- If poisoned, where would they die?
- Is there risk to nontarget species?
- What are the legal considerations?
- Could there be public relations problems?
- Is exclusion or habitat modification practical?

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 might help reduce this source of food; however, many people will pay little attention to requests to stop.

The most successful kind of habitat modification is to exclude the birds from their roosting and loafing sites (addressed in the section on exclusion).

Pigeons may be induced to move from an infested site by the persistent destruction of nests and eggs. Nest destruction is ineffective against sparrows and starlings but pruning trees sometimes deters roosting. Some helpful measures include:

- Spray high pressure streams of water from fire fighting equipment or other high pressure water lines. This 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.]

birds.] Use high pressure sprays only where the high pressure or water will not damage buildings or equipment. Remove all droppings and nest materials from the area.

- To follow a more traditional method when spraying is not safe, use a hook fastened to a long pole to remove nests.
- When the nests are on buildings or inhabited 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.

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, 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 sheetmetal 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.

Netting. Netting is used to block access of birds to large roosting areas in structures. Netting is especially useful in warehouses and around mechanical equipment areas where aesthetics are of minor consideration. It has been used successfully on cooling towers. Plastic nets have replaced metal and fiber nets in bird control. Plastic nets are normally extruded black polypropylene and are made with an ultraviolet inhibitor to reduce UV degradation. Knotted nets are also available. Nets will last from 2-5 years depending on exposure to sunlight.

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. The high cost of this method may eliminate this option on large buildings that have extensive roosting sites; there are long-term advantages. Covers are valid options to 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 and they usually cannot be seen from below. Sometimes plastic inserts are custom-fit into the indentations in order to block off ledges. Building deterrants in at construction time should be advocated.

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. Advise clients to regularly remove falling autumn leaves and other matter that can cover the spikes and reduce their effectiveness. Ensure that no tree branches hang over protected ledges.

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 a combination of isopolybutene (the same substances used in some adhesive bandages) and petroleum naphthenic oils.

- Before applying sticky repellents, clean ledges that are 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

sea gulls 3/8 inch; pigeons l/4 inch; starlings l/8 inch; sparrows l/16 inch. The pattern of application will depend on the site and personal preference.

Apply a straight bead on ledges and roof edges, l/2 inch from the outer edge, with another bead three inches in from the first, or they can be applied in a zig zag.

For another option combines a straight line l/2 inch from the outer edge and an "s" curve three to five inches back.

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 first.
- 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 l/16 to l/8 inch thick. [Liquid application is not recommended for sites where the appearance of the sticky repellent would be undesirable.]

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.

Certain precautions should be followed when sticky repellents are used.

- Remove nests.
- Check state and local regulations which may prohibit destroying or disturbing nests containing eggs or young.

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.

Ultrasonic Sound Devices

Ultrasonic sound devices are not effective in repelling birds. Research has demonstrated that most birds do not hear sounds in the ultrasonic range (over 20,000 cycles per second), which is why these devices are not effective.

Other Repelling Devices

Visual devices such as owl decoys, rubber snakes, etc., may work for a few days, but become ineffective because birds will become accustomed to their presence (habituate). Likewise, noise-making devices (e.g., fireworks, distress calls, warning calls) may be used to disperse birds, such as roosting starlings or black birds, but their effectiveness will diminish as birds habituate.

Trapping

Pigeons. In many instances, trapping can be an effective supplemental control measure. Trapping is especially effective against pigeons. Where a group of birds are roosting or feeding 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; which type and size is best is debatable. Most pigeon trapping programs use large walk-in traps. These can be four to six feet high and are 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 traps are not likely to be vandalized (a major risk in trapping programs). Trap placement is important, and moving an inactive trap just 10-15 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 with 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 the birds are calmly entering the trap, set it. Put bait and water (a "chick font" is ideal) inside the trap and just a handful or so outside the trap. 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. In most cases, trapped birds should be humanely destroyed. Some experts recommend gassing with carbon dioxide but others 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 these areas can be made into a giant trap. Late in the evening (after about a two-week acclimation period) these last entrances can be closed down after the pigeons have settled down for the night. The trapped birds can then be captured by hand or with "butterfly" nets.

Sparrows. Sparrow traps come in various sizes and shapes. The sparrow funnel trap is a double funnel that prevent sparrows from escaping after they have travelled through two funnels going for a food bait. Fine cracked corn, millet, wheat, or bread crumbs make good bait. Trap sites should be baited for a few days before you actually begin trapping. Sparrow traps are 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; the floor gives way, dumping the bird into a collecting bag. This trap also works against starlings. Male birds are attracted by a piece of string to use as nesting material.

Lethal Alternatives

AVITROL

AVITROL products are restricted use poison baits with flock-alarming properties used to control many kinds of birds. The different AVITROL baits: whole corn for pigeons, smaller grains for sparrows and other birds. Within 15 minutes of eating a toxic dose of AVITROL, birds flutter erratically and go into convulsions. They may fly away from the baiting site, or they may "dive bomb" into the ground.

Most affected birds die within a few hours, but some last longer. Only a small percentage of the flock (usually from five percent to 15 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.

Prebaiting

At most sites, birds must be trained to feed on bait. While baits are different for different birds, whole corn bait for pigeons is the most common and is discussed here:

Careful observations of the birds' feeding habits must be made to establish proper feeding locations and to determine that no nontarget birds are feeding on the pre-bait. The goal is to get at least 40 percent of the birds to accept the untreated pre-bait. Expect the effort to take from 3-days to 3-weeks. Remove all of the pre-bait corn before switching over to AVITROL. The better the acceptance of the bait, the better the chance to move the flock quickly.

AVITROL corn bait kernels are not used alone, but are mixed with untreated corn in ratios ranging from the usual l-part AVITROL and 29-parts untreated bait to l-part treated to 19-parts untreated where other bird food is available. No dilution ratio less than l-part treated to 9-parts untreated is

recommended. The higher the proportion of AVITROL, the higher the number and visibility of dead and/or convulsing birds. A ratio of 1:29 will kill 5 percent of the flock; a 1:9 blend will kill 15 percent.

- The amount of AVITROL bait set out should equal the amount of pre-bait consumed each day.
- Use the ratio that best fits the job.
- Keep in mind that the object is to relocate the flock, not kill every pigeon.

Retrieve toxic bait mixtures at the end of the day. Sweep or vacuum area.

One AVITROL application is adequate for most jobs. At large commercial operations (e.g., a freight yard), bait may need to be placed daily for a few days. Pick good sites. If pigeons become bait shy, wait about three weeks, then begin a new prebaiting program. If a site has been getting monthly AVITROL "maintenance" baiting, pigeons can become extremely bait shy. Prebaiting for as long as three or four months may be necessary, but it is usually best to switch to another control method.

Use care to follow label directions for using AVITROL specifically for each species of pest bird. Read the label carefully.

Secondary poisoning, in its classical definition, is not a risk with AVITROL since the chemical is metabolically changed in the tissue of affected birds. However, if a dead or dying bird has a supply of AVITROL-treated bait in its crop, there is potential risk to an animal feeding on that seed.

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 man.** Toxic perches are particularly useful where food is in constant supply or AVITROL bait is not accepted. They are applied in locations where birds will perch on them, usually in the evening hours. An average-sized job will require 10-12 perches. A large job might require 30.

Toxic perches can only be used in certain sites: inside buildings and structures (non-food areas), on building tops, structural steel, power plants, or substations, and at feed lots, loading docks, and storage yards. Pigeons may develop a site-specific aversion to perches placed at feeding, loafing, or watering sites, but not usually in roosting sites. Perches usually need refilling twice per year. In hot weather perches can sometimes leak toxicants.

Birds can absorb a toxic dose in less than a minute but may not die for four days. Pigeons will normally find a protected place out of the sun and wind once they begin feeling the effects of the toxicant. They usually don't fly after that time and die within 20-30 feet of the perch, if it was set in a roosting site. There is a secondary poisoning hazard if other animals feed on dead birds. There have also been reports of hawks and owls dying after using the perches. By law, dead birds must be picked up, buried, or burned.

