Nova Scotia
Structural Pest Control
Training Manual

2nd Edition
2006

NOVA SCOTIA
Environment and Labour

Notice

This manual is provided for information only. Users of this manual rely on the contents of this manual at their own risk. This manual is not intended to be a representation of the current law on the subject of pesticide use. Users of this manual should always check with the appropriate authorities in their area to ensure Users are conducting their activities in a proper manner and in accordance with the laws of their jurisdiction. The Government of Nova Scotia, as represented by the Department of Environment and Labour, is in no way responsible for the activities of Users of this manual.

Acknowledgments

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Special thanks is extended to Normand Doiron and John Robichaud for their input and review of this manual. As well, the New Brunswick and Nova Scotia Departments of the Environment would like to acknowledge the contributions made by the National Task Force on Pesticide Education, Certification and Training in the development of the standards from which this manual evolved.

This manual is a joint effort between the provinces of New Brunswick and Nova Scotia. Funding for the development of this manual was provided by the New Brunswick Environmental Trust Fund and the province of Nova Scotia.

Introduction

Structural pest control refers to the control of pests in, on or near a structure. A structural pest control applicator must be able to identify, and know the basic life history, habitat and damage of structural pests. From this information, the applicator must be able to deter-mine a method of control, and if that method of control involves the use of pesticides, the applicator must ensure that pesticides are used safely and effectively.

This manual, the Structural Pest Control Pesticide Safety Manual, in conjunction with the Applicator Core Training Manual, contains the minimum amount of information that all structural pest control applicators must know in order to become a certified pesticide applicator.

The Structural Pest Control Pesticide Safety Manual focuses on information specific to structural pest control. Detailed information is presented on major pests as well as application equipment utilized by structural pest control applicators. Applicators wishing to obtain a Pesticide Applicator's Certificate for structural pest control must be aware of the information contained within both manuals in order to pass an examination.

Both the Applicator Core Training Manual and this manual have been set up to help you prepare for the structural pest control applicator certification exam. Read the learning objectives box at the beginning of each chapter. This will allow you to recognize the most important points from each chapter. Read each chapter carefully and answer the questions at the end. The answers to the questions ca nbe found in an appendix at the end of the manuals. This section is to help you obtain and understand the correct answers. These learning objectives, questions, and answers have been designed to help you learn the most important points from each chapter.

NOTE: Information pertaining to fumigation is not covered in this training manual. In Nova Scotia, the use of fumigant gasses is not covered by a Structural Pesticide Applicator's Certification.

For additional information on pesticide certification, please contact:

Nova Scotia Department of Environment and Labour
P.O. Box 697
Halifax, N.S.
B3J 2T8
Tel: 902-424-5300

Copies of this manual are available on line at:
www.gov.ns.ca/enla/pests/applicator.asp

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Chapter

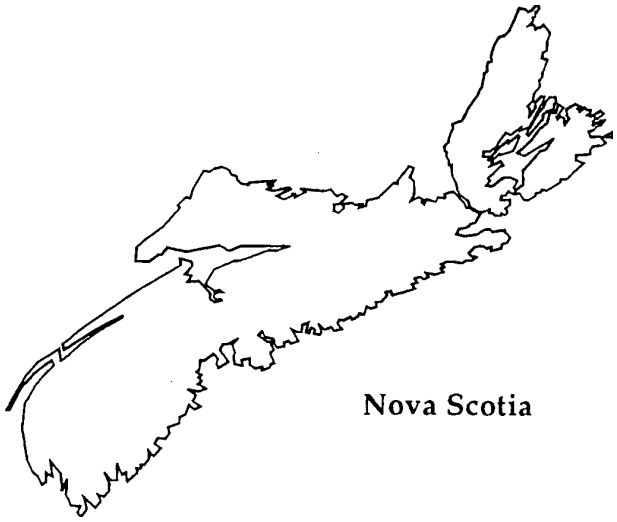
1

Legislation

Pesticides are regulated in Nova Scotia under the authority of the Environment Act and the Pesticide Regulations, administered by the Nova Scotia Department of the Environment and Labour. The intent of the legislation is to ensure that pesticides are used, stored and disposed of in an appropriate manner.

Every citizen has a responsibility under the Act to ensure that their use of pesticides does not result in pollution of the environment.

It is important that structural pest control applicators have a clear understanding of provincial legislation. Nova Scotia provincial pesticide legislation can be viewed on line at ***www.gov.ns.ca/enla/pests/regulations.asp***



Business Operator's Certificate

Any business that sells the service of applying commercial or restricted class pesticides must obtain a Business Operator's Certificate from the Nova Scotia Department of Environment and Labour. A completed Contingency Plan must be submitted along with the application for a Business Operators Certificate. The Business is responsible to maintain records of pesticides use. These records are subject to audit by NSEL.

The Business Operators Certificate is valid for no more than one year from the date of issue and expires on December 31. Specific terms and conditions are attached to the Business Operators Certificate. These terms and conditions are a legal document, enforceable under the Environment Act. It is the responsibility of the Business Operator to ensure that these terms and conditions are followed.

Structural pesticide applicators should be familiar with the Terms and Conditions of the Business Operators and the businesses Contingency Plan. These documents must be reviewed at the beginning of each season.

Pesticide Applicator Certification

All employees of the business who apply commercial or restricted class pesticides must be certified by the Nova Scotia Environment and Labour. Pesticide applicators must pass a provincial pesticide applicator certification exam to become certified. This certification authorizes the applicator to use **a pesticide, other than a herbicide or fumigant for the prevention or control of pests in or around a structure.**

Study material for the certification exam is contained in two manuals. They are the ***Applicator Core Training Manual*** and the ***Nova Scotia Structural Pest Control Training Manual*** **.** The ***Applicator Core Training Manual*** contains the general knowledge that all users of pesticides must know and forms the core for all pesticide applicator programs. The ***Nova Scotia Structural Pest Control Training Manual*** contains specific information on pest management, application technology, legislation and safety procedures for the structural category.

NOTE: In Nova Scotia, the use of fumigant gasses is not covered by a Structural Pesticide Applicator's Certification. Applicators wishing to use fumigant gasses must obtain certification in the fumigation category.

Permits and Approvals

Additional permits and/or approvals are required for pesticide application in certain situations. For additional information see the Activities Designation Regulations - Division II which can be found on-line at www.gov.ns.ca/just/regulations/regs/envactiv.htm

A permit from the Department of Natural Resources is required prior to conducting any bird or wildlife control program.

Some municipalities may have restrictions on the use of pest control products. Applicators should check with their local municipalities for further details.

A Note on Pesticide labels

The Pesticide label is a legal document. It is illegal to use a pesticide in any way other than for the purpose and in the manner stated on the label.

Pesticides used in structural pest management must be specifically registered for use in, on, or around structures. These products can only be applied in the types locations specified on the label. Labels may also include statements to "keep out of areas accessible to children and pets" or "place in tamper resistant bait stations".

A registered pesticide can only be used in meat packaging or food processing plants if it contains a cautionary statement specific to these two use locations, and it must also be included in the Reference Listing of the Canadian Food Inspection Agency (CFIA).

Self-test Questions

Answers are located in Appendix A of this manual.

1. What is the name of the regulation that covers the use of pesticides in Nova Scotia ?

2. Pesticide applicators who have a Structural Pesticide Applicator Certification may use fumigant gasses. True or False

3. A certified structural pesticide applicator may require an additional permit to conduct what type of pest control operation _____ ?

Chapter

2

Integrated Pest Management

Integrated Pest Management (IPM), is not a new approach in structural pest management. In fact, IPM has been practised in structural pest management for many years.

IPM is a process that considers all available information and control methods when managing pest populations. When using an IPM approach, pest populations are maintained below economically damaging or socially unacceptable levels. All practical measures to suppress the pest population to a tolerable level are considered: These include cultural controls (e.g., changes in maintenance practices, regular cleaning schedule, garbage elimination, changes in worker procedures) pest exclusion and physical modifications (e.g., screening, caulking, etc.) and pest control devices and pesticides Using a combination of these cultural, physical, biological and chemical control techniques to minimize adverse effects to the public or the environment.

The Applicator Core Training Manual has an entire chapter devoted to the topic of IPM. Make sure you are thoroughly familiar with the techniques involved in IPM.

Learning Objectives

Completing this chapter will help you to:

- Understand the concept of Integrated Pest Management.
- Be familiar with the components of an IPM program.

Structural IPM programs differ from IPM programs in other pest management industries in four main ways:

- Prevention of pest infestations is very effective and should be the main objective o f the pest management program;
- Unlike out door pests, eradication of certain structure invading pests with a specific area (such as a warehouse or food processing plant) is a realistic goal because the pests are inside specific boundaries;
- A working knowledge of building design especially plumbing, electrical and ventilation systems is essential;
- Communication with clients is particularly important for establishing tolerances and for educating clients about the IPM approach. Once a problem is under control, the applicator must work with the clients to develop a long term preventative program.

Putting IPM into Practice

When starting to implement IPM, it is often best to set realistic objectives for a small site or for a few types of pests before using IPM on a large scale. Before beginning an IPM program, it is important to collect and analyze information about a management site, including:

- physical characteristics of the building or structure,
- environmental and human health protection concerns including an inventory of areas that require protection,
- building use patterns,
- records of past pest problems and treatments that were used,
- maintenance practices, preventive measures and treatments that could be used,
- financial and other resources available to implement the IPM program,
- regulatory requirements or bylaws that apply,

When developing an starting an IPM program for a client site , a plan should be developed that includes all IPM components. The basic components of an IPM plan include:

- education of pest management technicians,
- site inspection and identification of all pest problems (including numbers of pests present) and possible contributing factors,
- client education,
- pest prevention including exclusion (e.g., caulking, screening, pallet management etc.) and sanitation (e.g., cleaning, waste management, cardboard box management) habitat alteration (e.g., open doors, windows, landscaping and lighting that promotes pest problems),
- selection of thresholds and suitable monitoring methods,
- selection and use of control measures (e.g, clean out trapping, pesticide application etc.)
- establishing a record keeping system and quality assurance program,

- program evaluation (usually done once a year),
- regular communication with client or client representative,

The following is a more detailed description of the IPM techniques listed above.

Thresholds

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

Inspection and Monitoring

Inspection of a structure involves searching for evidence of an infestation, such as actual pest sightings, droppings, cast insect skins, rodent hairs and damage. Pest harbourages, means of entry into the structure, and sources of moisture, food and heat should also be examined. Obtaining information from people who live or work in the structure is a very important part of conducting an 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.

No area in a structure should be excluded from inspection. For example, make sure to note the location of pipes, ducts, cables, telephone lines and all other utility lines leading into the structure. Make special notes on kitchen and bathroom areas. Pay close attention to the sanitary conditions and general structural maintenance of these areas. Inspect the exterior of a structure by walking the entire area, noting the location of such things as trash containers, dumpsters, drains, air conditioners and planters. Note any areas where pests may enter the structure or where they maybe living outside.

Tools required to perform a proper inspection include a flashlight, hand lens, hand tools, collecting vials, and sticky traps. A mechanic's mirror and stethoscope are also helpful in some situations.

A monitoring program involves trapping, sighting, and recording observations. Pests captured on sticky traps can be used to pinpoint areas and levels of infestations. Removing signs of infestation (e.g., droppings, nesting material and infested items), repairing pest damage, and then checking for re-occurrence may also be used to determine ongoing pest activity. A record of monitoring data should be maintained.

Client Education and Communication

Good communication between the pest control operator and the client is extremely important to the success of the IPM program. Communication must be an ongoing activity involving training, education and a routine review of the goals of the pest control program.

Control Methods

Habitat Alteration

Since infested areas provide harborage for pests, changing or eliminating some of these favourable conditions will make the build up of pest populations less likely. Such changes commonly include , moisture reduction, elimination of clutter, pallet management, and changes to lighting and landscaping which promote pest problems.

Sanitation

Sanitation is a key component to the success of any IPM program. The structural pest control applicator must educate the client on the importance of maintaining a high level of cleanliness both inside and outside a structure. By maintaining a clean environment, pests may be eliminated. Sanitation practices may include routine and "special" cleaning, review and improvement of waste management practices and management or packing materials such as cardboard boxes.

Exclusion

Exclusion techniques involve methods that maintain an environment free from pests. The selection of exclusion methods depends on the site and it's intended use. Exclusion can include approaches such as caulking, screening, weather stripping and installing barriers (e.g., porcupine wire) to reduce bird perching and loafing) to prevent pests from entering or using structures.

Physical Control

Physical control includes setting traps, glue boards or using other mechanical devices to reduce pest populations. In some situations, physical control also involves the use of heat and cold to manage pests. Physical control can also include nest removal using high pressure streams of water or manual methods (e.g., pole and hook).

Chemical Control - Pesticides

In order to control certain pests, or in certain situations, the structural pest control applicator must use a pesticide. A structural pest control applicator has more contact with the public than other types of applicators. It is of the utmost importance that the applicator convey and demonstrate a high degree of competency when applying pesticides. Failure to do so leaves the public with concerns about the risk of exposure to themselves, their family or coworkers, plus the possibility of damage to the surroundings.

The applicator must ensure:

- that the pest has been correctly identified,
- that an appropriate pesticide has been chosen to treat the pest,
- that the pesticide is registered to control the pest, taking into account the variety of formulations available, the surface to be treated, level of pest infestation, non-target exposure and odour sensitivity.

Application techniques (or treatments) used in structural pest control include the following:

- broadcast or general
- spot
- crack and crevice
- space
- bait

Broadcast or general application refers to the application ofa pesticide to broad expanses of surfaces such as walls, floors, ceilings and foundations where pests are present.

Spot applications refer to the limited application of a pesticide to a localized or specific area where pests congregate.

Crack and crevice applications refer to the application of small amounts of a pesticide directly into cracks or crevices, which may harbour pests.

Space treatment refers to the application of a non-residual contact pesticide as a suspension of fine droplets in air within an enclosed space.

A bait formulation is an active ingredient mixed with food or another attractive substance. The bait either attracts the pest or is placed where the pest will find it. Baits are available as liquids or solids and are placed in cracks, voids or other inaccessible areas.

Evaluation and Follow-up

Follow-up practices can make the difference between the success or failure to control pest problems. Follow up practices include detailed record keeping, supervisor oversight, a quality control program, and regularly scheduled client interviews and surveys

A Note on Pesticide Resistance

Repeated applications of the same pesticide or chemically similar pesticides over time can lead to the build up of resistance. When this occurs the most complete application cannot achieve acceptable control. With repeated applications after population recovery, the more succeptable individuals are killed and those that are less susceptible become the parents of the next generation. Alternating pesticides with different modes of action (e.g., organophosphates and pyrethriods) and of different types (e.g., baits and IGRs) can also be helpful.

Of the urban pests, the house fly and the German cockroach lead in the development of resistance to pesticides. The use of an integrated approach to pest management reduces reliance on individual pesticides can help slow or prevent the development of resistant pest populations.

Self-test Questions

Answers are located in Appendix A of this manual.

1. What does the inspection of a structure entail?

2. List tools required for an inspection ?

3. What is involved in a monitoring program?

4. Describe mechanical, physical and biological exclusion techniques ?

5. Name five application techniques commonly used in structural pest control ?

Chapter

3

Ants

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 applicators become involved with ant problems at some point in their career - most often because ants are found foraging or nesting inside structures.

Learning Objectives

Completing this chapter will help you to:

- Be familiar with key features in the life cycle, habitat and appearance of ants.
- Know control methods for ants.

The Ant Colony

Ants have a complex social structure consisting of workers (sterile wingless females), queens (reproductive females), males and larvae. Depending on the species, the workers may be further divided into two or more specialized forms (e.g., soldiers) to preform specific tasks for the colony. Body size and appearance may vary slightly between these forms depending on the task that they are doing.

Most mature ant colonies produce winged males and winged reproductive females during the early spring or summer.

The winged reproductive female mates with a reproductive male 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 to begin establishing a new colony. At this time, if her wings are not already broken off, she tears them off. She then produces eggs. The eggs hatch into tiny, white, legless grubs (larvae). The larvae 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. When the pupae have made matured they molt into the adult stage. Adults take on one of the roles or castes of the community.

Queens (reproductive females) may live for many years and produce eggs for the subsequent broods that go on to make the colony. Worker (non-reproductive females) tend the eggs, larvae, and pupae, forage for food and enlarge and defend the colony.

Foraging

Ants eat a wide variety of food, including other insects, seeds, nectar, meats, fats, sugars, and honeydew. Honey-dew is a liquid produced by plant sucking insects, such as aphids, mealy bugs, scale insects, and plant hoppers. These plant sucking insects feed in groups on plant stems and leaves where they may be protected by the ants who use the honey dew that they produce as a food source.