Chemosterilants

Chemosterilants (ORNITROL), have often been called the "birth control pill" for pigeons. When fed to pigeons, it inhibits ovulation in the female and sperm production in the male. The effects of a treatment lasts 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 non-reproducing pigeon population. Efficacy on birds associated with agriculture has been reported to be more variable.

The manufacturer recommends applications for 10 days two times per year -- in the early spring (March) and late summer or early fall. For each 100 pigeons, 7.5 pounds of ORNITROL corn are scattered daily for 10 days. Prebaiting with whole corn for a week will usually be necessary to achieve bait acceptance. Most birds eating ORNITROL will 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.

Shooting

A possible alternative or supplemental method for eliminating birds is shooting with air-powered pellet guns, if legally allowed.

- 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 birdshot or sandshot. However these are noisy, often illegal, and too powerful for urban sites.]
- Use care, errant shots can be dangerous.

Risks to Nontargets

Most lethal tactics in bird control pose some risk to nontarget birds, as well as other animals. No one wants to endanger non-pest birds, further, they are protected by various federal, state, and local regulations. Care must be taken to minimize the threat to nontargets or to use tactics that pose the least risk.

- Identify the nontargets in the area.
- Use tactics that pose the least risk.
- Modify tactics to minimize further risk.
- Monitor operations to be sure that no nontargets are being adversely affected.

Public Relations

People often react more negatively to a dying bird than to accumulated pigeon droppings or potential risks of parasites and disease from bird roosts. Pigeons and sparrows are sometimes 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.

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 can filter particles down to 0.3 microns.
- Wear disposable protective gloves, hat, coveralls, and boots.
- Wet down the droppings to keep spores from becoming airborne.
- Put droppings into sealed plastic garbage bags and wet down the outside of the bags.
- When finished, and while still wearing the respirator, remove the protective clothing and place them in a plastic bag.
- Dispose of trash bags. (Disposal, except for excessive amounts, should be permissible through standard trash pick-up.)
- Wash up or shower.

SUMMARY

Birds create enjoyment and recreation while greatly enhancing the quality of our lives. Unfortunately, they can become pests at times too -- feeding on crops, creating health hazards, roosting on buildings, contaminating food, or creating a nuisance. The major pest birds are pigeons, starlings, and house sparrows, although many birds can become pests in the right (or wrong) situation.

Birds are protected by many laws and regulations. Although pigeons, starlings, and house sparrows are not directly protected by federal law, their control is often strictly regulated by state and local governments. Public opinion is often strongly against any control measure that kills birds, even pest birds.

Nonlethal bird control methods include habitat modification (limiting food, water, and shelter), exclusion (with netting, porcupine wire, sticky repellents, etc.), and trapping. Most common lethal control measures are AVITROL poison baits and toxic perches. Be extremely careful when using bird poisons so that you do not harm nontarget birds and animals.

STUDY QUESTIONS FOR MODULE THREE
CHAPTER FOUR
BIRDS

1. Which of the following is true about pigeons:
   A. They prefer flat surfaces for resting and feeding
   B. They will feed on rooftops or the ground
   C. Feeding, roosting, and loafing sites are usually separate
   D. All of the above
   E. None of the above

2. Pigeons usually make a nest of small twigs, straw, or debris on buildings and other structures.
   A. True
   B. False

3. Which of the following is true about starlings:
   A. They feed at night
   B. They may fly up to 30 miles to their feeding sites
   C. They usually nest on the ground in low shrubbery
   D. All of the above
   E. None of the above

4. Starlings often congregate in large numbers during the winter.
   A. True
   B. False

5. Which of the following is true about house sparrows:
   A. They are nervous around people and will not nest in high-traffic areas.
   B. They often create fire hazards by nesting inside transformers and power stations
   C. They prefer to feed on small grains but will also feed on garbage
   D. All of the above
   E. 'B' and 'C'

6. The house sparrow was introduced into the United States, and is not a native bird.
   A. True
   B. False

7. The most serious health risk from pest birds is
   A. Disease transmitted by ectoparasites
   B. Inhaling disease organisms from their droppings
   C. Food contamination
   D. There are no serious health hazards associated with pest birds

8. Bird control is regulated under which of the following laws or regulations:
   A. Migratory Species Act of 1918
   B. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
   C. State and local laws and regulations
   D. Endangered Species Act
   E. All of the above

9. AVITROL poison bait should be applied weekly for a period of a month to be effective.
   A. True
   B. False

10. Where nonlethal bird control is required, which of the following bird management techniques may be used:
   A. Netting
   B. Sticky repellents
   C. AVITROL
   D. ORNITROL
   E. 'A' or 'C'
   F. 'A' or 'B' or 'D'

For Answers refer to Appendix *A*

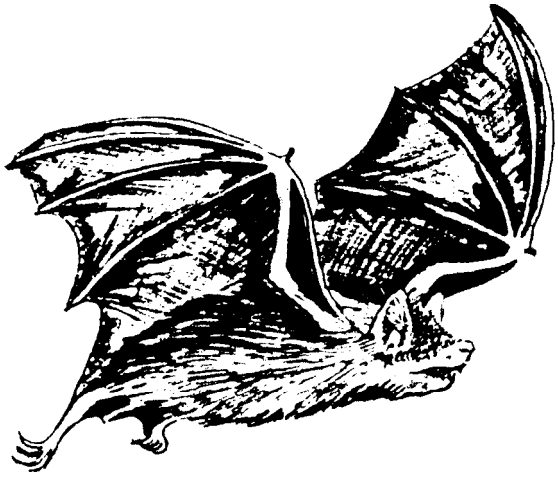
CHAPTER 5

OTHER VERTEBRATE PESTS

Learning Objectives

After completion of the study of Other Vertebrates, the trainee should be able to:

- Describe the habitats and life cycles of other vertebrates.
- Describe the impact of other vertebrates on household and structural resources.
- Discuss the non-chemical and chemical alternatives of bird control and management.



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; examples of these are skunks, raccoons, and possums. Some vertebrate pests have taken to living along with people -- next to or sometimes inside buildings, e.g., bats and squirrels.

Whatever the pest, sometimes they must be controlled; because they are often game animals or are otherwise protected, most control actions will be nonlethal.

The mammalian order of bats is second only to rodents in number of species.

BATS

Bats are the only true flying mammals. A thin membrane of skin stretches from the long, modified front legs to the back legs and then to the tail. The bones in the bats "fingers" are greatly elongated "ribs" for the wings.

Bats in the United States are almost always beneficial. Some species are endangered. Many bats feed on insects, and can consume up to l/2 their body weight in insects in one feeding. Occasionally, however, they become a nuisance inside buildings or pose a public health problem.

The bats that most often become a problem around people are the ones that live in colonies or groups. Examples from around the country are little brown bats, big brown bats, Mexican free-tailed bats, and big-eared bats. All of these species sometimes hibernate or roost inside of buildings.

Roosting and hibernating sites may occur in building attics, wall and ceiling voids, belfries, chimneys, unused furnaces, and the like. The bats' droppings and urine can cause a foul odor and stains on walls and ceilings. Their squeaking and scrambling noises can be intolerable to residents of the building.

Bats and Disease

Bats are associated with a few diseases that affect people. Rabies and histoplasmosis are the most serious. Rabies is a dangerous and fatal disease. 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 testing.

The incidence of Histoplasmosis (discussed in detail in the chapter on birds) being transmitted from bat droppings to humans is not thought to be high.

- 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 the chapter on birds.

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 daytime resting place or is sick. When not in flight, they rest in dark hiding and roosting sites (e.g., 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 humans and similar to sonar. They also make audible squeaking sounds, used for communication between each other.

In much of the country, bats migrate or hibernate when the weather turns cold. Sometimes they hibernate in hanging clusters inside buildings. Depending on the species and geographic location, they produce offspring from late spring to midsummer. Young bats grow rapidly and can fly in three to seven weeks.

Inspection

Look for two things:

- entry and exit points of the bats, and
- the location of the roost.

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, next to chimneys, 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.

Location of roost.

- Look inside in 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. The droppings can be told from mouse droppings, which they look like, but 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.

Control and Management of Bats

Pesticides are unnecessary for bat control. The best way of getting rid of bats roosting in a building is through "bat-proofing."

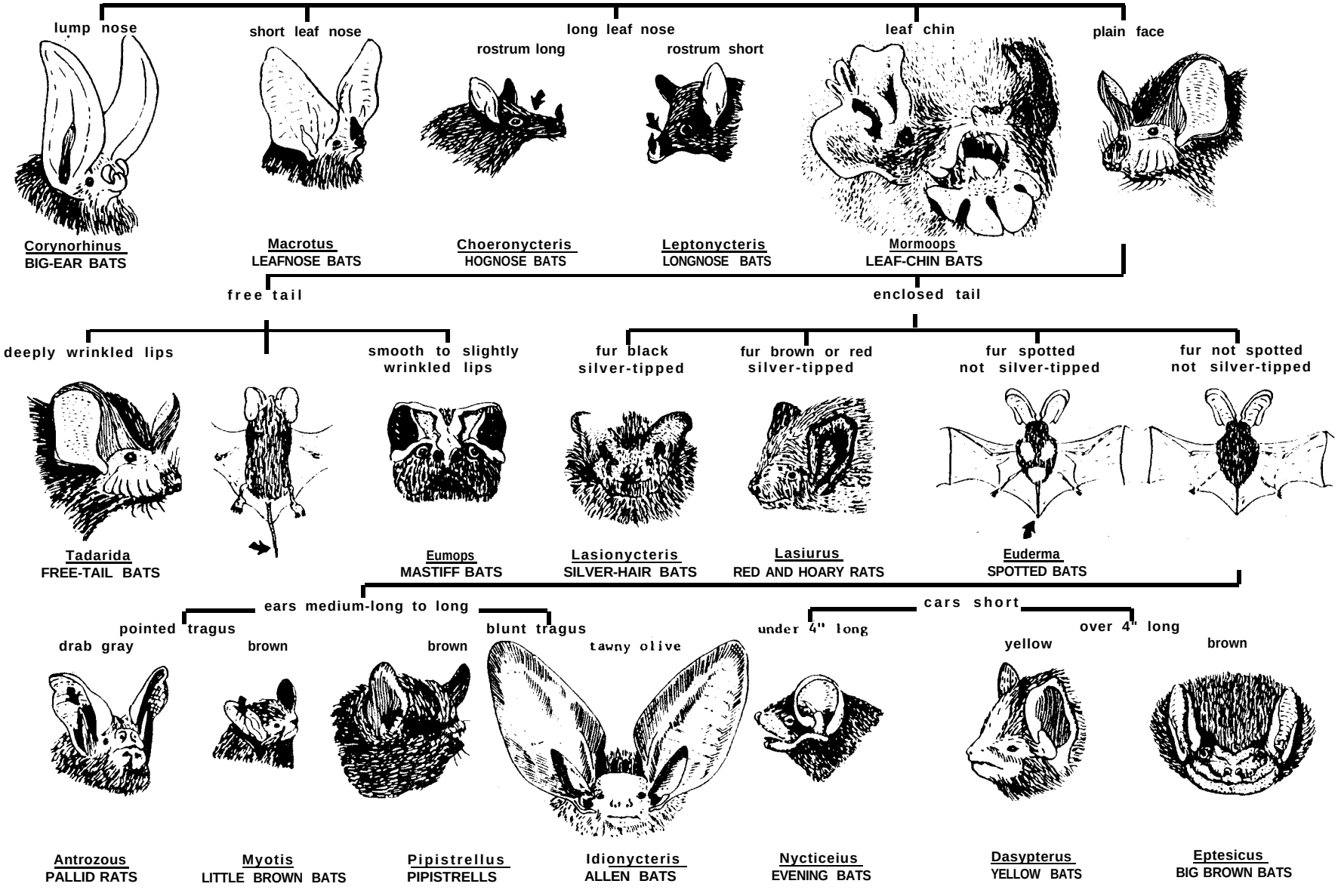
Batproofing. Making a building "batproof' means sealing or screening all of the openings used by the bats to enter a building. It can be a difficult job because, in many cases, all upper openings 3/8 inch and larger must be sealed, but this is the only permanent method of ridding a building of bats.

Be sure their are no bats inside before the building is sealed. Bats trapped inside may be even more of a problem than before.

June and July are peak months for bat complaints in much of the country. Unfortunately, this is the

BATS: PICTORIAL KEY TO UNITED STATES GENERA

Harold George Scott and Chester J. Stajanovich



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE. Communicable Disease Center, Training Branch. Atlanta, Georgia - 1960 - Revised 1962

worst time of year for control. At this time, bats are rearing young in their colony. The young can not fly and stay in the roost. Batproofing during this period traps the young bats. They will die and rot and smell. They may also crawl and flutter into living areas.

The best time of year to batproof a building is either in late fall after bats have left for hibernation or in late winter and early spring before the bats arrive. If batproofing must be done in summer, it should be done after mid-August.

- Seal all but one or two principal openings.
- Wait 3-4 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 batproofing materials include l/4 inch hardware cloth, screening, sheet metal, caulking, expanding polyurethane foam, steel wool, duct tape -- the same things used for rodent proofing. When old, deteriorated buildings have more openings than can be sealed economically. Large sections of plastic bird netting can be draped over the roof areas of these buildings to keep out bats at a reasonable cost.

Bat repellents. If batproofing is not possible, or bats need to be forced out of a building before it is batproofed, the bats can sometimes be repelled from their roost. At this time, only one chemical is registered as a bat repellent. Naphthalene crystals or flakes can be spread on attic floors or placed in voids. The crystals are most effective in confined air spaces. Three to five pounds will treat an average attic.

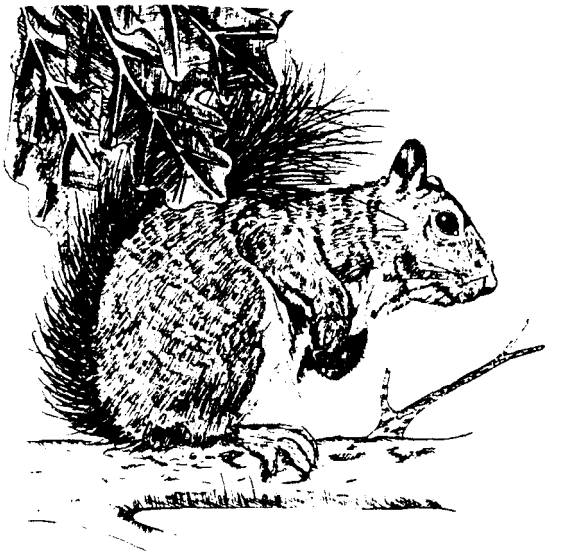
While naphthalene may repel the bats, it vaporizes and disappears in a few weeks. The bats often return. Many humans dislike the smell of naphthalene as much as bats and some people are very sensitive and should avoid all contact. Blasts of air have been used effectively to drive bats out.

Bright lights have had some success in repelling bats.

- On commercial buildings, flood lights can be pointed at the bats' entry points to keep them from entering. (Of course, 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 have, on occasion, kept 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 home, office, or store, it will usually find its way out again. When it cannot, capture the bat with an insect net, a coffee can, or even with a gloved hand. The bat can be released or destroyed.

TREE SQUIRRELS



Tree squirrels are found in forest areas throughout most of the United States. Many species have adapted extremely well to suburban and city life. Occasionally, these squirrels 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.

Tree squirrels usually build their nests in trees. They also may store food and find shelter in attics and garages. Probably the primary way squirrels become pests is by scrambling and scratching inside attics and in wall voids. Grey squirrels travel easily on power lines. They like to gnaw on wires.

The legal status of squirrels varies greatly with geographic area and species. Many are classified as game animals. Some are protected. Be sure to check with local game conservation officers if you plan any kind of lethal control or trapping program.

Control and Management

Squirrel proofing. Step number one 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.

- Heavy gauge l/2" hardware cloth or sheet metal can be used to seal most openings.
- Make other suitable repairs as for ratproofmg.
- Squirrels can be stopped from travelling on wires by installing two-foot sections of 2-3 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 and the squirrel will tumble off. Be careful near high voltage wires.