Ants mainly locate their food by foraging at random. Their strong sense of smell is essential once food is in the immediate vicinity. Ant eyesight is thought to be extremely poor and of little use in locating food. They forage by day or night depending on the species. Once a scout locates a source of food, she carries a piece of it back to the nest and alerts otherworkers. Many species lay down a pheromone chemical along the path from the food source to the nest. This provides workers with an odour trail to follow to the food.

Ant Control and Management

Correct identification of the ant species is necessary before a successful control program can be initiated. The correct identification of an ant pest allows the applicator to determine whether treatment is actually necessary.

The successful control of any ant infestation is to locate all of the ant colonies in or around the property. The inspection is the most important step in dealing with ant infestations. It is critical to take the time to perform a thorough inspection and identify the areas where ants are active. Determine if the ant colony is located inside or outside the structure. Whether the colony is inside or out, ants known to tend honeydew producing insects often forage inside before plant insect populations can build up outside. After populations of aphids, mealybugs, scale insects, and whiteflies 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 the house 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 procedure is effective, or whether the ants abandoned the structure due to natural habit.

Inspection

As a professional applicator, it is very important to interview your client to get information about the ant infestation. Observe ant worker movement and identify the focusof the infestation. Inside the structure, inspect holes and cracks where workers enter, old or new moisture stains, food debris, activity near appliances, around bath tubs and showers, in drawers, and in adjoining rooms. Outside the structure, inspect for workers behind vines, shrubs, other plants near the house, expansion joints, slabs, patio blocks, bricks, boards, plant pots, under and inside wooded columns and pillars, outside door and window frames, penetrations of the house wall by telephone wires, air-conditioning refrigerant pipes, trees that harbour colonies and provide access to houses by overhanging limbs that touch or even scratch shingles; water/electrical metres, and storm drain inspection manholes. Inspect plants for ants tending aphids, mealybugs, etc.

Control Methods

An environmentally responsible ant management program involves correcting all conditions contributing to the problem. These conditions must be corrected first. If insecticides are the only method used to control the ants, then the program will ultimately fail and the ants will return. Before planning a control program talk to your clients and establish a threshold. Ants are beneficial to the environment - clients should be encouraged to tolerate some ants especially in out door living areas, patios etc.

Physical Control

Ants are like all pests, they require food, water, and shelter to survive; by denying them access to any or all of these, you can reduce or eliminate them. There are a number of "good housekeeping" practices to follow:

- Store food and food waste in containers with tight fitting lids to eliminate access by ants.
- Ants are foragers and will seek out food wastes. Ensuring the living spaces, office and stotage spaces are as free of food debris as possible.
- If ants are entering a structure through a crack seal it with silicone caulk.
- Use dusts in cracks, wall voids, and other hard to get areas before caulking.

Habitat Alteration

A thorough, long term ant management program involves correcting any conditions in and around the structure that may be contributing to the infestation. It may be necessary to caulk wall penetrations and mortar masonry cracks, caulk door and window frames, repair water leaks, trim shrubbery away from the house, move firewood stacked against the house, and control ant tended aphids and mealybugs.

Chemical Control

It is important to know the species of ant when determining what type of insecticide to use. Whenever possible, select formulations with low toxicity, such as insecticidal soap, boric acid, and pyrethrum for baits, dust, and sprays. There are a number of controls that may be used.

Baits

Use baits with stomach poisons or with insect growth regulators. Baits are excellent in critical areas (eg. 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 odours especially fumes of pesticides. Ants and other insects can detect minute amounts of foreign or repellant chemicals.

Dusts

Use dust in wall voids and crack and crevice treatments. Dusts such as diatomaceous earth and silica gel have a drying effect on insects. Boric acid powder has a low toxicity to humans but acts as a stomach poison for ants. These dusts are effective when blown into cracks and wall voids before they are sealed.

Sprays

Sprays may also be used in crack and crevice treatments. Apply wettable powders and micro-encapsulated spray formulations where pesticides may be absorbed into surfaces. Drill holes where practical (eg. false floors in sink cabinets, window frames, wall panel grooves, and other voids). Use spot treatments when necessary but be wary of repellant activity. Insect growth regulations (IGR) are also an option for ant control.

It is important to develop a specific pest management plan. Where large outside areas need treatment, do not treat as anextension of a yard problem. Use spot treatments and perimeter spraying carefully and only after consideration of alternatives. The drawbacks to these reactive treatments include; nest areas can be completely missed, and ants tend to just move to other areas.

Reinspect or contact clients with troublesome ant control problems within a week to ten days depending on your control strategies. It takes baits and IGRs longer than dusts to show control.

Carpenter Ant *(camponotus spp.)*

There are many species of Carpenter ants in North America; but few enter structures to forage; fewer nest in structures. These two habits (foraging and nesting inside) coupled with their large size and vigorous activity make Carpenter ants impossible to ignore.

Carpenter ants are large ants ranging in size from 5 mm (smaller workers) to 25 mm for winged females and queens. 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.

A Carpenter ant colony begins in isolation, but not necessarily in wood. This first brood may be under a stone, in a roll of tar paper, or 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. Excavated wood is discarded 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 fluffy. Sawdust left over from construction or repairs may look similar at first glance but has a more gritty texture.

The process of ant gallery excavation results in galleries with very smooth sides. There is no dust or pellets (like that produced by wood-borers or dry wood termites). A Carpenter ant 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 sub-flooring and shower bases).

The most common urban outdoor harborage is a living tree with a rotted area inside; other common sites are stumps, firewood and wooden construction debris. The Carpenter ant is a valuable link in the reduction of plant cellulose. It is not surprising that mature wooded neighbourhoods often have structural Carpenter ant problems. New neighbourhoods 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.

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 bridge-like 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 Carpenter ants are nearly inseparable. In the majority of cases Carpenter ants make their nests in wood that has been wet. 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, down spouts, 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.

Tiny piles of “sawdust” on window sills, at the base of walls or around porch supports may signal the presence of carpenter ant nests may also be constructed inside walls and in these cases the swadust cannot be seen. Nests hidden in walls and wood work sometimes be located by tapping the suspect area with the butt end of a screwdriver and listening for a hollow sound. Sometimes a rustling sound similar to the crinkling of cellophane can be heard coming from inside the nest. Sounds are most noticable in the from latre evening to early morning when the ants are most active.

Habitat 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 or spray 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 areas should be evaluated and if needed removed by professional arbourists.
- Baits may not be effective.

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.

Occasional Structure Invaders - Garden Ants

There are numerous species of garden ants that occasionally invade structures in search of food. The most common invaders in the Atlantic region are the pavement ant, the thief and the litlle black ant.

The Pavement Ant *(Tetramorium caespitum)*

Around 3 mm 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. 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. Sweet- and protein-based baits are most attractive to pavement ants.

The Little Black Ant *(Monomorium minimum)*

This little ant is no more than 2 mm long; it has two nodes and is shiny black; the ant is widely distributed in North America. It normally nests outdoors and tends honeydew-producing insects. Baits are very effective in eliminating colonies.

The Thief Ant *(Solenopsis molesta)*

Less than 2 mm 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. Sweet-based baits may be helpful in eliminating colonies, but thief ants don't seem to feed on baits for extended periods of time.

Habitat Alteration

Habitat alteration provides the best long term control of structure invading garden ants.

- Remove stones that are sheltering ants.
- Recommend indoor sanitation including the elimination of moist garbage in dry weather.
- Caulk observed ant entrance points.
- Advise clients to wipe down any indoor ant trails with soapy water.
- Nests located around building foundations, doors an windows should be destroyed

The Pharaoh Ant *(Monomorium pharaonis)*

The Pharoh ant is a tiny ant, not much more than 2 mm 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 Canada. Pharaoh ants prefer warmer buildings and warm areas (26-29 C) in buildings for nesting. These ants are active year-round in heated buildings such as hospitals, office buildings, laboratory buildings, and food service facilities. Pharoh ants feed on a variety of materials including sweets, grease, meats, fatty foods and other insects.

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.

Nesting sites include wall voids, cracks in woodwork, stacks of paper, envelopes, bed linens, bandage packs, and 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.

Control and Management

Inspection

Focus inspection on areas that are difficult to clean or where there is poor sanitation.
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. To be effective the baiting program must be combined with a good sanitation program. Before baiting clean up all potential competing food sources such as spilled food, garbage etc. and properly store all food supplies. Place a bait station where every positive monitoring trap was located.

- Set commercial bait stations in public access areas.
- 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. Barrier treatments should not be used for Pharoh ants as it may promote colony budding which will spread the infestation through out the building.

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.

Self-test Questions

Answers are located in Appendix A of this manual.

1. List two reasons why ants are considered pests.

2. Describe the ant caste system.

3. List three "good housekeeping" practices to follow in managing ants.

4. Describe three types of insecticides commonly used to treat ants.

Chapter

4

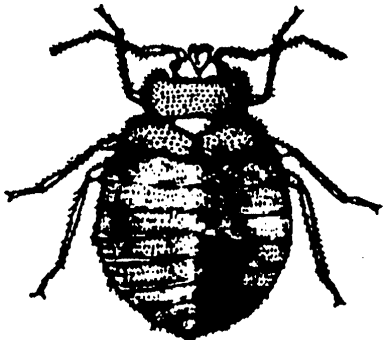
Bed Bugs

This wingless bed bug, a notable blood sucking parasite of man throughout written history, has moved with him all over the world. Bed bugs feed by piercing their host's tissue with slender thread-like stylets and sucking the host's blood. The bed bug's adaptation to humans is so complete their bites are nearly painless. These insects are pests of humans as well as domestic animals. They are one of the most important urban human pests and are often disliked more than cockroaches. In recent years, the number of bed bug calls received by structural pest management companies in the Atlantic region has been increasing.

Learning Objectives

Completing this chapter will help you to:

- Be able to describe bed bugs.
- Be familiar with control methods for bed bugs.



Cimex lectularius

The Common Bed Bug (*Cimex lectularius)*

Bed bugs are flat, oval, almost wingless insects, usually less than 7 mm long (1/4 inch). These reddish-brown bugs have moderately long, slender antennae, thin legs, and vestigial wings in the form of stubs. Notorious pests, they can run at a surprising speed. At night they hunt for sleeping mammals and birds. Adults have been known to survive without food for a year or more. The bed bug is nocturnal, usually feeding on the blood at night and hiding during the day.

They become mature in about four weeks when host blood is available and temperature, humidity and harbourage is favourable. If hosts are scarce, bed bugs can survive for a year without feeding. Hosts include many species of vertebrates besides humans, 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 can sometimes 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 may be deposited. Hatching occurs in one to two weeks, depending on temperature - the warmer the weather, the shorter the incubation time.

Nymphs

Nymphs are tiny and colorless at first. They go through five molts taking a blood meal between each one. This nymphal period can last from several weeks under favourable conditions to as long as a year when hosts are unavailable and temperatures are low.

Adults

Bed bugs undergo gradual metamorphosis and mate soon after becoming adults. Adult bed bugs prefer humans as hosts; while they have been known to harbour several human diseases, there have been no record of disease transmission.

Harbourage

Under normal conditions, bed bugs feed at night. Their 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.

If a room is heavily infested, there will usually be a strong characteristic odor which results from an oily, odorous material secreted by the bed bugs. After feeding on the blood of a human, they will defecate, and this will appear as small black spots and will be found near their hiding place.

People bitten by bed bugs react differently. Some people show no apparent effect from the bite. Others suffer a marked irritation and swelling in the vicinity of the bite.

Inspection

The bedroom is usually the center of infestation. All dark cracks and crevices are potential harbourage. If a bed bug infestation is suspected the following areas should be inspected:

- bed creases, crevices and seams,
- bed fame joints and areas where steel rods join any wooden portions of the structure
- curtain folds,
- any chesterfields or chairs in the bedroom,
- radiators,
- plush animals in bedroom,
- suitcases in bedroom,
- any camping, sleeping equipment used by the resident.

Habitat Alteration

Since bed bugs have alternate hosts besides humans (eg. rodents, some birds, etc.), excluding these animals from sleeping and living areas is very important. While it is difficult, infested woodland cabins must be vermin-proofed.

There are a number of things that should be done around the home or dwelling:

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.

Chemical Control

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 labelled for bed bugs are available. Use crack and crevice application methods to treat harbourage thoroughly. Ensure that treated tufted mattresses or de-pressed seams are dry and covered with bedding before they are used. Do not use space treatments or fogs because they are not effective. If treated infestations reoccur, evaluate to determine whether some harbourage was missed or if the structure is being re-infested. Keep good records on pesticide use and application methods.

Follow up

If infestations recur, determine whether some harborage was missed or if the structure is being re-infested. Revise the management plan. Monitor structures where periodic re-infestation 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.

Self-test Questions

Answers are located in Appendix A of this manual.

1. Why are bed bugs pests?
2. How long can bed bugs go without feeding?
3. Where are you most likely to find a bed bug infestation?
4. List 4 habitat alterations that can be done inside homes.
5. Are space treatments or fogs effective chemical control methods?

Chapter

5

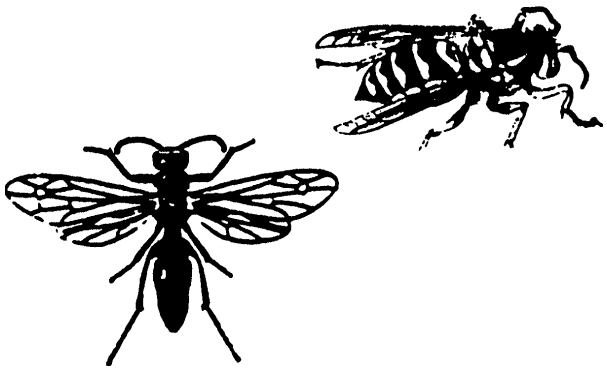
Bees and Wasps

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. The urban pests of the order Hymenoptera are the stinging insects, bees and wasps. However, yellowjackets, hornets and wasps serve our interest as they feed their young largely on flies and caterpillars and they are also responsible for pollination.

Learning Objectives

Completing this chapter will help you to:

- Be familiar with common stinging pests.
- Know when stinging insects are pests.
- Be familiar with ways to control stinging pests.



Bees

Bee hives can be found in any hollow wall in a building that has an entry way. Bee colonies can have up to 60 000 workers. The colony will also have several hundred drones (males) and one sexually mature queen. The queen's purpose is to lay eggs.

During the spring, more workers are produced as more nectar is available. The colony at this time usually becomes overcrowded. When this happens a new queen will develop and one of the queens will leave to start a new colony. The queen takes about half of the workers - they leave in what is known as a swarm. When new colonies are formed, the bees tend to be some-what docile and do not sting. However, in a day or two, they become more aggressive.

The stinger of a honey bee is barbed and usually, after the bee attacks, the stinger, venom sac and part of the abdomen are torn off and left in the victim's flesh. If this occurs, the bee dies. To remove the stinger, the victim should scrape it off with a knife. Removing the stinger by pulling it out usually results in more venom being pumped into the flesh.

Reaction to a bee sting varies, depending on the individual. Some people, aside from feeling the prick of the sting have no reactions, whereas others may have very severe reactions which could result in death.

Wasps, Yellowjackets, and Hornets

Many people refer to wasps, yellowjackets and hornets as bees and their main concern is with the fact that these insects can sting. Knowledge of these insects' behaviour is essential to their management. As the nests of these insects are usually the target for control, pest control applicators must understand the nesting and make-up of the colonies.

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. Nests of certain species are round and do not appear "comb" shaped at first sight.

Paper Wasps

From spring on, the queen lays eggs and the daughter workers feed larvae and expand the comb or nest. The workers obtain 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 new colonies can begin in the spring.

The males die in winter. The nest disintegrates and will not be used again. In the spring, the lone female reproductive begins her nest by attaching a thick paper strand to an overhanging structure. She then builds hollow cells by chewing wood or plant fibers (cellulose) mixed with water and shaped with her mouthparts.

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 (e.g., chewed up caterpillars) from their mother. When they grow large enough to fill the cell cavity, they break the glued spot and hold on their own.

Mature larvae, then, spin silk caps, closing off the cell, and molt into pupae. This same larval behaviour is followed by yellowjackets and hornets.. All larvae are females. Other than their white colour, the pupae look like adults. As they mature they develop adult systems, 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).

Management and Control of Paper Wasps (Polistes)
Paper wasps nests are often found near doorways and other human activity areas. Colonies can become a problem when the wasps are competing with people for food.