Squirrels often use overhanging branches as highways to rooftops. Tree branches should be trimmed back 10 feet from the building. If the branches can't be trimmed, a two foot wide band of metal flashing fastened around a tree, six to eight feet off the ground, keeps squirrels from climbing up the tree and jumping to the building.

Repellents. Naphthalene has been used (in the same way as for bats) to keep squirrels out of attics, particularly in summer homes and camps that are unoccupied in winter. There is at least one sticky repellent product for squirrels. It is similar to the sticky repellents used in bird control. Apply it to ledges, gutters, window sills, and the like, to keep squirrels off.

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 the trap. Good baits include peanuts, nut meats, peanut butter, whole corn, sunflower seeds, or rolled oats. Then the trap can be set. Good trap locations include the roof, the base of nearby trees, or in the attic itself.

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. Live trapping is not legal in all locals. Check with game authorities first.

GROUND SQUIRRELS AND CHIPMUNKS

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, on golf courses, and in gardens. The ground squirrels in particular can have extensive burrows with large mounds, especially along roads and ditch banks. On occasion, burrows beneath buildings have caused structural damage.

Ground squirrels can carry diseases (such as tularemia and plague), particularly when populations are dense.

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 temperatures are at their highest.

Ground squirrels are primarily vegetarians, feeding on grasses. When vegetation dries up, they switch to seeds, grains, and nuts. Chipmunks eat both plant and animal material, from seeds to nuts, from insects to worms -- to songbirds and frogs.

Management and Control

Depending on your state's laws, ground squirrels and chipmunks may or may not be protected.

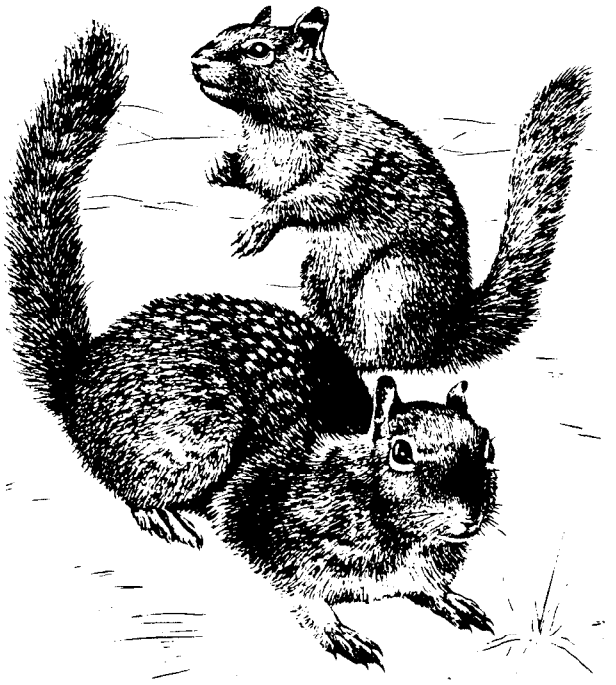
Ground Squirrels

Control is usually only 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 to the squirrels 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 and 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. 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; 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 the structure.

Chipmunks

Only rarely do chipmunks become a serious pest problem. In most cases, lethal control is unnecessary. Altering the habitat may cause the chipmunks to move.

- "Chipmunk-proof" the building to prevent entrance.
- Remove objects such as stones, logs, and debris close to a structure that may be provide an attractive denning environment.

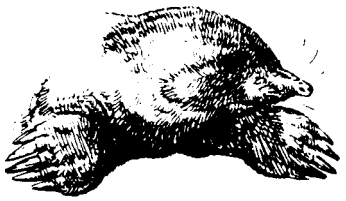
Trapping. Live trapping and relocating chipmunks (where permitted) is considered a humane method of control. Effective baits include peanut butter, nuts, sunflowers, seeds, oats, bacon, and apple slices. Relocation should be done into remote forest areas five miles from the trap site.

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 that are labeled for chipmunk control can be used as described for ground squirrels. However, burrow fumigation is not usually a recommended control tactic because chipmunk burrows are long, difficult to find, and often near buildings.

MOLES

Moles are not rodents like mice and gophers, but relatives of the insectivores (insect eaters) like shrews and hedgehogs. Moles search for food in deep as well



as shallow surface burrows, in lawns, meadows, stream banks, and open woodlots. They feed on earthworms and insect larvae (grubs). Only rarely seen above ground, moles are 4-9 inches long, including the tail, with long dark gray or brown fur. 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.

As they burrow, they sometimes damage plants, but the major problem with moles are those surface tunnels, mounds, and ridges that disfigure lawns. As they tunnel just below the surface, moles raise the sod up with their front digging feet, looking 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. Voles may use the surface burrows pushed up by moles and feed on plant tubers.

Management and Control

Although time consuming, the most effective method of control is by the use of traps. [Killing moles with fumigants, poison baits, or reducing food/prey is not effective.]

Since there is no easy way to know which parts of the surface tunnels are active and which parts 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.

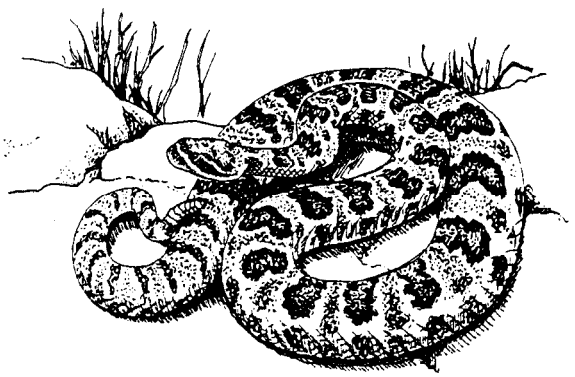
A choker trap consists of a cast metal frame with two spring retractable loops. Two slits are cut in the tunnel and the loops placed inside. When the mole triggers the trap, it is immediately crushed.

- When using traps, place a plastic pail with a warning sign over each trap.
- An average set will require 3-5 traps per acre.
- Check the trap every couple of days.
- After no results for 3-4 days, move the traps to new locations.

SNAKES

Most snakes are non-poisonous, harmless, and beneficial. But few people want them in their home. As a general guideline, poisonous snakes usually have a large triangular head, a pit between their eye and nostril, 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 the tip of the tail. When unsure assume that the snake may be poisonous and protect yourself accordingly.

Snakes are predators. Depending on the species, the 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.



Management and Control

If snakes are a regular 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.

- Eliminate rodent food and harborage.
- Mow grass short to expose rodent runs.

Snakes often enter structures through broken block foundations, cracked mortar, damaged vents. These should be repaired.

In a rattlesnake infested area, a snakeproof fence can be installed around a backyard or play area.

- Bury a galvanized l/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.

Snake removal. If a snake gets into a house or other building, several methods are available 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 and taken outside. The snake can be 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.
- Expanded trigger rat traps set in pairs along wall and floor junctions can kill smaller snakes.

A granular snake repellent can keep some species of snakes away from homes, camp sites, garages, and yards. Containing sulfur and naphthalene, the repellent is applied in a narrow band around the area to be protected. Sulfur/naphthalene repellents are most effective against rattlesnakes, coral snakes, garter snakes, and pythons.

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/or live trapping.

Skunks

There are two kinds of skunks that may become pests, the striped skunk and the spotted skunk. The striped skunk is about the size of a large house cat and has two broad stripes running from the back of the head to the large bushy tail. Spotted skunks are about half that size, with four irregular stripes beginning behind the 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. They may decide to live under houses, sheds, cabins, or storage buildings.

Of course, the main problem with skunks is their stink. But 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 humans. Another major problem in some areas of the country is the transmission of rabies.

Raccoon

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 10 and 25 pounds.

Their senses of hearing, sight, and touch are well developed, while those of 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, storm sewers, chimneys, attics, and crawlspaces. More than one den may be used.

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, the opossum is the only marsupial 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 14 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, but in some areas they have become the most common nonrodent mammal. They den in the burrows of other large animals, and 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. 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 end. If these defenses aren't successful, they may play dead. They have the undeserved reputation of being stupid.

As a pest, the main complaint against opossums is that they get into garbage, bird feeders, or pet food left outside.

Management and Control of Skunks, Raccoons, and Opossums

Exclusion. These animals can be prevented from entering buildings by repairing breaks in foundation 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 may also be present. Be sure that all animals have been removed before sealing the building. Otherwise, a serious odor problem from a dead animal could result.

- Pour one or two boxes of naphthalene balls down vent chimneys to run out racoons.

Live Trapping. The best way to remove animals from around buildings is to trap them.

> 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 furbearers under fish and game laws of your state. Know your state and local regulations before proceeding.

- If the animal must be killed, lower the trap into a tub of water or gas it with a fumigant or CO_2.
- If the animal is to be released, do it far away from human dwellings. Use what you have learned about the biology of the animal to find a suitable habitat. The release site for these large animals should be over ten miles away from the capture site.
- Remember to check state regulations.
- Set traps as close to the den as possible where damage is occurring, e.g., at

corners of gardens, breaks in stone walls, or along obvious animal trails.

- Set multiple traps in a number of different locations.
- Since these animals are active at night, check traps at least every morning; preferably twice a day.
- Check traps often to spot and release nontarget animals.

There is obviously a special problem when trapping skunks. Skunks don't like to "shoot," if they can't see their target.

- Cover all but the entrance of the trap with burlap or canvas before placing the trap, or
- Use a commercially-sold solid skunk traps.
- Approach the trap slowly and transport it gently.

To release a trapped skunk, stand more than 20 feet away and release the trap door using a string or fishing line.

The best baits for each animal are listed below:

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.

Mounting a good level of sanitation in a neighborhood is the best preventive measure for skunks, racoons, and opossums. Remind clients that released vertebrates must fight their way into new territory to establish themselves and overcrowded habitat results in increased risk of disease and marginal nesting sites. Prevention is the most humane way of managing vertebrate pests.

SUMMARY

Almost any vertebrate animal may become a pest by wandering where it is not wanted. Sometimes it will leave by itself. Sometimes, it will need to be controlled. Because vertebrates are often game animals, or otherwise protected, most control actions will be nonlethal. Exclusion is often the preferred method. For the larger vertebrates, such as raccoons, skunks, and opossums, live trapping is the most common solution. Be aware, though, that concerns about the spread of disease, and rabies in particular, has caused many states to prohibit the release of trapped animals in other areas. In these cases, the trapped animal must be killed or turned over to wildlife officials.

STUDY QUESTIONS FOR MODULE THREE
CHAPTER FIVE
OTHER VERTEBRATES

1. Which of the following is true about bats:
   A. They are usually beneficial to the environment.
   B. Most feed on animal blood.
   C. Many feed on insects.
   D. A and C.

2. The best control method for bats in attics is applying naphthalene crystals.
   A. True
   B. False

3. Which of the following control methods is never used against tree squirrels.
   A. Trimming tree branches that hang over a house
   B. SQUIRREL-DEATH bait blocks
   C. Squirrel-proofing with 1/2-inch hardware cloth
   D. Naphthalene repellent

4. When necessary and if not prohibited by state laws, ground squirrels can be controlled with traps, rodenticides, and fumigants.
   A. True
   B. False

5. Burrow fumigation is a good method for controlling chipmunks.
   A. True
   B. False

6. Which of the following is true about moles:
   A. Trapping is the most effective control measure.
   B. Poison bait is the most effective control measure.
   C. Moles feed on grass roots.
   D. A and C.

7. Which of the following are acceptable snake control methods:
   A. Clean up brush piles.
   B. Use a snake repellent in a band around the area to be protected.
   C. Eliminate rodent food and harborage.
   D. A and C.

8. Control of skunks, raccoons, and opossoms almost always involves exclusion or live trapping.
   A. True
   B. False

9. Which of the following statements are true concerning trapping skunks, raccoons, or possoms:
   A. Trapped animals should always be released at least ten miles away.
   B. Traps should be checked every 48 hours.
   C. The best trapping sites are close to the animal's den.
   D. All of the above.

For Answers refer to Appendix A

APPENDIX A

ANSWERS TO STUDY QUESTIONS

PEST MANAGEMENT AND CONTROL

Chapter 1 Pest Management and Control

(1) An unwanted organism (2) B or D
(3) B (4) C (5) C and E (6) B

Chapter 2 Using Equipment in Urban Pest Management

(1) B (2) E (3) B (4) B (5) C
(6) D

Chapter 3 Laws and Regulations

(1) C (2)A
(3) FIFRA, the Federal Insecticide Fungicide and Rodenticide Act
(4) C

MODULE ONE STRUCTURAL PESTS

Chapter 2 Cockroaches

(1) C (2) B (3) A (4) A (5) A
(6) B (7) C (8) B

Chapter 3 Ants

(1) B (2) B (3) B (4) C (5) B
(6) A

Chapter 4 Stored Product Pests

(1) A (2) B (3) C (4) D

Chapter 5 Fabric Pests

(1) B (2) C (3) A (4) D

Chapter 6 Silverfish and Firebrats

(1) A (2) C (3) B (4) B

Chapter 7 Fleas

(1) B (2) A (3) A (4) A (5) C
(6) A

MODULE TWO INVADING PESTS

Chapter 1 Houseflies and Their Relatives

(1) ***Drosophila*** or fruit flies often have red eyes, visible veins and cross veins in their wings, and are attracted to yeast producing materials such as over ripe fruit, sour mops, etc. Phorids have a humped backed appearance, move in jerks and have wings with four indistinctly seen veins. Phorids infest manure, garbage and other rotting materials and can infest buried refuse and emerge in buildings. Both are small.

(2) House flies have dark, indistinctly striped thoraxes and gray and tan abdomens; flesh flies usually have gray thoraxes with three distinct stripes, Blow flies are solid metallic green, bronze, blue or black; cluster flies, in the same family as blow flies, have yellow or gray hairs covering the thorax.

(3) One group of flies is mosquito or gnat-like with obvious, even somewhat long antennae. Their larvae have a head capsule and usually live in water. The rest of the flies, the majority of the species, are usually not mosquito-like but are more robust with very small antennae. The larvae of this group are often maggot-like.

(4) Cluster fly larvae parasitize earthworms. In the late warm months of summer, especially August, they often enter buildings where they overwinter. On warm winter days these flies and others, make nuisances of themselves by flying around. Cluster flies along with house flies, face flies and flesh flies are part of the “attic fly” fauna.

(5) Locate the breeding sites.
Find ways they are entering.
Investigate garbage pick up schedules and garbage handling procedures.
Caulk entry points.
Advocate screening entry points.
Investigate ways to use air curtains, light traps.
Apply pesticides in cracks and crevices where flies enter or hide.

Investigate the need for fly bait.
Educate workers and supervisors on fly biology and control.

(6) Seek out infested materials that are producing yeast: over-ripe fruit and vegetables, open or broken cans of fruit and vegetables, sour mops and rags, moist pet food and bedding. Use traps baited with ripe banana to locate the main infested area. Eliminate yeast producing materials.

Chapter 2 Stinging Insects

(1) Several species of yellowjackets make suspended aerial nests. They attach a paper comb of cells to a structure or plant limb and construct a paper envelope around it. These combs are enlarged, and tiers are added as the colony grows. The envelope is also enlarged to accommodate growth. A common example of this yellowjacket group is the bald faced hornet. Many other species nest in the ground and start the first paper comb of cells in an existing hole; later, they add combs and enlarge the hole. Several species, particularly the German yellowjacket, ***Vespula germanica*** make nests in wall voids and attics of structures.

(2) Species of ***Polistes,*** the paper wasps, attach a single paper comb of cells to a structure or plant twigs. This comb is enlarged around the edge but additional tiers are not added nor is it covered by a paper envelope.

(3) Mud daubers are non social wasps with fertile, single queens that gather mud and construct cells attached to structures. These females sting and paralyze spiders and place them in cells along with a wasp egg. The wasp grub hatches, eats the paralyzed spiders, pupates, and the following spring, emerges as an adult male or female. These wasps mate, and the females continue the annual cycle.