To control Paper Wasps nests which are found on structures, the following tips may be helpful:

- Remove old nests and scrape the point of attachment (this spot is often selected by new queens for attachment of new combs).
- Caulk openings in attics, window frames and around walls to keep females out of unused rooms and spaces.
- If pesticides are to be used for nest destruction:
- Use a product labelled for Paper wasps.
- Use a pressurized spray; use extension poles if necessary.
- If a ladder is needed, wear a bee suit and veil. Proceed cautiously.

Yellowjackets

Yellowjacket colonies begin with a large fertilized queen; she develops smaller daughter workers and later reproduces 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 yellow jackets make the aerial football-shaped paper nests, commonly called hornets nests. Two of these yellowjackets are common - the Aerial yellowjacket and the Bald Faced Hornet.

The Aerial yellowjacket begins its nest in March or April and is finished and no longer active by the end of July. Their nests are usually attached to building overhangs and are more round than those of other species. The Bald Faced hornet is larger than the other yellow jackets and is black and white - not black and yellow.

In the spring, the Aerial nesting queen develops a small comb, like the Paper wasp with a dozen or so cells, but she encloses it with a gray paper envelope. The daughter workers take over the nest duties and by mid summer the nest is full size. A full-sized Bald Faced hornet nest consists of not a single umbrella comb like the Paper wasp, but four to six wide circular combs - one hanging below the other and all enclosed with a paper , layered envelope. Bald Faced hornets capture flies as well as species of yellowjackets for food. Their nests are attached to trees or shrubs, or on buildings. Although Aerial colonies have large number of workers, their food gathering habits rarely bring them in contact with people.

Underground Nesters

The stinging wasp, often identified as a yellowjacket, is black and yellow. Primarily yellow bands cover a dark abdomen. They begin their nests much like the aerial nesters - with an enveloped small comb made of wood fiber paper. However, these nests are started in soil depressions, rodent burrows or any small hole that will provide protection until the nest is finished.

As the workers begin nest care, they enlarge the entrance hole and expand the nest. Combs are placed in tiers. Nests can be found in building wall voids, attics, hollow trees andother enclosed spaces as well as the ground.

Aerial and Ground Nesters

Only a few species of stinging insects require control. The following are habits and characteristics of those species which normally come in conflict with people:

- They live in areas which people have modified for their use such as golf courses, parks, yards or other recreation areas.
- They have large colonies
- Their habits do not restrict them to a specific kind of prey. Essentially, they are scavengers and they enjoy garbage cans, dumpsters and picnic areas.
- Problems with yellow jackets commonly occur when:
- People step on or jar a colony entrance.
- A colony invades a structure in such a way that it threat-ens the inhabitants.
- They are a nuisance in competing for food.

Management of Yellow jackets

Management of outdoor food is very important in a yellowjacket control program. Some sanitation tips to keeping mind:

- Clean garbage cans regularly and fit them with tight lids.
- Keep garbage at a minimum.
- Remove attractive refuge several times a day during periods of activity.
- Keep openings in structures closed or place screens over openings.

If it is necessary to treat nests with pesticides, try and conduct the application of ground and aerial nests after dark (workers are in the nest at that time). Begin your application with the entrance hole in view and a plan of action. Wear a bee suit and veil during the application. Ensure pant legs and shirt sleeves are taped in order to keep the insects out of the suit. Gloves should also be worn. Move slowly as quick movements will be met with aggressive behaviour.

Make sure that the plastic extension tube from the pressurized liquid spray is inserted into the entrance hole. Note: If the pesticide to be applied lowers the nest temperature, be aware that the pesticide will damage shrubbery. Plug the entrance hole with dusted steel wool or copper gauze. Dust the plug and the area immediately around the entrance. This will help in killing any yellow jackets returning to the nest.

An ongoing monitoring program is vital in a yellow jacket control program.

Self-test Questions

Answers are located in Appendix A of this manual.

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

2. When is the best time to treat nests with pesticides?

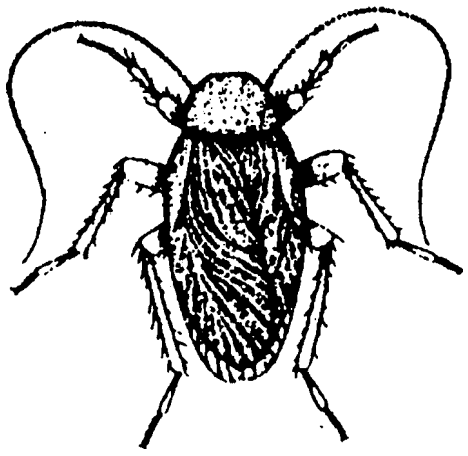
3. Name three ways in which yellowjackets are pests.

Chapter

6

Cockroaches

Cockroaches are an ancient group of insects that have remained relatively unchanged for the past 400 million years. Ancient fossils had the same appearance as the cockroaches of today. They are recognizable by their oval flattened bodies, elongate hairlike antennae and long legs. World-wide there are approximately 3500 species of cockroaches. Most live wild in the tropics; a few, called urban cock-roaches, choose to enjoy the moist, even temperatures at which humans maintain their homes and workplace. Cockroaches are one of the most adaptable insect groups known. Because of this, they are also one of the most difficult insects to control.



Learning Objectives

Completing this chapter will help you to:

- Be able to identify common species of cock-roaches.
- Be familiar with life cycles and characteristics of common species of cockroaches.
- Know what is involved in a cockroach control program.

Cockroaches

All cockroaches develop by gradual metamorphosis. The number of eggs varies with the species. Once hatched, the nymphs may require up to a year or more to reach adult-hood, depending on the species, temperature, or other environmental conditions.

Cockroaches are omnivorous and feed on a variety of plant and animal matter. Most species are capable of living off a large variety of foods found in household pantries, restaurants, bakeries, and any place where food is stored or processed. A heavy infestation will stain any surface where they congregate in large numbers. This is a clue to their presence when estimating the extent of an infestation. Heavy infestations will also impart a strong musty odour.

Cockroaches are nocturnal in habit and do not roam freely during the daytime unless their harbourage is disturbed. Most cockroach infestations begin with the introduction of a few individuals in merchandise or other goods brought into a house. Although clean and sanitary conditions discourage cockroach infestations, any house can become infested. If the premises are maintained in an unsanitary condition, the infestation will spread rapidly. They require a source of food, and buildings where bits of food and grease accumulate in cracks and crevices provide such sources. They also require moisture and warmth. Anything that will reduce the food sources and moisture will aid in the control of cock-roaches. However, once a colony of cockroaches has established itself in a structure, sanitation in itself will not rid the premises of the infestation.

A concerted effort must be made to determine the exact location of the cockroaches. This will enable you to direct pest management strategies in those areas. If pesticides are required, spot treatment in the cracks and crevices where cockroaches hide is strongly recommended. It is essential with any pest management strategy that a thorough monitoring program is in place.

Pest control applicators should be familiar with the following five species of cockroaches.

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 applicators will need to double their efforts in analyzing every German cockroach infestation, and should be pre-pared to use more than one technique to bring the infestation under control.

Appearance

Adult German cockroaches are 1 cm (1/2 inch) long or slightly longer. Males are greyish-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 tanstripe 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 pronotuin, 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 0.6cm (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, 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.

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

Behaviour and Harbourage

Aggregations of cockroaches live in areas of high humidity and nearby food. They will find harbourage into which they can fit closely. As the number of roaches increase and favourable harbourage is filled, roaches are forced to leave the aggregation or remain in less favourable harbourage. 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 favourable temperatures, humidity, food supply, and protection.

Mating. Females do not respond to mating behaviour for more than one week after becoming adults. 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.

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 an applicator'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 harbourage 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 harbourage 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 harbourage, in and around refrigerators, stoves, under sinks, and undisturbed cabinets, provides both protection and food. The most favourable 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 bath-rooms, food areas are usually nearby or available through holes around plumbing pipes. These pipes provide additional harbourage and areas for population expansion into adjacent rooms

or apartments.

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

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

If cockroaches find new locations with favourable conditions, they can migrate from one harbourage 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.

Brown-Banded Cockroach *(Supella longipalpa)*

Brown-banded cockroaches are not generally as widespread as the German cockroach, but where they find favourable harbourage, such as warm apartments and overheated office buildings, they build up infestations rivalling the German cockroach.

Appearance

Adult brown-banded cockroaches are the size of German cockroaches - about 1 cm (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 cm (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-drown with very light side margins and never shows two strips 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 harbourage site. The capsule is very small, only about 0.3 cm (1/8 inch) long, and a little less than 0.3 cm (1/8 inch) wide. It is oval and light tan to brown in colour. 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 (eg., up to 95 days at a room temperature of 22 degrees Celsius). 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 darkareas 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 capsule, fly to windows where the sexes meet and mate - and the cycle begins again. This parasitic wasp has been used as part of cockroach pest management programs.

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.

Behaviour and Harbourage

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 favour areas near stoves and warm motors, such as those in refrigerators, electric clocks, light timers, televisions, and radios.

American Cockroach (*Periplan eta 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.

Appearance

Adult American cockroaches are long: 3 cm (1 1/3) to 4 cm (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 colour, and its pronotum is ringed by an irregular light colour that is almost yellow. Often this margin is bright and wide, darkening toward the centre 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 0.8 cm (5/16 inch) long and 0.5 cm (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 the climate allows American cockroaches to spend most of their lives outdoors, egg capsules can be found in moist wood. Although females pro-duce 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 30-50 plus days.

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

Adult. Adults commonly live more than one year, giving the American cockroach an entire life span of 20-21 months.

Behaviour and Harbourage

Large populations of American cockroaches live in warm moist habitats. They can be found outdoors in alleyways, dumps, stacked firewood and rotting wood, and in tree canopies. As well, they can be found in boiler rooms or other harbourage with water heaters, floor drains, water sumps, and warm moist basements.

Oriental Cockroach (*Blatta orientalis)*

The Oriental cockroach is often called the waterbug, and sometimes the black beetle, or just plain, beetle.

Appearance

Adult Oriental cockroaches are very dark-brown or shiny-black. The female is slightly longer than the male - 3 cm (1 1 / 4 inch) to his 2.5 cm (1 inch). Unlike other domestic cock-roaches, 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 1 /4 of the abdomen exposed.

Life Cycle

Eggs. The Oriental cockroach female produces an average of eight egg capsules from spring to midsummer. 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, 1 cm (3/8 inch) long, and 0.6 cm (1/4 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 colour, 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 many adults are new ones. By fall, almost the entire population is adult. Neither males nor females fly.

Behaviour and Harbourage

Oriental cockroaches favour 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 win-ter in rock walls or other protected sites. These cockroaches are more sensitive to lack of water than other roaches.

Smoky-Brown *(Cockroach Periplaneta)*

The smoky-brown cockroach is a relative of the American cockroach and resembles it in size and shape.

Appearance
Adult Smoky-brown cockroaches are slightly over 2.5 cm (1 inch) long, and both sexes have wings that are longer than the abdomen. Their very dark-brown mahogany colour is striking; no light markings appear on the pronotum or wings. Nymphs, like adults, are also dark-brown. Antennal 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 larger and dark-brown. The female usually glues it to objects in the harbourage. 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.

Behaviour and Harbourage

The Smoky-brown roach 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.

Cockroach Control and Management

Inspections of areas with a flashlight are the most effective method of locating cockroaches. The trained applicator can search dark, undisturbed or remote places of harbourage that a client may have thought too inaccessible.

The use of sticky traps is another inspection or monitoring method used for detection. Correct trap placement depends upon the applicator's understanding of foraging habits. 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 harbourage. Hand mirrors, magnifying hand lens, or other small tools may aid in locating cockroaches.

Control Methods

Indirect Control

- As with any insect problem, it is important to observe good housekeeping practices. These include:
- Proper storage of food.
- Proper storage of garbage, particularly kitchen waste.
- Screen vents, ducts, and windows.
- Reduce access to water sources.
- Ensure kitchen area is cleaned regularly to eliminate food sources such as crumbs, grease, etc.
- Seal cracks and crevices that could harbour cockroaches.
- Educate your clients.

Habitat Alteration

Professional applicators have a responsibility to thoroughly interview their clients to obtain as much information as they can concerning any pest infestation. With respect to cock-roaches, applicators should understand that changes can be made that will alter or eradicate the insect problem. The applicator should be knowledgeable of the following steps:

All areas should be inspected. This includes behind, under, on top of, and around all appliances, shelving, tables, walls, cabinets, and any other area that may harbour pests. Inspection tools should include a flashlight, a mechanic's mirror, screwdrivers, flushing agent, and pencil and paper. Make a sketch of the structure and include the areas inspected and the problems you found. This will help in assessing the pest control program and may help convince the client of the need to keep the area clean.

Sanitation is especially important and includes the removal of food, harbourage, and any other discarded items that may be of use to the pests. It is important to stress to the client the importance

that all areas should be cleaned up and kept as clean as possible.

Exclusion is an easy method of controlling cockroaches by eliminating areas in which they hide and breed, and the routes by which they move within a structure.

Exclusion is the process of sealing up and removing all entry points, harbourages, and other areas that are attractive to pests. Depending on the species of cockroach, areas that may need sealing are: doorways, windows, openings in walls, tunnels, sewers, cracks and crevices, etc.

Monitoring for the pest is particularly important because it indicates the extent of the infestation and where the infestation is a problem. After a control program is initiated, it is still important to monitor to ensure the control program is working.

Chemical Controls

In controlling cockroaches, the applicator should concentrate on injecting pesticides into active harbourage rather than preventively treating uncertain harbourage. The crack and crevice type of pesticide application is recommended. Use a narrow diameter extension tube in infested cracks and crevices to provide a thorough application.

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.

Space treatments include aerosols, fogs, or ultra-low dosage dispensers. They flush cockroaches out of their harbourages, causing them to cross residual pesticide applications, or it lands on the insects killing them by direct contact. Fog treatments should not be used in food or occupied areas without prior removal of food and follow-up surface cleaning.

- There are four factors that explain the success of the cock-roach in human habitations:
- They flourish in the human tropical environment.
- They can utilize human clutter and interior building design for their harbourage.
- They feed on a wide range of food and are not subject to periodic scarcities.
- They develop in a short period of time allowing them to adapt and overcome environmental and pesticidal stresses.

Cockroaches, in general, live on the same wide range of food that humans eat. Accepting many different foods shortens not only foraging time, but foraging distance as well. Cock-roaches tend to build large populations quickly.

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 pesticides.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Name the five common species of cockroaches. Describe each.

2. Which species of cockroaches is the most difficult to control?

3. Name two areas in homes where cockroaches tend to live.

4. Nymphal stages of two species of cockroaches are often difficult to distinguish between. Name the two species.

5. List four factors for cockroaches survival success.

6. Describe steps to take in a cockroach control program.

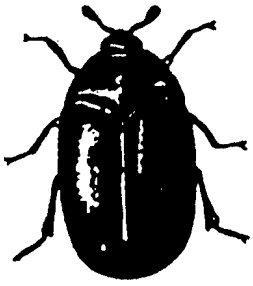
Chapter

7

Fabric Pests

Fabric, or textile, pest infestations sometimes present the most difficult problems a pest control applicator can en-counter. 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 sub-stances 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. Insects are the only animals capable of digesting keratin. Only a few microorganisms and fungi in other kingdoms are keratin reducers.



Learning Objectives

Completing this chapter will help you to:

- Be familiar with various species of carpet beetles and clothes moths.
- Be able to discuss inspection and preventative techniques for fabric pests.
- Understand pest management procedures for fabric pests.

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, yellow jackets, 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.

Carpet Beetles

All species of hide and carpet beetles belong in the beetle family Dermestidae. Adult beetles have short, dubbed antennae, are black in colour or with yellow-white or orange scales or covered with fine smooth hair. The females can lay eggs throughout the year; the adults tend to be cyclical and most active in the 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.

The following are descriptions of both the adult and larval stages of common carpet beetles.

Adults

- The Larder beetle *(Dermestes lardarius) is* large, oblong, and will grow from 0.6 cm (1/4 inch) to 1.0 cm (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 maculatus) is* large, oblong 0.6 cm (1/4 inch) to 1.0 cm (3/8 inch) long. Its dorsal or topsurface is dark-brown or black, sometimes with white scales on the margin of the thorax; the under-surface is also covered with white scales.

- Some other species of Dermestes resemble the Hide beetle with similar habits (i.e. 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 0.3 cm (1/8 inch) in length, dark brown or black and is not shiny.