(4) (a) A division of labor by groups within the colony e.g., a queen, worker daughters, and males.
(b) Several "generations" of young are produced by the same mother, some of which enter into colony life expanding the nest and caring for the young (infertile worker daughters), while others (fertile males and females) leave the nest to mate with other reproductives. Some colonies exist only one or at most two years, e.g., yellowjackets. Others exist for many years, e.g. ants, honeybees.

(5) (a) Aerial yellowjacket: Locate aerial nest. Using a bee suit apply canned pressurized pesticide to the entrance at the time of day when most wasps are in the nest. Cut the nest out of the shrub etc and discard it when occupants are dead.
(b) Ground-nesting yellowjacket: Locate nest entrance in ground. Using a bee suit at the most appropriate time of day spray or dust pesticide in entrance hole. Dust a plug of steel wool, etc and insert it in the entrance.
(c) Yellowjacket in wall void: Locate the nest entrance in the structure. Using a bee suit approach the entrance in the safest manner, inject spray from a canned pressurized pesticide and plug the entrance with pesticide dusted steel wool. Caulk up entrance after assurances that the nest is no longer active.
(d) Honeybee in wall void: Locate the colony entrance. Inspect inside the structure as well as outside. Using a bee suit inject spray in the entrance using a canned pressurized pesticide and plug the hole with pesticide dusted steel wool. As soon as it can be ascertained that honeybees are no longer alive remove comb, dead bees, honey, etc. Do not let the comb and honey supply melt and run.

Chapter 3 Spiders

(1) The female black widow has a shiny jet black body and legs. Her globose abdomen is proportionally large with a red hour glass design on the belly. This design can be easily seen and taken as a warning since the black widow hangs upside down in her cob web. Male black widows are small striped and harmless.

(2) The brown recluse spider ***Loxosceles reclusa*** has a brown cephalothorax with a dark violin shaped design on the dorsal surface. The abdomen is a tan brown color with no distinctive markings. The brown recluse is found in houses within an arched shaped geographical range encompassing states in the south and midwest bordered by Texas, Oklahoma, Kansas, Missouri, Iowa, Illinois, Kentucky, Tennessee and Alabama. Several other species of closely related recluse spiders are found in the southwestern deserts and one is regularly introduced from the Mediterranean area. None of these latter species is considered particularly harmful.

(3) Inspect accumulations of logs, wood, bricks, construction materials as well as stacks of baskets and equipment that has not been

moved for some time. Privies, sheds and inside such things as water meters are potential nesting places. Black widows move into secluded spaces and remain if they are not disturbed, Be careful when reaching into potential black widow nesting places.

(4) Inspect rooms and spaces in a home that are little used by occupants. Examples are guest rooms and furniture, little used closets, behind heavy furniture, clothes hanging from past seasons without being disturbed or worn. When spiders live outside in the southern portion of its range look in window wells, and accumulations of undisturbed materials near the structure.

(5) D

(6) ▸ Caulk and tighten structures to keep spiders from wandering in.
▸ Get rid of accumulations of trash near structures.
Modify lighting arrangements that attract flying insects that become spider prey.
Inspect flower arrangements brought inside.
▸ Keep webs brushed out.
▸ Use residual sprays or dusts in spider harborage.
▸ Use barrier spray around buildings where spiders are an obvious and threatening problem but follow with other pest management procedures also.

Chapter 4 Mites, Ticks, Bedbugs and Lice

(1) First, establish that pesticides should not be used in the school for these pests. Close inspections of pupils and siblings should be made in their homes, especially homes of students where the teacher has observed louse nits in their hair. Emphasize how head lice can be transmitted and that safe preparations to control head lice can be obtained and should be used according to label directions.

(2) Lyme disease, Rocky Mountain Spotted Fever.

(3) Lyme disease: Northern deer tick, ***Ixodes damani***
Rocky Mountain Spotted Fever: The American dog tick, ***Dermacentor variabilis*** and in some areas possibly the lone star tick, ***Amblyomma americanum.***

(4) None.

(5) None.

(6) Crab lice are typically transmitted from person to person during sexual intercourse. These lice are usually found in human pubic hair.

Chapter 5 Miscellaneous Invaders

(1) Boxelder bugs. Adults and nymphs come down female boxelder trees and fly to houses to overwinter. The bugs work their way inside and become reactivated on warm winter days. For pest management the trees supporting the bug populations should be identified. Usually boxelder trees are weed trees and can be cut and removed. Window frames and door frames should be tightened up by weather stripping and caulking. Bugs can be killed as they crawl down the trees or on the sides of houses by using pesticide sprays as well as plain water and detergent sprays. Bugs inside can be killed by contact sprays or vacuumed. Attics should be monitored since many bugs enter at this level to overwinter.

(2) Clover mites. These small red mites carry two long legs in front of them as they move from grass sod or from wall voids on late winter days when temperatures reflecting from the south sides of houses and adjoining yards are raised in small localized areas. Clover mites thrive in new lawns but cease activity in cold weather or hot weather. Populations are reduced as lawns and landscapes mature, but until then mites are attracted to warm houses by the thousands. Fall populations may migrate into wall voids and join the later winter movements.

Barriers of gravel covered plastic can be dusted or sprayed on infested sides of houses. Where high infestations are monitored the lawn can be treated also. Inside vacuuming will remove migrating mites.

(3) Millipedes are cylindrical arthropods with two pairs of legs per segment. These pests live in moist plant material and feed on plant parts and fungi in decaying leaves. Centipedes are cylindrical or long flattened arthropods with one pair of legs per body segment. Centipedes feed on very small insects. Like millipedes, they live in decaying plant material. The house centipede lives in basements of homes and buildings. They have very long legs and usually live inside rather than outside.

Millipedes and centipedes must be excluded from buildings by tightening cracks and crevices that serve as entrances. Their breeding sites such as mulching and leaf

litter should be removed from the foundations and doorways of buildings. These sites can be replaced by plastic ground cover and gravel. Barrier sprays can be used when migrations are high. Dusts where it can be used control house centipedes best.

(4) Cricket problems are usually caused by black field crickets migrating into buildings and homes when dry weather hits or weeds and other plants on which crickets feed die or become unpalatable in late summer. Inside field crickets are disruptive because of their chirping and the fact that they will feed on soiled clothes on closet floors.

Crickets should be excluded by caulking, weatherstripping, etc. especially around doors, ground level windows, etc. Where high populations are seen in roadside ditches or in landscaping around buildings they can be sprayed before movement starts.

Cave crickets or camel crickets are wingless insects with long hind legs and antennae. These insects live in basements or ground level apartments and are occasionally bothersome. They can be killed with contact sprays or dusts.

MODULE THREE VERTEBRATES

Chapter 2 Rats

(1) B (2) B (3) A (4) B (5) A (6) A
(7) E (8) A (9) A

Chapter 3 Mice

(1) D (2) A (3) A (4) B (5) D (6) A
(7) A (8) C

Chapter 4 Birds

(1) D (2) A (3) B (4) A (5) E (6) A
(7) B (8) E (9) B (10) F

Chapter 5 Other Vertebrates

(1) D (2) A (3) B (4) A (5) B (6) A
(7) D (8) A (9) A

APPENDIX B

SELECTED BIBLIOGRAPHY

Selected References in Pest Management and Control

Reference to Appendix B, Bibliography, gives the trainee an opportunity to learn more about

- regionally-specific problems
- areas of personal interest
- information that can lead to professional growth and development.

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APPENDIX C

GLOSSARY

Glossary of Terms for Urban Integrated Pest Management

Reference to Appendix C, Glossary, gives the trainee an opportunity to learn more about specific

- meanings
- concepts, and
- issues.

ABSORPTION-- The movement of a chemical into plants, animals (including humans), microorganisms.

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 capacity of a pesticide to cause injury within 24 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-- Relatively simple 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 normal bloodclotting. The 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 - - A n invertebrate animal characterized by a jointed body and limbs and usually a hard body covering that is molted at intervals. For example, insects, mites, and crayfish are in the phylum Arthropoda.

ATTRACTANT-- A substance or device that will lure pests to a trap or poison bait.

AVICIDE-- A pesticide used to kill or repel birds. Birds are in the class Aves.

BACTERIA-- Microscopic organisms, some of which are capable of producing diseases in plants and animals, Others are beneficial.