- The Common Carpet beetle *(Anthrenus scrophulariae),* the Furniture beetle *(Anthrenus flavipes)* and the Varied Car-pet beetle *(Anthrenus verbasci)* are about 0.3 cm (1/8 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 0.3 cm (1/8 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 0.3 cm (1 /8 inch) long to about 0.5 cm (1/5 inch) long. Larvae can be separated into the same groups as the adults:

- The Larder beetle is long, about 1 cm (1/2 inch), hairy, dark brown in color with two teeth on its 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 ex-tends from about 0.6 cm (1/4 inch) to about 1 cm (1/2 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 0.6 cm (1/4 inch). They are wider in the middle than at front or rear end, with dark hair bristles that extend out from the body. The tail end is darker with short brushes of bristles.

- Warehouse and Cabinet beetles usually are small but they may reach 0.6 cm (1/4 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.

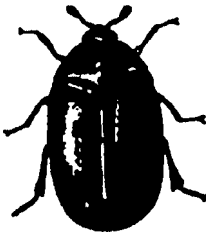
Larder Beetles *Dermestes*

These beetles (from which the entire family takes its name) are larger than other Dermistids, but rather than feeding on fabrics or grains, their larvae commonly eat bird and mammal flesh. They feed in 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 mill; 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 faecal pellets.

Warehouse and Cabinet Beetles *(Trogoderma)*

The several common *Trogoderma* 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 13, Stored Product Pests.)

Control Methods for Carpet Beetles

Inspections

Inspections for Dermestid beetle infestations depend first on the type or kind of beetle identified. The professional applicator must look for faecal pellets as well as irregular holes and loose patchy fur. You must advise clients to take all woolen clothing and furs out of closets and brush them. Brushing helps to dislodge eggs and larvae and infestations are discovered in the process.

Inspect every storage box, under all furniture sitting 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 as part of the pest management plan.

Habitat Alteration

The professional applicator should advocate to the client the discarding or cleaning of any wool or fur product that has not been cleaned since wearing. Furniture should be moved and wool carpets cleaned in infested rooms. A thorough vacuuming of all rooms for pet hair that can support small beetle populations should be conducted.

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 greater likelihood that furs or woolens in long term home storage will be infested than those that are used seasonally. Ensure all cleaned fur, feather, and woolen products are stored in tight chests or good plastic garment bags. Furs are best kept safely in refrigerated vaults at furriers.

Chemical Control

Where infestations are found, spot applications of registered pesticides can be applied to storeroom or closet baseboards and corners.
After the infestation is eliminated, apply pesticides in the cracks and crevices of infested rooms.

Use mothballs or moth crystals in tight chests where vapours and odour will not be breathed by occupants of the house.

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. The emphasis should be placed on educational pro-grams for curatorial staff and storage management personnel in critical facilities.

Clothes Moth Species

Clothes moth favour warm humid climates. Adults of the clothes moth do not feed and are short lived. The larvae of the moths feed largely on contaminated wool and other fabrics containing keratin.

The clothes moths are small delicate moths. Unlike most moths, the clothes moths are not attracted to lights. They are light shy and prefer darkness. When disturbed, they tend to conceal themselves in folds of materials or other secluded places. The damage left by the feeding of the larvae is the key to identification of the clothes moth. Adults can be identified by size, shape, and colour.

Adults

The Webbing Clothes Moth *(Tineola bisselliella)* has a length at rest of 0.6 cm (1 /4 inch) to 0.8 cm (1/3 inch) with a wing span of less than 1 cm (1/2 inch) from tip to tip. Its head and front wings are a golden buff. Larvae spin fine silk over the area of their infestation. Faecal pellets, pupal cases and caste 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 andfront wings are dusty-brown or tan with three small dark spots on each front wing.

Larvae

The Webbing Clothes Moth larvae are small, creamy white caterpillars. The Webbing Cloths Moth larvae is between 0.6 cm (1/4 inch) to less than 1 cm (1/2 inch) atmost 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 itshead 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 Methods for Clothes Moths

All woolens should be inspected where clothes moths have been sighted, especially clothing that is stained or has been worn and not cleaned. Brush clothes 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 micro-organisms growing on the stains, clothes moth larvae will die.

The professional applicator should recommend the dry cleaning of all woolens that are in need of it. Have clients inspect all wool products in storage. 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.

Chemical Control

Ensure woolen products are cleaned. Make spot applications in storage areas with approved pesticides. Apply mothballs at the label rate to chests and storage bags.

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 stuffing. Re-view records regularly and provide educational programs to curatorial staff and those in textiles storage businesses.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Name two types of insects which are considered fabric pests. Describe each.

2. What is the name of the protein that only insects can digest?

3. What do the larvae of Larder beetles prefer to feed on ?

4. Are Clothes moths attracted to light ?

5. Can Clothes moths live on wool that has been cleaned ?

Chapter

8

Fleas

Fleas are abundant in most regions of the world, except in very dry places. Because of their irritating bites and ability to transmit disease, fleas are among the most medically important groups of insects.

There are many different species of fleas throughout the world. The professional applicator is ordinarily concerned with just a handful of the total. The principal species of fleas that the professional applicator may encounter is the cat flea. The various species of fleas all have a host preference. For example, the cat flea prefers cats, the dog flea prefers dogs, etc. However, when the normal host is not present, the fleas will readily attach to any other warm-blooded animal - including humans. Thus, when a cat is removed from the premises, the remaining fleas will attach to the human in-habitants.

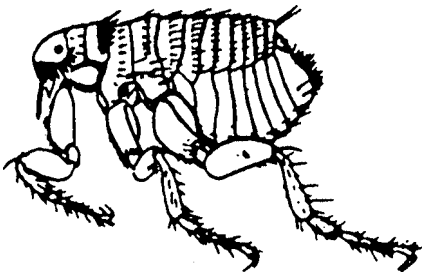
The secret to flea population management is the flea's life cycle. The adult flea must contribute timely nourishment for larvae under special conditions or the young will not survive.

Learning Objectives

Completing this chapter will help you to:

- Understand the cat flea life cycle.
- Be familiar with control methods for fleas.
- Realize the importance of communicating with your client.

Cat Flea *(Ctenocephalides felis)*



Eggs

Following each blood meal, the female flea will lay from several to a dozen eggs at one time and is capable of laying several hundred in her lifetime. These may be deposited on the body, bedding, or nest of the host (normally a cat). Eggs laid on the host are dry and tend to fall off easily, especially hen the animal scratches or shakes itself. As a result of these activities, flea eggs may be scattered about under the edges of carpeting and rugs, under and between sofa seat cushions, in cracks and crevices in the floor or floor covering and in the space between the bottom of baseboards and the floor. Thus, they are most often found in the home around the place where the pet sleeps.

Larvae

In two to ten days, the flea eggs hatch into small, hairy, legless, blind, worm-like larvae. The larvae have chewing-type mouthparts that are much different from the piercing-sucking type mouthparts formed in the adults. Likewise, flea larvae have different feeding habits and food requirements. They do not bite or feed on people or animals, but merely subsist on the feces of adult fleas, bits of dead animal skin, hair, feathers, and other organic debris. Food is plentiful if it finds itself in the host's sleeping area or nest. Larval development progresses through three developmental stages(instars) and is normally completed in about three weeks. However, under unfavourable conditions, full development may not be reached for several months.

Pupae

As the larvae approaches the pupal stage, it starts to weave a cocoon around itself that is spun from its own saliva. As the material is woven, the larva incorporates into it various pieces of debris - a bit of carpeting, pet blanket, some grains of sand, a small rock, hairs, organic debris, whatever is handy. This incorporated material tends to camouflage the pupal case in its own surroundings, making it difficult to detect. The flea pupae is the stage of the flea's life cycle that is most likely to vary in length. In warm weather, with potential human or animal hosts in the vicinity, adult fleas emerge from the pupae stage in only one or two weeks. Depending on their environment, fleas may stay in this pupal stage for as long as one year.

Adults

One of the factors that triggers the flea pupae to emerge is the vibration on the floor caused by a person or animal living nearby. Twenty-four hours after they emerge, they are ready to seek a blood meal and to mate. Fleas most often bite people on the legs or ankles. While the adult flea can live several months without food, the female must have a blood meal before she will produce eggs. Adult fleas live for a year or longer. When pets are available, flea infestations often go unnoticed. If the pet dies or is temporarily moved, however, the hungry fleas attack humans. When the flea inserts its mouthparts into the human skin in search of blood, it passes saliva down through the mouthparts and into the wound. The saliva contains an anticoagulant to keep the blood from clotting while the flea is feeding.

Flea Allergy

The flea saliva also 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 likely to be effected 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.

Generally, the flea bite causes a swelling of the tissue and an itching sensation after the flea leaves. A typical flea bite has a small, central red spot surrounded by a red halo and a little swelling.

Control Methods

Inspection

Inspection of a home or building will principally involve finding 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 favourite places and move among them throughout the day.

Where they habitually stop and rest, flea eggs and dried blood accumulates.
Kennels and dog houses are obvious places where fleas buildup but there are other places pets prefer to sleep or rest at certain times of the day. Examples are under particular bushes, porches, or in crawl spaces.

Outdoor flea infestations rely on dependable hosts and warm humid climatic conditions. Flea larvae require moisture because they easily dry out and die.

Reinfestation

Some species of urban wildlife harbour cat flea infestations(raccoons, squirrels). When urban neighbourhoods mature, their habitat for wildlife increases. 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 cannot get to these animals! This behaviour 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 harbourage 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. If vacuuming is augmented by use of growth regulators, better success can be predicted. The steam cleaning of carpets can also be helpful because the process kills adult and larval fleas. This, in conjunction with the vacuuming, should go a long way to eliminating the problem.

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 outbuildings.

Chemical Control

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 cleaning 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.

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's) have proven very effective in flea control. Growth regulators interfere with or replace natural hormones essential for the flea larvae to change into pupae. IGR's have long residual times and leave a good margin of safety for humans. Since IGR's do not affect the pupa or adults, fleas that have reached those stages complete their development. The "pre-adult" flea, 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 (eg. microencapsulated pesticides, emulsifiable concentrates, dusts, and space sprays) have varied residual periods. The sprays should be applied as even, fine overlap-ping fan sprays under low pressure. Over-wetting 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.

Preventive treatments: 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 IGR's 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.

Outside: Where pet re-infestation 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 best 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 micro-encapsulated 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 conditions. Dusts where they can be applied are often more effective. Take care not to over-apply dusts. Dusting burrows or the protected nesting areas of re-infesting wild animals can be very effective.

Ultrasonic devices: Cat fleas have **NOT** been shown to react to a broad spectrum of ultrasound.
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 control applicators 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 re-treatment should be scheduled before a rebounding population cancels out all of the previous work and co-operative effort.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. What is the secret to flea population management?
2. Are cats the only host available to a cat flea?
3. Does the female flea require a blood meal in order to produce eggs?
4. List the 4 stages in a flea's life cycle.
5. Describe the appearance of a typical flea bite.
6. Is vacuuming an effective way to control fleas?
7. How do insect growth regulators (IGRs) control fleas?

Chapter

9

Domestic Non-Biting Flies

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. There are only a few species that fall within the category of domestic flies. This group breeds in urban areas and is commonly associated with peoples activities. The immature stages develop in moist, decomposing organic matter, and are associated with the solid wastes created by man. It is for this reason they can transmit disease causing organisms from such filth to food.

Learning Objectives

Completing this chapter will help you to:

- Be familiar with common species of domestic flies.
- Understand pest management activities to control domestic flies

Domestic Flies

Flies develop by complete metamorphosis. The female lays very small white eggs, usually about one millimetre in length. These are deposited in or near damp locations since they are susceptible to drying. They will usually hatch within a day, and the larvae will live in moist organic matter until ready to pupate. The cast pupal cases are clues to the breeding place. It is usually necessary to look at the adult for identification characteristics, since there are very few clues available for identification based on the larvae or pupa. When the fly emerges from the pupal case, it is full size. It emerges as an adult and will not increase in size. For a short time after emergence, it is unable to fly and is referred to as a "crawler". Most domestic flies have similar life cycles. The

developmental period is relatively short when compared with that of other insects. This coupled with the females' ability to lay thousands of eggs give these pests tremendous reproductive capabilities.

House Flies All dull grey flies found inside or even near structures will likely be called house flies. 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 0.6 cm (1/4 inch) long. They have a dull grey thorax with dark stripes and a dull abdomen with yellow sides.

Flesh flies (the family Sarcophagidae) live on meat scraps, dead animals, and dog excrement. They are more than 0.6 cm (1/4 inch) long. They have a dull, grey thorax with three distinct dark stripes and a grey checkerboard abdomen.Blow flies (the family Calliphoridac) are about 0.6 cm (1/4inch) 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 0.6 cm (1/4 inch) long. Its thorax is covered with grey or yellowish hairs; it has nostripes. Its abdomen is dark grey with light patches.

Inspection

When any of these flies become problems inside, their breeding site and 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 composted will support infestations.

House flies infest most garbage, manure (horse, cattle, poultry, pet) and filth accumulations. 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. The blow flies are scavengers and live in manure, dead birds, and rodents in wall voids and chimneys. One blow fly, the cluster fly, parasitizes earthworms. It is very important to look for fly sources in buildings that are infested. Garbage collection areas are the main area of concern. Proper sanitation methods must be adopted. 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.

The professional applicator during any pest management inspection must evaluate garbage disposal. Garbage that is left in the building or on loading docks is an attractant. Garbage should be removed from the premises twice a week. In favourable weather, house fly larvae mature in 6-10 days and blow files 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. The professional applicator must emphasize sanitation to the client. If sanitation cannot be improved, other methods of control will not be effective. It is important to conduct the following:

- Remove breeding materials such as garbage and manure.
- Clean garbage cans and dumpsters regularly.
- 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 closes.
- Replace white security lights inside and outside with yellow lights.

Pesticide Applications

- 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. Monitor these traps to see what types of flies are being caught.
- Do not place ultraviolet light traps where they will attract insects from outside; do not put them in competition with other lights such as those from vending machines.
- 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 non-residual pesticides can be used if an adult infestation must be quickly reduced outside.

The professional applicator must conduct a follow-up inspection to ensure sanitation and exclusion methods are being properly maintained. Observe client and worker habits that run counter to the pest management program (sanitation, habitat alteration, and so forth).

Attic Flies, Cluster Flies

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 harbourage, 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 and the house. This same behaviour takes place in office buildings, hospitals, and other structures.

Inspection

Frequently finding dead flies 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 labelled for fly control to surfaces where flies rest, provided those surfaces are not used by people

Small Structure Infesting Flies

Fruit Flies *(Drosophila)* and Phorid Flies (*Phoridae)*

These small flies (from two different fly families) often are mistaken for each other. They are about 0.3 cm (1/8 inch) 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

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 odour 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 material. 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 fore margin of the wing near the attachment to the thorax. These veins do not extend to wing tip, and other veins are weak or nearly invisible. Phorids run in short jerks.

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 are about 0.3 cm (1/8 inch) long. Their dark colour 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 sink, commodes, and floor drains dry out, large numbers can enter dwellings from the sewer.
- Drain traps should be cleaned mechanically 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. Overtime, 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 neighbourhoods. The filter bed should be cleaned by reverse or back flushing.

It is important to understand that domestic 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, and homes. They are annoying indicators of sanitation, structural, and cultural problems.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Describe how the treatments for fruit flies and phorid flies are different.

2. What is one outstanding characteristic of flies ?

3. Can domestic flies carry disease ?

Chapter

10

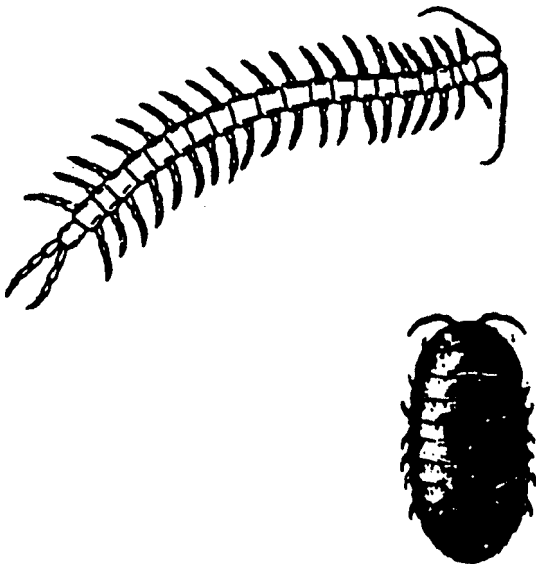
Occasional Invaders

Occasional invaders do not regularly occur inside buildings. However, when they do appear in a building, they are easily recognized and are disliked by many people.