BACTERICIDE-- Chemical used to control bacteria.

BAIT-- A food or other substance used to attract a pest to a pesticide or to 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 humans. Usually insect parasites, predators, pollinators, etc.

BIOLOGICAL CONTROL-- Control of pests using predators, parasites, and disease-causing organisms. May be naturally occurring or introduced.

BIOMAGNIFICATION-- The process where one organism accumulates chemical residues in higher concentrations from organisms they consume.

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- The measurement of dispersal or output and adjustments made to control the rate of dispersal of 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 to make a pesticide dispense effectively. A carrier is also the material, usually water or oil, used to dilute the formulated product for application.

CERTIFIED APPLICATORS-- Individuals who are certified to use or supervise the use of any restricted use pesticide covered by their certification.

CHEMICAL NAME-- The scientific name of the active ingredient(s) found in the formulated product. 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 has a toll-free number that provides 24-hour information for chemical emergencies such as a spill, leak, fire, or accident. 800-424-9300.

CHLORINATED HYDROCARBON-- A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment. Examples: Chlordane, DDT, methoxychlor. Few are used in urban pest management operations today.

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 material to cause injury or illness (beyond 24 hours following exposure) from repeated, prolonged exposure to small amounts. [See also Acute Toxicity]

COMMERCIAL APPLICATOR-- A certified applicator who for compensation uses or supervises the use of any pesticide 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(s) has only one recognized common name.

COMMUNITY-- The different populations of animal species (or plants) 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 compound that causes death or injury to insects when it contacts them. It does not have to be ingested. Often used in reference to 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, e.g. sanitation, changing work practices, changing cleaning and garbage pick-up schedules, etc.

DECONTAMINATE-- To remove or break down a pesticidal chemical from a surface or substance.

DEGRADATION-- The 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 treated surface after application.

DERMAL TOXICITY-- The ability of a pesticide to cause acute illness or injury to a human or animal when absorbed through the skin (see **Exposure Route).**

DESICCANT-- A type of pesticide that draws moisture or fluids from a 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 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 an infestation 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 in the suspension of one 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 the active ingredient enclosed in 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, rubs off, etc.).

ENDANGERED SPECIES-- Groups of interbreeding plants or animals that have been reduced to the extent that they are near extinction and that have been designated to be endangered by a Federal Agency.

ENTRY INTERVAL-- See **Re-entry Interval.**

ENVIRONMENT-- Air, land, water, all plants, man and other animals, and the interrelationships which exist among them.

ENVIRONMENTAL PROTECTION AGENCY OR EPA-- The federal agency responsible for ensuring the protection of man and the environment from potentially adverse effects of pesticides.

EPA ESTABLISHMENT NUMBER-- A number assigned to each pesticide production plant by the EPA. The number indicates the plant at which the pesticide product was produced and must appear on all labels of that product.

EPA REGISTRATION NUMBER-- An identification number assigned to a pesticide product when the product is registered by the EPA for use. The number must appear on all labels for a particular product.

ERADICATION-- The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE-- The manner (dermal, oral 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 control pesticide registration and use.

FLOWABLE-- A pesticide formulation in which a very finely ground solid particle is suspended (not dissolved) in a liquid carrier.

FOG TREATMENT-- A fine mist of pesticide in aerosol-sized droplets (under 40 microns). Not a mist or gas. After propulsion, fog droplets fall to horizontal 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. Usually, it pentrates 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% 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. The active ingredient is either mixed with or coated onto an inert carrier to form a small, ready-to-use, low-concentrate particle which normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER-- Water sources located beneath the soil surface from which spring water, well water, etc. is obtained (see also **Surface Water).**

HAZARD-- see **Risk.**

HERBICIDE-- A pesticide used to kill or inhibit plant growth.

HOST-- Any animal or plant on or in which another lives for nourishment, development, or protection.

IGR, INSECT GROWTH REGULATOR JUVENOID-- A pesticide constructed to mimic insect hormones that control molting and the development of some insect systems affecting the change from immature to adult (see **Juvenile Hormone).**

INERT INGREDIENT-- In a pesticide formulation, an inactive material without pesticidal activity.

INGREDIENT STATEMENT-- The 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. Sometimes generalized to be synonymous with pesticide.

INSECTS, INSECTA-- A class in the phylum Arthropoda characterized by a body composed of three segments and three pairs of legs.

INSPECTION-- To examine for pests, pest damage, other pest evidence, etc. (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 injury. 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 that 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 other invertebrates have larvae, including crustaceans, and especially mites and ticks).

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 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-- 0ngoing surveillance. Monitoring includes inspection and recordkeeping. Monitoring records allows technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the management or control program.

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 target(s) of a pesticide application.

NYMPH-- The developmental stage of insects with gradual metamorphosis that hatches from the egg. Nymphs become adults.

ORAL TOXICITY-- The ability of a pesticide to cause injury or acute illness when taken by mouth. One of the common exposure routes.

ORGANOPHOSPHATES-- A large group of

pesticides that contain the element 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. Includes such items as long-sleeved shirts, long trousers, coveralls, suitable hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT-- see **IPM**

PEST-- An undesirable organism: (1) any insect, rodent, nematode, fungus, weed, or (2) any other form of terrestrial or aquatic plant or animal life or virus, bacteria, or other micro-organism (except viruses, bacteria, or other micro-organisms on or in living man or other living animals) which the Administrator declares to be a pest under FIFRA, Section 25(c)(l).

PESTICIDE-- A chemical or other agent used to ill, repel or otherwise control pests or to protect from a pest.

pH-- A measure of the acidity/alkalinity of a liquid: acid below pH7; 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; e.g., caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, etc.

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 as to the proper first aid techniques and antidotes for poisoning emergencies. Centers are listed in telephone directories.

POPULATION-- Individuals of the same species. The populations in an area make up a community (see **Ecosystem).**

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, many insects, etc.

PROFESSIONAL-- One who is able to make judgments based on training, experience, and an available data base.

PROPELLANT-- The inert ingredient in pressurized products that forces the active ingredient from the container.

PUPA (plural Pupae)--The developmental stage of insects with complete metamorphosis where major changes from the larval to the adult form occurs.

RATE OF APPLICATION-- The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per acre, per 1,000 square feet, per linear feet, or per cubic feet.

REENTRY INTERVAL-- The length of time following an application of a pesticide when entry into the treated area is restricted.

REGISTERED PESTICIDES-- Pesticide products which have been registered by the Environmental Protection Agency for the 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 product(s) which remains 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)(l)(C).

RISK-- A probability that a given pesticide will have an adverse effect on man or the environment in a given situation.

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.

SIGNAL WORDS-- Required word(s) which appear 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. Common application method for termiticides.

SOIL DRENCH-- To soak or wet the ground surface with a pesticide. Large volumes of the pesticide mixture are usually needed to saturate the soil to any 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 completely 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: rivers, lakes, ponds, streams, etc. (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-- The plants, animals, structures, area or pests at which the pesticide or other control method is directed.

TECHNICAL MATERIAL-- The 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, counted, etc. 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 (e.g., hospitals and garbage rooms). A threshold may be set at zero (e.g., termites in a wooden structure, flies in an operatory).

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, unacceptable cost, etc. Pest levels that depend on pest observations vary. The tolerable level in some situations will be zero (e.g. termites). Urban pest management programs usually 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 homes, 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. Pest control workers certified in Categories 3, 7, and 8 usually work in urban pest management or urban pest control.

USE--The performance of pesticide related activities requiring certification include: 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 easier it will evaporate.

VECTOR-- A carrier, an animal (e.g. 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 cause many animal and plant diseases.

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, waiters station, loading dock at a restaurant 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.

For the 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.