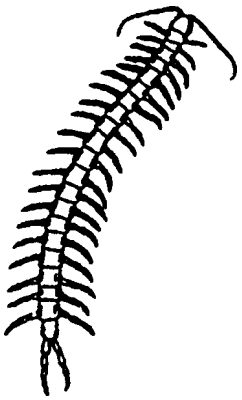
Learning Objectives

Completing this chapter will help you to:

- Know common occasional invaders.
- Be familiar with control methods for occasional invaders.



Centipedes *(Class Chilopoda)*

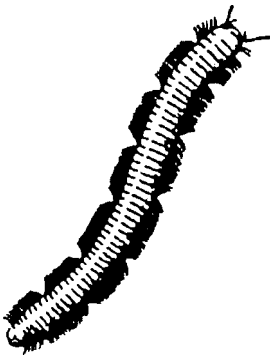


Centipedes are sometimes combined with millipedes in the large group Myriopoda. Centipedes are many-segmented arthropods with one pair of legs attached to each segment and somewhat long antennae. Except for one group, centipedes live outside under stones and logs. The centipede that lives inside is known as the house centipede, *Scutigera coleoptrara.*

Adults are over 2 cm (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 with an insecticide; 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. They feed on damp and decaying wood and vegetable matter. Millipedes migrate in dry weather (they can migrate in wet weather as well or if their food supply is lacking) 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.

Control Methods

Habitat Alteration

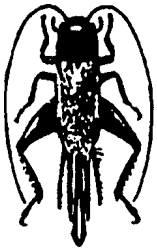
- Remove leaf litter and compost near house foundations.
- Caulk around door and window facings.
- Weatherstrip doors and ground level windows.
- Remove any food sources.

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 (*Order Orthoptera Family Gryllidae)*



Field Crickets ***(Acheta assimilis)***

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 harbourage and food with grasshoppers.
The most commonly-seen crickets are field crickets; adults are very dark and about 2 cm (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 append-age 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 buildup 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.

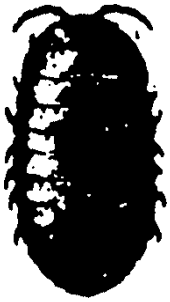
Habitat Alteration

- Caulk, tighten, and weatherstrip basement and ground floor doors and windows to keep crickets out of houses.
- Thin plantings next to buildings 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 placesfor cave crickets in crawl spaces and garages.

Pesticide Application

- Direct pesticide spray applications in cracks near 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 labelled 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 *(Order Isopoda)*

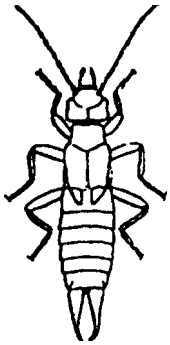


These small, oval land crustaceans, protected by objects on the ground, feed on decaying vegetable matter and fungi. They prefer damp areas. They have been known to clip outside potted plant roots, but very little damage is expected of them. Heavy infestations outside encourages movement that causes individuals to find their way inside. Their generic names, Porcellio and Armadillidum, seem to distinguish these small oval arthropods.

Habitat Alteration

- 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 green-houses. 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 harbour together.

The European Earwig
(Forficula auricularia)

This dark brown insect grows to be almost 2 cm (one inch) long. 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 burrows in soil, mulch, rubbish, and grass thatch. The striped earwig is about 2 cm (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 odour when crushed.

Control Methods

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 harbourage 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 bank of low mowed grass on which residual pesticidal sprays or granules can be applied where ear-wig 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 labelled for this use
- Dust in dry basement areas to kill earwigs there.

Clover Mite *(Bryobia praetiosa)*

This fast-moving, harmless mite has a body less than 0.2 cm(1/16 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). 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 20ºC (69ºF) 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 to high. Both egg and mite development and activity suspend when temperatures exceed 24 ºC (75ºF) or fall below 7 ºC (45ºF) 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 seems to be highest and most invasion 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 contributes to the mites' well being; 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.

Control Methods

Habitat Alteration

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 6 m (20-foot) band to decrease grass protection and temperature insulation.

- Caulk building cracks and the spaces where windows 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 labelled 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 else-where. Place pesticides near the building being invaded. Treat under sheathing, where possible, to kill mites that have accumulated there.

Pesticide Application - 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 pressurize canned pesticides, labelled for mite control, are effective.

Follow-up

Monitor lawns in new areas or subdivisions with actual or potentially high clover mite populations.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. What is one distinguishing feature between centipedes and millipedes?

2. When do crickets tend to move into structures?

3. Are earwigs active during the day?

4. When are clover mites most likely to invade an area?

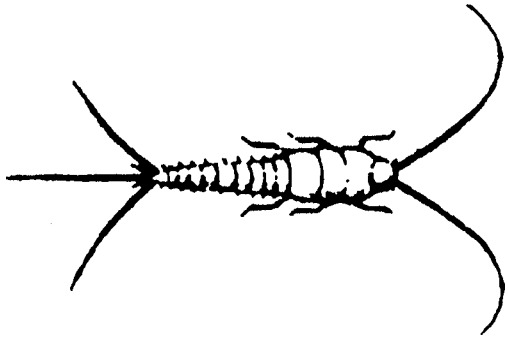
Chapter

11

Paper Pests

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 wall paper was the usual wall covering and when coal furnaces had glued, taped, insulated pipes -hence they are commonly referred to as "paper pests" .

Silverfish and Firebrats belong to the insect order *Thysanura.* 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 antennae 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. Psocids, which are not bristletails, are also discussed in this chapter.

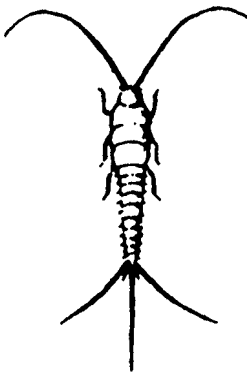


Learning Objectives

Completing this chapter will help you to:

- Be familiar with common paper pests.
- Understand pest management procedures for the control of paper pests.

Silverfish *(Lepisma saccharina)*



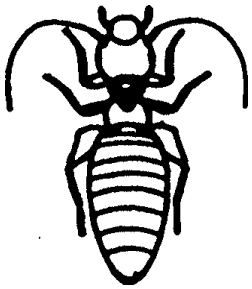
The silverfish is about 1 cm (1/2 inch) long when full grown and is covered by a sheen of silvery scales. It prefers temperatures between 21ºC to 27ºC, and requires high humidity. Adults can live from two to three years. They feed on starchy substances like flour, starch, glue, paste, and starch sizing on textiles but can also digest cellulose fibers Silverfish buildup 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 faecal 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.

Firebrats *(Thermobia domestica)*

Firebrats are not silvery but are mottled dark-grey and dull yellow. Their cosmopolitan distribution, size, shape, and appendages are like silverfish, but firebrats prefer decidedly higher temperatures and surroundings warmed to 32ºC 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.

Psocids



Psocids are tiny, pale grey or yellowish - white, wingless, soft bodied insects rarely more than 0.2 cm (1/16 inch) long. They feed primarily on mold that grows on decomposing starchy materials. Psocids are sometimes called "booklice" because they are found in greater numbers on books and papers sized with starch and stored in damp situations. Psocids require a minimal relative humidity of at least 60 per-cent.

This level accomplishes two purposes: the moisture keeps the Psocids from drying out, and it promotes the mold and 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.

Control Methods

Inspection

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, flour paste, and stored textiles especially those that are starched or sized. Inspect areas with high humidity and high temperatures.

Habitat Alteration

It is important to eliminate areas of high humidity and temperatures. Ventilate closed rooms, attics, and crawl spaces. You may also use dehumidifiers to reduce the humidity. Eliminate stored materials that may harbour an infestation. Dispose of infested storage boxes and relocate stored materials in dry spaces after inspection of materials. C lean and caulk cracks and crevices where lint accumulates and allows these insects to feed and breed. It may be helpful to use a household cleaning agent to reduce the mold that feeds Psocids.

Chemical Control

Use crack and crevice applications of registered pesticides inareas of infestation to kill newly hatched bristletails and psocids. Dust may be useful in both spot applications and crack and crevice treatments.

As a professional applicator, it is your responsibility to educate the client regarding the pest's need for starch based foods, humid conditions, and the firebrats attraction for high temperatures.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Name three common paper pests. Describe them.

2. Why are silverfish, firebrats and psocids referred to as "paper pests"?

3. Which prefers to live in higher temperatures - silverfish or firebrats?

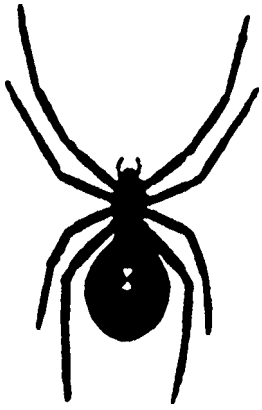
Chapter

12

Spiders

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, pest control applicators are frequently called upon to control these pests.

Spiders 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.



Learning Objectives

Completing this chapter will help you to:

- Be able to describe the life cycles and habitats of common species of spiders.
- Be familiar with the characteristics of harmful spiders.
- Understand pest management procedures for spiders.

Spiders

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 leg like mouthparts help hold their paralysed 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 append-ages 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 silkretreats such as tubes and funnels, they make irregular cobwebs as well as the evenly spaced, spiralled 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 - the Black Widow and the Brown Recluse. Pest Control Applicators should have an awareness of these spiders.
Female Black Widows have large, round shiny black abdo- **Black Widow**
mens usually decorated with two touching red triangles on **Latrodectus mactans**

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 1 cm (1/2 inch) or larger, shiny black spider is easily recognized. 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 their tangled webs in dark, quiet areas. Mature females are so large they can hardly crawl. Pest control applicators are rarely called to control Black Widow spiders but applicators can 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, piles of firewood, under bricks or stones. Move cautiously when treating any potential spider harbourage.

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 will set in. Death seldom results from Black Widow bites in healthy adults; children and the elderly however, are vulnerable. Bite victims should receive medical treatment as soon as possible.

Control Methods

Habitat Alteration

Eliminate harbourage sites carefully. Pesticide Applications

Pesticides must come directly in contact with the spiders since they do not leave their webs or wander after they have become established in the summer.
A biological control method involving Mud Dauber wasps can be utilized. The wasps paralyze the spiders and store them in their mud cells for their larvae to devour.

Brown Recluse Spider (*Loxosceles reclusa)*

Loxosceles reclusa is a dusky-tan or brown spider that 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 brown 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 in-door infestations.

Recluse spiders tend to stay in areas where there is no activity, such as unused rooms. This spider seldom bites. The bites, when they occur, are sharp but not initially painful like those of the Black Widow. A blister is quickly raised, broken and surrounded by a red welt shortly after a

bite. The depressed centre of the bite turns dark within one day. Death seldom occurs from a Recluse spider bite.
The spider is delicate and after biting, it can often be found lying where is was slapped by the victim. The spider should be killed and taken to a physician, along with the victim.

Inspections
Recluse spiders should be sought near places where bites occur. Look along walls in unused rooms, under and behind furniture, in the far reaches of storerooms, under stairs, in unused closets, and in hanging clothing that has not been worn recently.

Concentrate on areas in homes or buildings that are not often subject to traffic. Outdoors, these spiders may be found in cracks between the soil and foundations, door stoops and in window wells.

Habitat Alteration

Recommend to your clients careful mopping or dusting of seldom used rooms. Inspect clothing that hasn't been worn recently and store the clothing in plastic bags. In the evening, reinspect areas that were disturbed by mopping or dusting. Kill any moving spiders.

Pesticide Application

Residual pesticides, labelled for spiders, should be used carefully to control the Brown Recluse spider. Apply the pesticide in all cracks and crevices, especially in spaces where there is little activity. Spot treatments usually aren't as effective as crack and crevice treatments as spiders touch spot residues only with hairs at the tips of their legs.

The remainder of species of spiders detailed in this chapter may or may not bite. However, if they do bite, their bites are not considered fatal.

Yellow House Spider *(Chirocanthiummildei)*

These spiders are about 0.6 cm (1/4 inch) long with legs and cephalothorax darker than the abdomen. It has been re-ported as being yellow, white or greenish.

In late summer or early fall, Yellow House spiders migrate into structures and automobiles. At this time, they have no treached 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 (i.e. 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. 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.

Control Methods

Inspection
Inspect rooms, particularly bedrooms of suspected Yellow House bite victims. Inspect obvious webbing sites in the fall.

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 areas.

Look for webs inside jets and burner trains of gas appliances that are inactive during the summer-winter trans-action 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 spiders.

Keep grass low next to building foundations to discourage wandering spiders.

Pesticide Application

Where biting is a problem, apply a residual pesticide labelled for spiders in cracks and crevices, including closets and furniture joints.

The Aggressive House Spider *(Tegenaria agrestis)*

This common funnel-weaving spider's body is about 1 cm (1/2 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 and other bites that result in ulcerating lesions.

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.

Orb Weaving Spiders Web Weaving Spiders
Usually only the large, conspicuous orange and yellow, or black and yellow, species of orb weaving spiders are noticed in late summer when they build webs that extend three metres (one foot) or so across on porches or small trees and shrubs. These large flat webs have many straight strands radiating out from the centre and are connected with spiral thread winding around and around from the middle out to the perimeter. The spiders, often with bodies 2.5 cm (one inch) long and very long legs, sit in the centre of the web waiting for flying insects to be trapped. The large orb weavers are not aggressive toward people; if the client's fear is great, the webs can be knocked down.

Cobweb Weaving 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 cob-web spiders and the Black Widow is one of them. Most are smaller than the Black Widow. They have the same type of globular abdomen, but it is always dull in colour 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 discolour 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 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 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.

Wolf Spiders Wandering Spiders

The hairy 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 1 cm (1/2 inch) in length. They have husky cephalothoraxes and are brightly coloured, 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 coloured 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 change their colour to more closely align with the flower's colour. 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 how they got inside.
- Tighten under door and around window screens.
- Caulk door and window frames and all wall penetrations.
- Remove vegetation and litter from the foundation, door-ways, 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 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 applicator must have clear access to all spider habitats. Unless efforts are made to exclude spiders (e.g., tighten gasps around entrances, and observe material being brought into the facility), spiders will reenter.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. List identifying features of a spider.
2. Describe the process of "ballooning"
3. Name two spiders which are harmful to humans.
4. Describe a spider bite.
5. How did the Aggressive House spider get its name?
6. What spider's bite resembles the bite from a Brown Recluse spider?
7. Are large Orb Weaving spiders aggressive towards people?
8. Why are cobweb spiders a problem when found inside a building?
9. What spiders are typically brought into buildings on cut flowers?

Chapter

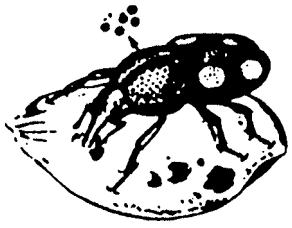
13

Stored Product Pests

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 (eg., candy, pet food, baking mixes).
- Food serving establishments, where it is prepared for public consumption.
- Retail food stores, where it is sold.
- Pantries and cupboards, where it is held for use.

The most commonly attacked products are cereal, grain , spices and nuts. Less commonly attacked are dried fruit, 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 pro-vide the greatest potential for infestation and reinfestation.



Learning Objectives

Completing this chapter will help you to:

- Know when insects are pests of stored products.
- Be able to describe common stored product pests
- Be familiar with ways to control stored product pests.

Control and Management

Inspection

In large facilities, a pest control applicator 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 flash-lights.
- 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.
- Work safely. Use hard hats and be careful of heat machines,and electrical hazards.

Habitat Alteration

- Institute a good ongoing cleaning program. Pesticides used 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.
- 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 colour)
- 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 control migrating in-sects.
Install insect electrocuters properly to attract flying in-sects.
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)*

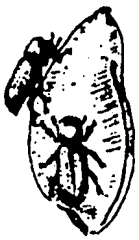
These two similar snout beetles are found in stored wholegrain. Adult beetles have snouts with jaws (mandibles) at the tip. W ith these jaws, females chew holes in the grain and deposit eggs. Larvae devour the inside of the seeds, pupate, and later, emerge to renew the cycle. Rice weevils can fly. Granary 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 cm (1 / 2 inch), is larger than the common golden-coloured clothes moth. With wings folded it is more than 0.6 cm (1/4 inch) long. The Angoumois Grain moth is most commonly found in whole corn. Like the weevil, it is more often a problem ingrain 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 *(Rhyzoperthe dominica)*



A small cylindrical brown beetle about 0.3 cm (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 Bastrichids, 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 0.3 cm (1/8 inch) to less than 0.6 cm(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 0.3 cm (1/ 8 inch) holes. The pest can be a problem in restaurants and homes. Infested and potentially-infested legumes seeds should be discarded. 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).

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 colourful moth. Sitting on a wall, it is 0.8 cm (1/3 inch) long (somewhat longer with wings folded backward). The head and thorax is brown, the basal half of the wings are grey, and the last half coppery with dark bands. These moths can fly short distances in-doors. Active flight for several days wears off most of the coloured scales, but their grey band and coppery scales can be seen using a hand lens.

Larvae, or caterpillars, grow to be about 1 cm (1/2 inch) long, cream coloured (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 starts with small 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 population grows, larvae may wander outside the pack-age (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 meals 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 tha tfor the Saw Toothed Grain Beetle. Fogging is usually required in order to eliminate these beetles.

Saw Toothed Grain Beetle *(Oryzaephilus surinamensis)*

The Saw-toothed grain beetle is a tiny, slender, dark-brown beetle that measures a little under 0.3 cm (1/8 inch) long. With a good hand lens, a pest control 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 harbourage alteration is indicated. Older products will produce large populations simply because more generations develop over time. Saw-toothed 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.

In the same family as Carpet, Hide, and Larder beetles (see Fabric Pests, Chapter 7), Trogoderma 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; it has been known to build-up in large infestations.

Cabinet or Warehouse Beetles (*Trogoderma species*)

Trogoderma adult beetles range from 0.2 cm (1/16 inch) to about 0.6 cm (1/4 inch) in length. They are about half as wide as long, which gives them an oval appearance. Their base colour is black with three reddish-brown, golden, or grey 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 ware-houses, storage rooms and homes. These beetles commonly infest cereal, spices, rodent bait, dry dog food, wheat germand other processed cereal products with a high-protein content.

Control Methods

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.

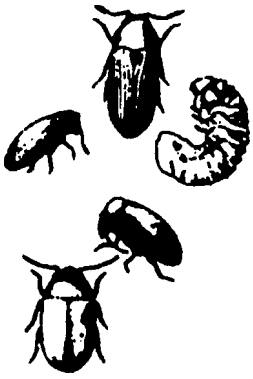
Pesticide Application

Limit use of pesticides registered for food areas to applications 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*)

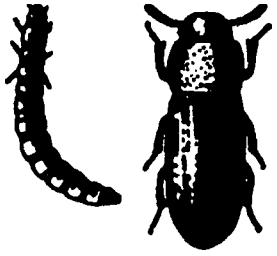


These beetles are similar in appearance; while related to some wood borers or Powderpost beetles, their habits are quite different. Adult Cigarette and Drugstore beetles are oval, about 0.3 cm (1/8 inch) long and reddish-brown in colour; they can fly. The Cigarette beetles is covered with tiny hairs 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 pyrethrum dusts and dried flowers (through the glue that attaches the flowers head to wire stems). In homes, spices are favourite 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 0.3 cm (1 / 8 inch) long, reddish-brown in colour, 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.
- Recommended that stored products be rotated, bought in smaller quantities, and older packages discarded if use is not planned.
- Pesticide application is normally required.
- 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 0.3 cm (1/8 inch) long to nearly 0.6 cm (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 grub like. 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 housefly manure, mammal and bird nests, decaying animal and vegetable refuse and even opium cake.

Control Methods

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.

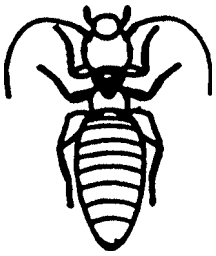
Pesticide Application
Apply spot treatments in cleaned, non-food areas.

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 and Grain Mites.

Psocids



Psocids are tiny, pale grey or yellowish-white, wingless, soft-bodied insects little more than 0.2 cm (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 Psocides, discard the starchy source of mold and dry out the storage area.

Grain Mites

The most common grain mite is call *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 colourless 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.

Self-Test Questions

Answers are located in Appendix A of this manual.

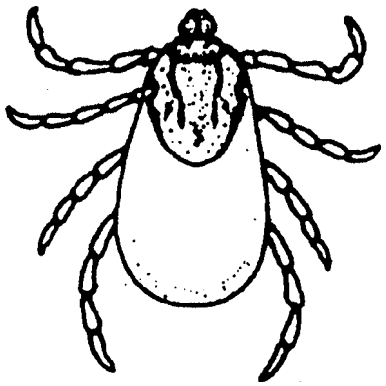
1. Name one difference between the Rice and Granary Weevils.
2. What stored product pests infest the Legume family?
3. The spice paprika is the preferred meal for what beetles?
4. Which pests are sometimes referred to as "book lice"?
5. List the commonly attacked stored products.

Chapter

14

Ticks

Ticks are members of the Arachnid order Acarina. Unlike many other members of this order, ticks can be identified without using a microscope. Ticks feed on human blood and may also transmit diseases. For this reason, the appearance of ticks tends to frighten many people. The pest control applicator must recognize this fear and deal with it in a calm fashion when faced with a tick control situation.



Learning Objectives

Completing this chapter will help you to:

- Know the difference between the two types of ticks.
- Be able to describe the life cycle of a tick.
- Be familiar with control methods for ticks.

Soft and Hard 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 ticks and hard ticks. Soft ticks feed on hosts that return periodically to a nest, shelter, cave, and so forth. Hard ticks are found on pets, cattle, wildlife, and people. Campers, hikers, and hunters are sometimes hosts for hard ticks.

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 have three hosts - one for each stage.

DEER TICKS (also called Black Legged Tick)
Ixodes scapularis

Deer tick 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 2 mm 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 areas where larvae fed the previous late summer. Their habitat is best described as woodlands: bushy, low shrub woodland edge regions and grassy areas that border woodlands. This is also deer and mouse 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.

Dog Tick *(Dermacentor variabilis*)

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 3mm 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 un-pigmented light receiving areas, at the edges of the shield.

With a favorable food supply, 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.

Tick 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 being noticed by 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 the 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.)

Ticks and Diseases

Several species of hard ticks are significant human disease vectors and are responsible for the spread and increase of lyme disease. All applicators should be familiar with lyme disease and the ticks that transmit it.

There are many reasons why ticks are successful parasites and successful at transmitting diseases. They are persistent bloodsuckers with long feeding periods that 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.

Lyme Disease

Deer ticks, carry 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.

Precautions for At-Risk Group Members

Education programs, tailored for at risk group members, should be conducted in areas where lyme disease is present. At risk group members include:

- 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, hunts and participates in outdoor recreational sports, or lives in areas of preferred tick and host habitat is the third risk group.

Information on ticks and lyme disease in Nova Scotia can be found on the environment and labour website at www.gov.ns.ca/enla/pests/athome.asp

The following precautions are recommended:

- Wear long pants tucked into socks while working or hiking in tick habitat.
- Schedule regular body inspections for ticks at noon and 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.
- For adults; Use insect repellents on clothes and skin. Do not use formulations with over 20-30 percent active ingredient on skin.
- For Children: See health Canada's website for the most recent recommendations regarding the use of insect repellants on children. www.pmra-arla.gc.ca/english/consum/insectrepellents-e.html

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. If the tick is identified as a deer tick, see a physician. 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.

Tick Pest Management

Inspection

Look in rooms where pets sleep, under the edge of rugs, under furniture, in cracks around baseboards, windows and door frames. It is important to check pets regularly for ticks. It is also important to do a personal check for ticks. Outdoors, 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.

Habitat Alteration

- 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.

Chemical Control

A considerable reduction in the numbers of both hosts and vector can be obtained by eliminating brush and weeds and frequent mowing of grass. Pesticide sprays that are registered for control of ticks may be applied to low vegetation. There are also products registered to control ticks on pets. Note: The use of flea and tick collars has produced variable results.

Commercial repellents are useful for application to a person's body and clothing when working in areas where ticks are known to be a problem. Wear long pants tucked into socks while working or hiking in tick habitat. It is important to schedule regular body inspections for ticks at noon and bedtime. Continued monitoring and record keeping is important.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Why are ticks pests?

2. Describe two types of ticks ?

3. Describe the tick's life cycle.

Chapter

15

Vertebrate Pests

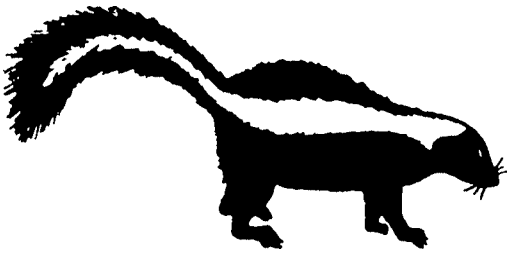
Vertebrate pests include such pests as:

- birds (see Chapter 16)
- rodents (see Chapter 17)
- skunks
- regional pests such as ground hogs, bats, wolves, raccoons, deer, and squirrels.

Vertebrates are pests when:

- they damage property, crops, feed, food or livestock
- when they carry diseases affecting man or animals.

Structural pest control operators should carefully weigh the benefits and the drawbacks of vertebrate pest control when planning pest control programs for these pests.



Learning Objectives

Completing this chapter will help you to:

- Know when vertebrates are pests.
- Understand the importance of having an awareness of the pest's behaviour and biology.
- Be familiar with ways to control vertebrate pests.

Pest Behaviour

Knowing the vertebrate's behaviour and biology is important as it helps determine the most effective control methods, the best time to implement the control and the best location for the control (e.g. - traps or poisoned baits.)

The selection of effective control methods will depend upon:

- population density
- mobility of the pest
- habitat of the pest
- preferred foods of the pest
- availability of food
- pest's wariness of man and foreign objects
- predators of the pest

The best time to implement a control will depend upon:

- availability of food
- when migration takes place
- when population numbers are lowest (just be-fore young are born).

Controls should be set in place before this time when the pests are actively moving about in search of food whether the pest hibernates. The best locations to trap, or control a vertebrate pest can depend upon finding: the den, the burrow or nest and exits, the regularly travelled routes, and the feeding areas.

Vertebrate Pest Control

Vertebrate pests may be controlled by:

- removing the pests from a feeding or breeding location
- destroying their habitat
- encouraging natural predators
- frightening away or repelling the pests
- shooting the pests
- trapping the pests
- preventing reproduction of the pests with chemical sterilants
- poisoning the pests with pesticides (including avicides and rodenticides)

The control measure chosen depends on:

- the legal status of the control measures
- the cost of these controls
- their effectiveness

Legislation for the protection of wildlife may prevent the destruction of some pests or may require special permits for their control. Shooting, trapping and the use of pesticides may be limited to specific times of the year or specific locations. Check with federal, provincial, and/or municipal authorities before using any control measure to control a vertebrate pest.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. When are vertebrates pests?

2. Name 8 methods to control vertebrate pests.

3. What are 3 factors that determine the chosen control method?

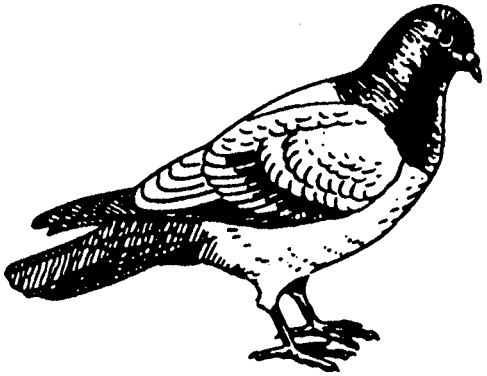
Chapter

16

Birds

To many, birds offer enjoyment and recreation while greatly enhancing the quality of life. Birds are studied, viewed, photographed, enjoyed or hunted by many people. For these reasons, birds are protected by laws, regulations and public opinion.

Birds can become pests when they create health hazards, roost in large numbers on or in buildings or structures, contaminate food or create a nuisance. Few species of birds can be classified as pests - whether birds are pests depends on time, location and activity.



Learning Objectives

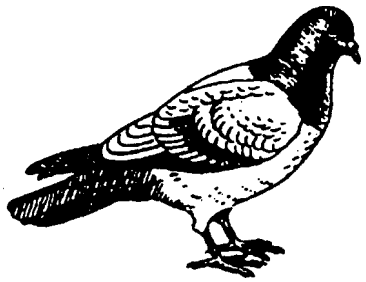
Completing this chapter will help you to:

- Know when birds are pests
- Be able to describe common bird pests
- Be familiar with ways to control birds

Common Bird Pests

There are three species of birds which commonly present problems to the pest control applicator. The three species of birds are pigeons, starlings and sparrows. You, as the applicator, must be able to identify the bird and determine an effective method for control.

Pigeons *(Columba livia)*



Pigeons are a common species of birds found in many urban areas. People derive pleasure in feeding pigeons. Pigeons are easily recognized by their "coo-oo-oo" sounds and the way their head bobs when walking. They typically have grey bodies with a white rump. However, body color can range from grey, white, tan or black. Pigeons have a black band on their tail and red feet.

Pigeons are considered a serious bird pest associated with buildings. Although they are primarily seed or grain eaters, in urban areas pigeons will feed on garbage, spilled grains, insects, food left out by outdoor restaurants, and food intentionally left out by bird lovers who feed pigeons bread, peanuts, and cookie crumbs.

Pigeons prefer to congregate together when roosting, loafing and feeding. Roosting, feeding and loafing sites are usually separate areas. Roosting sites are in areas protected from the elements and are used for nesting, congregating at night and for shelter. Loafing sites are nearby sites used by inactive birds during the day. Feeding sites may be a distance away. When pigeons are not feeding or mating, most of their time is spent on cooing, preening and sun bathing. Roosting

sites are normally flat, smooth surfaces where pigeons can rest and feed. Pigeons prefer open feeding areas so it is common to observe pigeons feeding on top of tall buildings. Common roosting and loafing sites include building roofs and ledges, towers, monuments, bridges and signs. Common feeding sites are such areas as parks, squares, food loading docks, garbage areas, railroad sidings, food plants and wherever people eat outdoors.

Male pigeons reach sexual maturity at 3 to 4 months of age; females at 6 months. Pigeons usually mate for life unless a mate dies. If a mate dies, the surviving mate will re-mate within a few days. Once pigeons have selected a mate and mating has begun, they start construction of a nest. Nests are constructed by both the male and female but the male selects the nest site. Nests are usually located in protected areas in or on buildings or structures.

One or two creamy white eggs are laid 8-12 days after mating. The eggs are incubated by both parents for approximately 18 days. Young pigeons commence feeding on solid food 10 days after birth and by the time they are a month old, the young are full grown. Life span of a pigeon is extremely variable. The life spans can range from 3 to 15 years.

Starlings (*Sturnus vulgaris*)

Starlings are robin-sized birds that sport purplish-black and green coloured feathers during the summer months. Starlings have relatively short tails and appear chunky and humpbacked. In urban areas, starlings can cause problems when they build nests in or on buildings or other structures. Starlings roost in large numbers and their droppings can lead to many problems.

Starlings average about two broods per year with four to seven young per brood. Both parents are involved with the building of a nest and incubating the eggs. Young starlings leave the nest when they are about three weeks old. Starlings are social birds and during the evenings, they will congregate on high perches such as power lines. As cold weather approaches, starlings begin their migration south.

Sparrows *(Passer domesticus)*

Sparrows tend to prefer living in close approximation to people. The sparrow is a brown chunky bird. The male has a distinctive black bib with the female and young birds having a grey breast.

Sparrows average three broods per season with four to seven eggs per brood. Young sparrows typically leave the nest after two weeks.

The male sparrow selects the nesting site. The nests have a roof and are often found in trees or shrubs, on building ledges, in signs, on light fixtures and under bridges. Nests often plug rain gutters.

Sparrows are aggressive and social birds. They will stay in an area as long as food and nest sites are available. Sparrows are very tolerant of humans. Grain is the preferred food of a sparrow. However they will feed on fruits, seeds and garbage.

Health Hazards

Large populations of roosting birds may present risks of disease to people nearby or to the pest control applicator. The most serious health risks are from disease organisms growing in accumulations of bird droppings, feathers and debris in a roosting area. If conditions are favourable, especially if the roost has been active for some time, disease organisms can flourish in these rich nutrients. Food may be contaminated by birds but this risk is limited to food processing areas normally. When parasite-infected birds leave their roosts or nests or invade buildings, the parasites can bite or irritate people.

Some common diseases which birds could pass on to humans are summarized below.

Histoplasmosis

This systemic fungal disease (mold) is transmitted to humans by airborne spores from soil contaminated by pigeon and starling droppings (droppings from other birds and bats can also spread this disease). Infection occurs through the inhalation of the spores. The spores can be carried by the wind, particularly after a roost has been disturbed.

Most infections are mild and produce either no symptoms or a minor flu-like illness. However, the disease can lead to more serious illnesses and even death. There have been reported cases of a potentially blinding eye condition which results from infection by this spore.