NAVAL FACILITIES ENGINEERING COMMAND July 1992
APPLIED BIOLOGY PROGRAM

Like most communities, naval shore installations are plagued with a wide variety of pests. Mosquitoes, flies, ticks, fleas, spiders, mites and other pests bite people. Beyond the annoyance, these pests also transmit diseases such as malaria, encephalitis, dysentary, dengue and many others. Ants, silverfish, cockroaches, and crickets among many others can infest residences and offices. Myriads of insects combined with rats and mice can infest, damage, and contaminate food, fibers, and fabric products. Decay fungi, the ubiquitous termite, and some kinds of beetles and ants have damaged wood structures in nearly every area of the world. Even piling supporting piers and sea walls are under continual attack by marine borers. Weeds grow wherever their roots can reach the soil without regard for esthetics, fire hazards, or maintenance; and insect pests and snails destroy desirable vegetation wherever it grows. In addition, aircraft often strike birds in flight resulting in thousands of dollars in damage to the aircraft and occasional loss of life. All of these pest problems interfere with naval operations or consume resources needlessly.

The management of pests is needed to support operations and to protect personnel, materials, real property, the environment and resources under Navy stewardship. To accomplish this, professional pest management, comprehensive programs, and competent pest control personnel are required. By law, trained and certified personnel are required to use certain pesticides, and our objective is to have all pest control personnel trained and at least 80% of the applicators certified in the various pest control categories. Instructions are used to guide the Navy's program. The Navy frequently supplements and often substitutes in-house efforts with commercial services where the required skills and equipment are readily available, and when contract performance is cost effective. In these situations, a Navy quality assurance evaluator or inspector who is specifically trained in pest control technology is used to determine the contractor's performance.

Federal regulations apply to Navy pest management programs, such as the Federal Insecticide, Fungicide and Rodenticide Control Act. Indeed, there are half a dozen Federal laws that regulate pesticides in some manner. The philosophy of the Navy's pest management program is to minimize the use of pesticides when other methods are available This strategy is not to eliminate pesticides, but to simply use them in perspective with long term prevention of pest problems.

The Naval Facilities Engineering Command Applied Biology Program, (Code 1634), provides both technical and management guidance, and continuity for installation pest control operations and certain other public works functions. The program is staffed with biologists with a background in entomology (the study of insects). The applied biologists are located regionally in field divisions (as are pest species). They provide on-site technical guidance to approximately 225 shore installations with pest control programs, and provide training for nearly 500 installation pest controllers and pest control quality assurance personnel.

This assistance includes:

a. Installation Pest Management Plans. Our applied biologists assist in the development of pest management (operating) plans and help the Commanding Officer in achieving pest management goals while complying with pesticide regulatory agencies. Plans include recommendations for control strategies, resource requirements, materials, equipment, staffing, facilities, safety and environmental protection. Plans are coordinated with BUMED for safety and disease vector control. These plans are maintained

through periodic on-site technical reviews by the biologists. This process evaluates an activity's entire pest management program to ensure compliance with safety and legal mandates, current control technologies and good practices.

b. Training. Triennial training is provided for planner-estimators, pest controllers, and quality assurance evaluators, to plan pest control programs, apply pesticides or inspect contract operations, respectively. The training is consistent with the Federal Insecticide, Fungicide and Rodenticide Act and the DOD Plan for Training and Certification of Pesticide Applicators.

c. Records and Operational Reports. In monitoring installation control operations, the biologists review pest control records from each installation for materials of choice, use patterns, etc., and offer adjustments as appropriate. Annually, this data is summarized for the installations, the EFD program managers, and Navy management who, in turn, report to DOD, the States, the Environmental Protection Agency and other interested agencies.

d. Wood Protection. Guidance is provided for selection, procurement, and use of preservative-treated wood products. Designs are reviewed to ensure service-life will be maximized through use of the most appropriate wood products, and quality assurance assistance is provided for procurement problems with products that do not conform to specifications or end-use requirements. The biologists participate in joint Navy-Industry sponsored research projects on treated wood products.

e. Material Procurement. The biologists review pesticide procurements from the installations for actual need and compliance with EPA and state regulations. This effort is coordinated with the Naval Supply Systems Command to restrict pesticide application to trained individuals. Application equipment procurements are also coordinated in the same manner to ensure that installations receive equipment best suited for their actual needs.

f. Liaison. The biologists serve as focal points for Navy installations to coordinate with federal, state, and local agencies on pest control matters. These may include operations, pesticide procurement usage; training and certification of personnel, record keeping, and in coordinating multi- agency operations. As of March 1989, 33 states have signed a cooperative memoranda of agreement with DOD to permit local purchase of pesticides by installation pest controllers.

g. Miscellaneous functions. Research projects related to pest management are coordinated by the biologists to better resolve pest problems at the installations. To avoid "building-in" pest problems the biologists review designs and plans early in the construction process. The Navy uses a performance work statement including quality assurance tailored by the biologists for contracting pest control services at the installation level. The biologists can be called in to assist with investigations of pesticide misuse, spills, new or introduced pest species, early structural failures, and other problems initiated through installation service requests. The program also distributes pollution abatement and occupational safety and health funds for correcting pollution and safety deficiencies, respectively, found at shore installations.

Please contact a NAVFACENGCOM field division applied biologist for any of these services. See the attached map of EFD regions and a list of the biologists.

NAVFACENGCOM EFD APPLIED BIOLOGISTS AND WOOD PROTECTION SPECIALISTS

1 Oct 92

Office	Consultant	Area
Applied Biology Program Naval Facilities Engineering Command 200 Stovall Street Alexandria, VA 22332-2300	Mr. William A. Gebhart (Code 1634) DSN 221-2480 703-325-2480 FAX 703-325-6904	Navy-wide Pest Management and Wood Protection Programs
Northern Division (143) Naval Facilities Engr. Command 10 Industrial Hywy., Stop 82 Lester, PA 19113-2090 (Also provides Applied Biology Program services to Chesapeake Division shore activities)	Mr. Stephen Kincaid Mr. Simeon Hahn Mr. Jeffery J. Davis Ms. Diana McPherson 215-595-0567 DSN 443-0567 FAX 215-595-6199	Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, and Northern Virginia.
Northern Division (164/PF)	Mr. Peter L. Fish DSN 443-0598 215-595-0598 FAX 215-595-0599	Navy-wide Wood Protection Specialist
Atlantic Division (l6lA) Naval Facilities Engineering Command, Norfolk, VA 23511	Dr. Daniel G. Maiello 804-445-1859 DSN 565-1859 FAX 804-445-6653	Virginia (Norfolk area), West Virginia, Kentucky, North Carolina, Iceland, United Kingdom, Greece, Egypt, Italy, Spain, Antigua, Puerto Rico, Cuba Panama, Bermuda, Newfoundland (Argentia) Mombasa and Bahrain
Southern Division, Code 16A Naval Facilities Engineering Command, P.O. Box 10068 Charleston, SC 29411 (Also provides program services to Midwestern shore activities)	Mr. C. W. Bennett Mr. Melvin P. Marks Mrs Sharon E. Bartku 803-743-0508, 10, 11 DSN 563-0508, 10, 11 FAX 803-743-0563	North & South Carolina, Georgia, Florida, Tennessee, Alabama, Arkansas, Mississippi, Texas, Louisiana, Oklahoma, New Mexico, Ohio, Indiana, Illinois, Iowa, Michigan, Minnesota, Wisconsin, Kansas, Missouri, Nebraska, North & South Dakota, Colorado, Wyoming and Andros Is., Bahamas
Western Division, (162A) Naval Facilities Engineering Command, P.O. Box 727 San Bruno, CA 94066 (Western Division Supports Southwestern Division)	Mr. A. Reese Christopherson 415-244-3573 DSN 494-3573 Mr. Scott Dombrosky 415-244-3572 DSN 494-3572 FAX 415-244-3511	Alaska, Arizona, Nevada, Oregon, Washington, Utah, Montana, Idaho, and California
Pacific Division, (114A) Naval Facilities Engineering Command Pearl Harbor, HI 96860-7300	Mr. Lawrence Pinter 808-474-5961 DSN 430-5961 Dr. Stanley Y. Higa 808-474-5956 DSN 430-5965 Secretary 808-471-3948 DSN 430-3948 FAX 808-471-5874	Hawaii, Midway, Guam, Philippines, Okinawa, Japan Australia, Korea, Singapore, Diego Garcia and New Zealand
U.S. Navy Public Works Center Code 106.2E Box 13, FPO Seattle 98762	Mr. Akira Masui DSN 234-7414	U.S. Navy installations in Japan (less Okinawa)