Cryptococcosis

Pigeon droppings may contain a disease fungus which, if inhaled, can lead to two forms of disease. One form of the disease affects the skin of humans and creates acne-like skin eruptions or ulcers with nodules just under the skin. An-other form of the disease begins with a lung infection and spreads to other parts of the body, particularly the central nervous system. This disease can be fatal.

Ectoparasites

Pigeons, starlings and sparrows may be hosts for ectoparasites. When these birds invade buildings, so do the ectoparasites. Some of these parasites can bite and irritate inhabitants of the buildings, including humans.

Droppings, feathers, food and dead birds in roosting or loafing sites can also lead to an increase in flies, carpet beetles and other insects which may also invade the 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 carpet beetles and other dermestids, spider beetles, and mealworms.

Tools and Methods for Managing Pest Birds

Legal Considerations

With very few exceptions, all birds are protected by laws and regulations.

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; non target 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 residents, migrants, adults, 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 nontargets?
- 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 limiting is not practical. These birds will have a number of feeding and watering sites -- often far from roosting and loafing sites. Where people are feeding birds in parks or lunch areas, education can help reduce this source of food; and in most cases, 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.**

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. This method destroys the nest, eliminates ectoparasites, cleans droppings and feathers from the nest site, and harasses the roosting birds. Use high pressure sprays only where the 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 the remove nests. When the nests are within 20 feet of occupied sites, treat the immediate nest area with an insecticide/acaracide to eliminate ectoparasites.

Nests must be destroyed every two weeks during the spring and summer months until the birds move to other nest sites.

Exclusion

Attempts should be made to exclude birds from buildings. 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 and screens, eliminating large crevices, blocking openings into vents, cooling towers, and roof-top equipment with hardware cloth.

Exclusion methods also includes the use of netting, custom-designed sheet-metal or plastic covers, porcupine wire (Nixalite, for example), electrified wires, and sticky repellents to keep birds from roosting on ledges, roof edges, window sills, building signs, and other surfaces favoured 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 usually eliminates this option on large buildings that have extensive roosting sites. But covers are valid options where limited applications will keep birds off selected sites, and where aesthetics are an important consideration. The covers usually consist of sheet metal installed at a 45 degree angle to prevent the birds from landing. Sometimes plastic inserts are custom-fit into the indentations in order to block off ledges.

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 isopolybutene (the same substances used in some adhesive bandages) or 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 inch; pigeons 1/4 inch; starlings 1/8 inch; sparrows 1/16 inch. The pattern of application will depend on the site and personal preference. The caulking gun should be held at angle of 30-45 degrees.
- Apply a straight bead on ledges and roof edges, 1/2 inch from the outer edge, with another bead three inches in from the first, or they can be applied in a zig zag or "s" curve.
- For another option combine a straight line 1/2 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 on ledge and roof edges.
- Apply bulk gels with a paint roller, putty knife, or bulk caulking gun.
- Apply liquids with a roller, brush, or compressed-air sprayer to girders, rods, sign supports, and rooftops. They can also be used to treat the upper surface of branches in trees and bushes. The repellent should be 1/16 to 1/8 inch thick. Liquid application is not recommended for sites where the appearance of the sticky repellent would be undesirable.
- 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 provincial and municipal 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.

Trapping

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 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. 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 calcium cyanide but many feel it is simpler and more humane to kill the bird by breaking its neck.

Sometimes indoor roosting sites can be used as a giant trap. Pigeons often use attics, rooftop elevator houses, or empty floors of poorly maintained structures as nest and roost sites. By screening all but one or two entrances 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.

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 usually more effective when placed on the ground. Nest box traps attract a sparrow with a potential nest site. Once inside, the bird trips the mechanism, dumping the bird into a collecting bag. This trap also works against starlings, as does the center drop trap. The birds, attracted by food, drop through an opening and cannot escape. However, starlings are not usually good candidates for trapping programs.

Lethal Alternatives

AVITROL

AVITROL is a poison bait with flock-alarming properties used to control many kinds of birds. There are different AVITROL baits for each pest bird species: whole corn for pigeons, smaller grains for sparrows and other birds. Within 15 minutes of eating a toxic dose of AVITROL, birds flutter erratically and go into convulsions. They may fly away from the baiting site, they may fly into windows, or they may "dive bomb" into the ground.

Affected birds convulse for an hour or more. Most die within a few hours, but some last for as long as 15 hours. 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.

Pre-baiting

At most sites, birds must be trained to feed on bait. While baits are different for each bird, the general process is the same. Here is the procedure for pigeons:

- Place untreated whole corn in numerous piles on flat rooftops, ledges, and similar sites in the treatment area.
- Place many small piles (1/4 pound each) 20 feet apart.
- Place about twenty 1/4-pound piles of bait on a flat 5,000 square foot roof.

The goal in prebaiting is to get at least 40 percent of the birds to accept the untreated bait. Expect the effort to take from three days to three weeks. When possible, remove all untreated prebait corn before switching over to AVITROL.

Cardinals, blue jays, doves and certain other seed-eating birds also eat whole corn. Do not use AVITROL where nontarget birds fed on the prebait unless the site is one of many. When this happens, continue baiting the isolated site with untreated corn. In this way, nontargets will be

kept away from your AVITROL baiting sites.

AVITROL Whole Corn is not used alone, it is mixed with untreated corn in ratios ranging from 1 part AVITROL and 29 parts untreated bait, up to the maximum ratio of 1 to 9. The higher the proportion of AVITROL, the better the chance to move the flock quickly. However, this also increases the number and visibility of dead or convulsing birds.

With good bait acceptance, a ratio of 1:29 (treated:untreated) will generally kill about five percent of the flock, a 1:9 blend will generally kill 15 percent or more. Use the ratio that best fits the job. Keep in mind that you're trying to relocate the flock, not kill every pigeon.

The amount of AVITROL bait set out should be about half the total prebait used each day. For example, if eight pounds of prebait have been set out each day for a flock of about 100 birds, four pounds of the AVITROL blended bait should be sent out when switched over.

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. 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 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 this bird.

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 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 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 so usually die with 20-30 feet of the perch, if it was set in a roosting site. There is 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.

Risks to Nontargets

Most lethal tactics in bird control pose some risk to nontarget birds, as well as other animals. Nontargets are protected by various federal, state, and local regulations, as well as by public opinion. Care must be taken to minimize the threat to nontargets or to use tactics that pose the least risk.

1. First, identify the nontargets in the area.

2. Second, use tactics that are least at risk.

3. Third, modify tactics to minimize risk.

4. Forth, monitor operations to be sure that no nontargets are being adversely affected.

Public Relations

People often react more negatively to one dying bird than to accumulated pigeon droppings on sidewalks or potential risks of parasites and disease from bird roosts. Pigeons and sparrows are 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, and keep wet.
- 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 should be permissible through standard trash pick-up.)
- Wash up or shower.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Name three species of birds which are considered common pests

2. Why are birds pests (list and describe three situations)

3. Describe 6 control methods for birds

4. 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

5. Pigeons usually make a nest of small twigs, straw, or debris on buildings and other structures. True or False

6. 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

Chapter

17

Rodents

Most people, at one time or another have seen a rodent scurrying around a building, more often than not, that rodent was a mouse. However, both rats and mice are common rodents and both can present many problems to the public.

Rodents are pests when they compete for food, contaminate food, or cause damage to buildings. Rodents are also possible transmitters of disease and for these reasons, many people require rodent populations to be controlled.

Learning Objectives

Completing this chapter will help you to:

- Know when rodents are pests.
- Be able to distinguish between rats and mice.
- Understand the importance of having an awareness of rodents behaviour and biology.
- Be familiar with ways to control rodents.

Common Rodent Pests

There are many species of rodents. However the three species which commonly present problems for the pest control applicator are the Norway rat *(Rattus norvegicus),* the roof rat *(Rattus rattus)* and the house mouse *(Mus* musculus). Refer to the field identification guide for a summary of distinguishing characteristics between the Norway rat, the roof rat and the house mouse.

The Norway rat (also called the brown rat, house rat, sewer rat, and wharf rat) and the roof rat (also called the black rat, ship rat, and Alexandrine rat) look very much alike but there are noticeable differences. In general:

- A Norway rat looks sturdier than the roof rat; the roof rat is sleeker.
- A mature Norway rat is 2 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 tail combined; a roof rat's tail is longer than its head and tail.
- 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.
- A Norway rat's snout is blunt; the roof rat's snout is pointed.

Habits of Rats

The pest control applicator must have a thorough under-standing of rats in order to carry out an effective control program.

A mature female rat can give birth to about 20 young in a year (4 to 6 at a time). However, the average life span of a rat is less than 1 year, with females having the longest life expectancy.

The young are born in a nest and by 3 weeks, they are imitating their mother. Young rats learn from their mother; this innate ability can make control difficult for the pest control applicator. At three months, the young are independent and able to mate.

Social Behaviour

Rats are social animals and live in colonies with well defined territories. Each colony has a complex social hierarchy. Ratsare aggressive with females being very protective of their young and their nest.

Senses of Rats

Rats have poor vision. They are nearly colour blind and react to shapes and movement rather than identifying objects by sight. Their eyes are adapted to dim light.

Rats have an excellent sense of smell and they use their long whiskers and guard hairs as guides through their numerous runways. They have a keen sense of hearing as well as taste. 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 in their territory. Until they become familiar with an object, they will avoid it; even then rats use extreme caution. When using poison baits, if the poison only succeeds in making the rat ill, they will avoid similar baits in the future.

Food and Water

Norway rats prefer protein-based foods such as meat, fish, insects, pet food, nuts and grain. Household garbage is ideal food for the Norway rat. Roof rats prefer plant materials such as fruits, nuts, seeds, berries, vegetables and tree bark. They occasionally feed on garbage and meats. If their preferred foods are not available, both rat species will feed on any food that is available. Rats tend to hoard food. Water is required by rats on a daily basis.

Range

Rats usually begin foraging just after dark. Most of their foodgathering occurs between dusk and midnight but they can exhibit active moments anytime, night or day. Rats commonly travel 30 to 45 m (100 to 150 feet) from their nest looking for food and water.

Nests

Outdoors, Norway rats tend to nest in burrows dug in the ground. The burrows are shallow and usually short with a central nest. There are extra exits used for emergency es-capes. The nest openings are hidden under grass, boards or are plugged with dirt. Indoors, Norway rats build their nestsinside walls, in spaces between floors and ceilings, underneath equipment, between and under pallets, and in crawl spaces, storage rooms or any other cluttered area that is typically unoccupied. Norway rats prefer to build nests in the lower floors of a building.

Roof rats commonly nest above ground in trees, in piles of wood or debris, vine-covered fences and stacked lumber. Indoors, roof rats prefer to nest in the upper floors of a building in the attic and in attic or ceiling voids near the roof line. At times, they will nest in lower levels of a building, as do Norway rats.

Both species also nest in sewers and storm drains. They may have more than one nest also.

Inspection

Rats provide many signs that they are infesting an area. Aninspection will identify if an area is infested, and will identify where the rats are feeding and nesting, their pat-terns of movement, and the size of the population. By carrying out an inspection of an area, the pest control applicator will be better able to decide what control methods touse, and where and when to use them.

Use a flashlight just after dark to determine signs of infestations, old or new. As well, listen for sounds such as clawing or gnawing which will indicate the presence of rats. Other signs to look for in an inspection are listed below.

Droppings

A single rat may produce 50 droppings daily. Roof rat droppings are normally smaller than those of the Norway rat. The highest number of droppings will be found in areas where rats are feeding or nesting.

Determine if a rat population is active by sweeping up theold droppings and reinspecting for new droppings a week later. The appearance of the droppings will also help in determining if the rats are currently active. Fresh rat drop-pings are black or nearly black, they may glisten and look wet and they have the consistency of putty. Week old drop-pings become dry, hard and appear dull. After a few weeks, droppings become grey, dusty and crumble easily.

Urine

Both wet and dry urine stains will glow blue-white under anultraviolet light (blacklight).

Grease Marks

Oil and dirt rub off a rat's coat as it scrambles along. The grease marks build up in frequented runways and are noticeable. Look along wall/floor junctions, on pipes and ceiling joists or at regularly used openings for grease marks.

Runways

Rats constantly travel the same paths. Look for well-polished trails that are free of dust. Runways inside are harder to detect than those outside.

Tracks

A rat's foot print may show four or five toes. They may also leave a "tail-drag" in the middle of

their tracks. Look in dust or soft, moist soil for tracks. The use of a tracking patch in suspected runways or near grease marks is a useful tool for finding tracks. (A tracking patch consists of a light dusting powder, such as unscented talc. Don't use flour which may attract insect pests.) Note: a tracking patch is not the same as tracking powder and is not to be used in the same fashion. Tracking. powder is a rodenticide in the dust form.
Gnawing Damage

As a rat's incisor teeth grow substantially in a year, they keep their teeth worn down by working them against each other as well as gnawing on hard surfaces. Look for gnawing damage by inspecting floor joists, ceiling joists, door corners, kitchen cabinets and around pipes in floors and walls.

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.

Health Hazards

Rats are responsible for the spread of many diseases. Some times they transmit diseases directly, by contaminating food with their urine or feces. Or they can transmit disease indirectly, for example a flea first biting an infected rat, then a person. The following are some of the more important diseases associated with rats:

Plague

The "Great Plague" which killed large numbers of people in Europe is transmitted to people by the oriental rat flea.. The disease The flea bites an infected rat and then, feeding on the human, inoculates them with the bacteria that causes the disease. Although no major outbreak of plague has occurred since the 1920's, there is still a danger.

Murine Typhus Fever

This is a relatively mild disease in humans. Murine typhus is transmitted from rats to humans by a rat flea. The disease organism enters the blood stream when faeces of infected fleas are scratched into a flea-bite wound.

Rat-Bite Fever

Rats are known to bite humans. A small percentage of peoplebitten by rats can 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 tothe flu, it can be fatal. It is of particular risk to infants.

Salmonella Poisoning

Rats frequent areas where *Salmonella* bacteria thrive, such as sewers and rotting garbage. The bacteria can also thrive in arat's intestinal tract. If rat droppings end up in food preparation areas, on food, dishes or silverware, *Salmonella* food poisoning may occur.

Leptospirosis or Weil's Disease

This disease is seldom fatal to humans. The disease organ-isms 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 can get the disease from eating raw or undercooked pork infected with the nematode. Rats aid in the spread of trichinosis when pigs eat food or garbage contaminated with infested rat droppings.

Rabies

Rats have never been found to be infected with rabies in nature. There has been no evidence that rabies are transmitted from rats to humans.

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 non-target 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 four major formulations of rodenticides used to control rats: food baits, water baits, tracking powders and fumigants.

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.

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."

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.).
- Put 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.
- Put 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 1/8-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.

House Mice

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 are found throughout Canada 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. Pest control operators often 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.
Many failures in mouse control can be blamed on an applicator using rat-control techniques.

The house mouse easily adapts to life with people. Pest control applicators will find that the house mouse is the most troublesome and economically important rodent. Mice are a nuisance, can cause damage to food and buildings and have the potential to transmit disease and parasites.

The house mouse is a small, agile rodent. House mice vary in colour from light brown to dark

grey but most often are a medium brown or dusky grey, except the belly, which may be a lighter shade than their general colour, but never white. The mouse has moderately large ears. The tail is nearly hairless and about as long as the body and head combined. The feet and eyes are small.

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 and deposit about 18,000 droppings. The amount of food contaminated by the mice is estimated to be about ten times greater than what is eaten.

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.

Habits of House Mice

Under ideal conditions, the house mouse may produce as many as 10 litters (about 50 young) in a year. Environmental conditions, such as the availability and quantity of food, play a role in the frequency of pregnancies, litter size and survival.

New-born mice are quite undeveloped and are nearly hair-less. At about 3 weeks, the young start to eat solid food and take trips on their own.

Social Behaviour

Mice are primarily active at night. Movements of house mice are primarily determined by temperature, food and hiding places. Home ranges of mice tend to be the smallest when living conditions are good.

Mice tend to travel over their territory daily, investigating any changes or new objects. They are very aggressive and show no fear of new objects.

Senses of Mice

Mice have relatively poor vision and are colour blind. They rely heavily on smell, taste, touch and hearing. An important sensory factor with mice is touch. Like rats, they use their long whiskers and guard hairs to enable them to travel. Mice also have an excellent sense of balance.

Curiosity

Mice quickly detect new objects in their territory and investigate. They will immediately enter bait stations and sample a new food (although they normally only nibble the food). They will also investigate traps and glue boards. Because of this curiosity, control programs against mice are often successful early, with the opposite being true for rats.

Physical Attributes

The pest control applicator must understand what a house mouse
is capable of in order to effectively plan a control program.

- Mice are excellent jumpers.
- They can jump against a wall or flat vertical surface and use it as a spring board for added height.
- They can run up almost any vertical surface without much difficulty if the surface is rough.
- They can run along extremely thin areas such as electrical wires.
- They can travel for some distance hanging upside down.
- They are capable swimmers although they do not take to water as well as rats do and they tend not to dive below the surface.
- They can walk or run along ledges too narrow for rats.

Food and Water

House mice prefer cereals over other items although they will feed on a wide variety of food. Mice get much of their water from their food but they will drink if water is available.

Mice are nibblers and have two main feeding periods, at dusk and just before dawn.

Range

Mice are territorial and seldom travel more than 10 m (30 feet) from their nest. Their range is much smaller than the rats' range of 30 to 46 m (100 to 150 feet).

Nests

House mice may nest in any dark, sheltered location. Nests are constructed of any fibrous, shredded material such as paper, cloth, or insulation and generally look like a loosely woven ball.

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 as many failures in mice control are due to an applicator using rat-control techniques.

Inspection

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 deermice (Peromyscus sp) and meadow mice (Mircrotus 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 ultra-violet light.

Grease Marks

Like rats, mice produce greasy smears where dirt and oil from 0their fur marks pipes and beams. House mouse spotsare 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.

Gnawing Damage

Recent gnawing on wood are light in colour, turning darkerwith 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 saw-dust around baseboards, doors, basement windows and frames, and kitchen cabinets.

Visual Sightings

Mice are often active in daylight and this may not indicate ahigh population as it does with rats.

- Use a powerful flashlight or spotlight at night in ware-houses 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 atthe base of a wall, especially if mice have invaded the premises only recently.

Mouse Odours

- Smell for the characteristic musky odour 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 numbers of mice observed or food consumed is not highly reliable as a census technique with house mice. Unlike rats (which maytravel 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 5 to 10 meter intervals (20 to 30 feet) 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 sections 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 1/4-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 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 1/16-inch deep.
- Do not allow tracking powder to drift into nontarget areas.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Name three species of rodents which are common pests
2. Are rats a major carrier or rabies ?
3. What is meant by the term “Neophobia” ? Do both rats and mice exhibit neophobia ?
4. What is the range a rat will travel from it’s nest ?
5. Describe rat and mice droppings.
6. Describe the difference between tracking powder and a tracking patch.
7. What three types of rodenticides are used to control rodents?
8. List three ways in which mouse control programs differ from rat control programs.

Chapter

18

Wood Destroying Insects

Wood destroying insects infest and seriously damage wood, resulting in economic hardship for many people. These insects can infest both unseasoned and seasoned wood. However, the pest control applicator is normally concerned with infestations in seasoned wood.

Anobiid Powder-Post Beetle

Lyctid Powder-Post Beetle

Learning Objectives

Completing this chapter will help you to:

- Know when wood destroying insects are pests.
- Be able to describe common wood destroying pests.
- Be familiar with ways to control wood destroying pests.

Powderpost Beetles

The term "powderpost beetle" applies to any one of three beetles found in the super family *Bostrichidae*. The larvae of these beetles reduce wood timbers to a mass of powder-like material. The adults do not normally damage the wood - they simply use the wood for reproductive means.

Powderpost beetles infest flooring, studs and other parts of buildings, lumber, furniture, and many other wood products. Infestations in buildings are often a result of using wood that is infested. Powderpost beetles are often brought into homes in firewood. The first sign of infestation is piles of very fine sawdust and the presence of small holes in wood.

True Powderpost Beetles (Family *Lyctidae*)

Adult lyctid beetles lay their long, cylindrical eggs in the surface pores of wood. The larvae bore into the wood as soon as they hatch. Lyctid larvae are white with dark brown heads and mandibles. The front end of the body is larger than the back. These larvae can be easily identified by examining the last pair of spiracles; they are much larger than the rest.

Larvae live in and eat the wood. At time of pupation, they bore near the surface of the wood and pupate. Adults bore out through the surface, pushing out a pile of fine sawdust. The adults are flattened and reddish-brown to black in colour. They are small beetles.

False Powderpost Beetle (Family *Bostrichidae*)

This beetle, since it rarely attacks wood commonly used people, does not cause as much problems as other powderpost beetles. As well, this beetle does not reinfest wood so dam-age is limited to one generation. These beetles however can work quickly and thoroughly on wood with a high starch content.

Adult bostichid beetles bore into the wood to lay their eggs. Mature larvae are curved and wrinkled, lack hairs and have 3 pairs of short legs. As these beetles tend to be larger than other powderpost beetles, they cause larger holes in wood and produce more sawdust.

After pupation, the adults emerge and are dark brown or black in color. The adults have a cylindrical body with the exception of their thorax which is rough. The antenna has three distinct segments.

Bostichid beetles are dependent upon starch and other nutrients from the wood - they are unable to digest cellulose. Bostichids commonly infest hardwoods but have been known to infest some softwoods.

Furniture Beetles (Family *Anobiidae*)

The furniture beetle not only attacks furniture as its name applies but structural timbers as well. Anobiid beetles lay their eggs in cracks and crevices of seasoned wood. The eggs hatch into larvae and the larvae burrow into the wood. Here the larvae will live and tunnel for a year or more. When it is time to pupate, the beetles burrow towards the surface and then pupate.

The Anobiid larvae are slightly curved, wrinkled and have tiny hairs on their bodies. They have three short pairs of legs. Adults are small and vary in colour from red to blackish-brown.

Anobiids infest all seasoned woods, however their preference is the sapwoods of softwoods. Because of this, anobiids commonly infest areas that contain a high amount of pine.

Control Methods

Non-Chemical

Wood destroying beetles do not develop rapidly in wood that is dry. Therefore, one manner in which infestations could be kept at a minimum involve methods in which wood is kept dry. For example, using vapour barriers, ventilation and heat could be ways in which wood could remain dry. In many cases, effort should be made to reduce the moisture content of wood and in turn, this would be helpful in reducing the chance of infestation.

Infested wood should be removed and replaced, where this is practical. However, this is a limited method for control as removal of wood could only be done where it is economically feasible. If infested wood is removed, wood that was near the removed wood should be carefully inspected.

Chemical Control

In order for the pest control applicator to treat the problem, it is necessary first to identify the beetle responsible for the damage. The type of treatment required can be determined by keeping in mind the history and habits of the identified beetle.

If damage has been caused by true powderpost beetles, control activities will be geared towards articles made of hardwoods. Usually, this involves a complete application ofan insecticide to the entire article of wood.

If the damage has been caused by either bostrichid or anobiid beetles, unless the applicator is able to properly identify the exact species damaging the wood, control techniques be-come much more complex. Not only would these beetles attack both hard and softwoods, but the applicator must look at the severity of the infestation, possibility of re-infestation, area under attack, speed of control needed an the economic threshold for treatment.

To effectively treat wood destroying beetles, the pest control applicator must be able to chose the right insecticide for the right beetle. The insecticide chosen must interact with the insects. As the beetles are well concealed, this presents a major problem for the applicator. Products with a long residual life would be effective but the applicator needs to kill the beetles while they are in their tunnels such that minimum damage results to the wood. Residual sprays in most cases provide effective control. These sprays should be applied at low pressure, using a flat fan nozzle for thorough coverage.

For finished woods, it is recommended to use oil solutions in order to avoid damaging the wood's finish (ex. spotting.) With oil solutions, make an application to an inconspicuous area first to ensure the product will not damage the finish. With oil solutions, the oil carrier may have a solvent reaction with the finish and therefore, it is advisable to ensure nothing is placed on or no one touches the treated surface until it is dry.

In some instances, it may be necessary to resort to the use of a fumigant. Fumigants require special knowledge and handling procedures. Prior to using a fumigant in the treatment of beetles, please contact your pesticides regulatory agency at the Department of the Environment for information pertaining to the use of fumigants and any regulations governing such use.

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Which wood destroying insect attacks only hardwood?

2. Do adult wood destroying insects damage infested wood?

3. List two ways to identify infestations.

4. Which wood destroying insect prefers to infest areas where pine is the predominant wood?

5. Name one non-chemical control method used to keep infestations at a minimum.

Chapter

19

Application Equipment

The most needed and reliable tool in pest management is the ability of the structural pest control applicator to use their knowledge of pest management. The second most important tool is well-cared-for application equipment and good supplies. It is reassuring and convenient to have tools that seldom fail. Regular cleaning, calibration and the repair of equipment are musts for all structural pest control applicators.

Application equipment detailed in this chapter is in addition to the information on equipment found in the Applicator Core Training Manual. In order to have an understanding of the various types of equipment available for pesticide applications, equipment components and maintenance of equipment, refer to the Applicator Core Training Manual.

Learning Objectives

Completing this chapter will help you to:

- Learn the names and uses of various types of application equipment.
- Under stand the basic principles of operation for each type of equipment.
- Be familiar with the advantages and disadvantages of each type of application equipment.

Pesticide application techniques used for structural pest management include:

- broadcast,
- spot,
- crack and crevice,
- space,
- baits.

Broadcast application refers to the application of pesticides to broad expanses of surfaces such as walls, floors, ceilings and foundations where insects are or may be found.

Spot application refers to the limited application of pesticides to localized or specific surface where insects are likely to occur. Spots are not to be adjoining (contiguous) and in general the total area of the spots does not exceed 10 % of the surface area being treated (e.g., carpets). Pesticides which are registered for spot treatment only are not to be applied as a broadcast treatments. There is an increase in exposure potential to the applicator and bystanders during broadcast application

Crack and crevice application refers to the application of small amounts of insecticide or rodenticide directly into cracks and crevices where insects or rodents hide or through which they may enter a structure. It does not permit the treatment of surfaces.

Space treatment refers to the application of a non-residual contact insecticide as a suspension of fine droplets in air within an enclosed space.

Bait application refers to the placement of insecticide, rodenticide or avicide bait where insect, rodent or bird pests are found. Baits are available as solids, gels or liquids, and placed in crevices, voids, bait boxes, or other protected areas.

Application Equipment

Application equipment used for structural pest control includes:

- sprayers
- dusters
- ULD applicators
- foggers
- crack and crevice injectors
- baiters

Sprayers

Sprayers are used to apply water or oil based insecticides to different types of surface areas. The

liquid spray mixture is pressurized in either the tank or the hose and forced through a small orifice (nozzle) to produce a broad spectrum of droplets. This process is referred to as hydraulic pressure atomization. Droplet sizes range from 100 to 400 urn (microns or micrometres; 1 um = 1/1000 mm or 1/25000 inch) for a fine spray and 400 + urn for a coarse spray. Sprayers are used for broadcast, spot, and crack and crevice treatments.

Sprays are applied with hand-operated compressed air sprayers, hydraulic power sprayers or ready-to-use (RTU)pressurized containers

The hand-operated compressed air sprayer is the most widely used type of equipment in structural pest control. It offers adequate tank capacity, operating pressure and spray pat-terns for structural applications. It is used for broadcast, spot, and crack and crevice treatments both on the exterior and interior of structures. This type of sprayer has three major components - tank, pump unit and application wand with hose. (Refer to Figure 19-1)

Spray tanks are usually constructed of stainless steel, and have a 2, 4, 8 or 12 litre capacity. These capacities are standard for structural applications and many pesticide labels provide dilution information for these specific volumes. Maintenance includes rinsing out the tank and cleaning the outside.

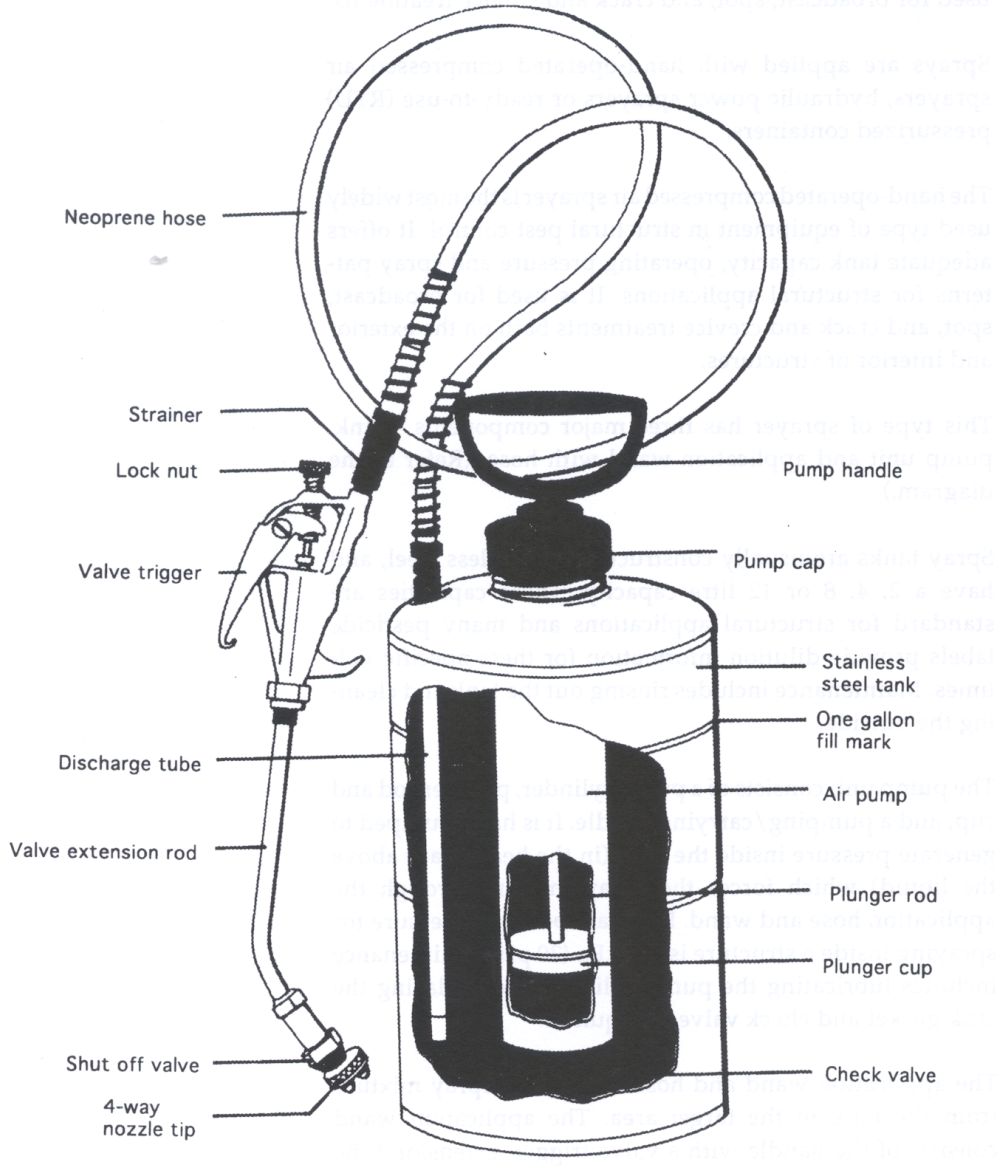
The pump unit consists of a pump cylinder, plunger rod and cup, and a pumping/carrying handle. It is hand pumped to generate pressure inside the tank (in the head space above the liquid) which forces the spray mixture through the application hose and wand. Normal operating pressure for spraying inside a structure is 140 kPa (20 psi). Maintenance includes lubricating the pump cylinder and replacing the tank gasket and check valve as required.

The application wand and hose deliver the spray mixture from the tank to the target area. The application wand consists of the handle with a valve trigger, extension tube and nozzle, to control the flow of the spray mixture and the spray pattern delivered. The application hose is constructed of synthetic rubber in order to be flexible and resistant to corrosion and punctures. Maintenance of the application wand includes replacing the 0-ring and valve seat in the nozzle tip assembly, and the valve packing in the valve trigger, when leaking occurs. The spray hose should be replaced if damaged.

Nozzles are available in various styles and sizes but most hand sprayers are equipped with multi-tip nozzles that produce both fine and coarse flat fan spray patterns (80 and 50 degree spray angles respectively), and a pins tream pat-tern. Nozzle tips, usually made of brass, are easily damaged. Nozzle maintenance consists of tip replacement when an inconsistent spray pattern is produced.

Hydraulic sprayers are used when applying large volumes of spray mix as a broadcast or spot application around the perimeter, or on the exterior, of a structure to control insect pests.

The major difference between hand and power operated sprayers is in the pump system. The pump in power operated sprayers is normally driven by a gasoline or electric engine. The three common types of pumps used for structural applications are the diaphragm, piston and roller.



The Hand-held Compressed Air Sprayer:
The Workhorse of the Industry

Figure 19-1

Advantages

Sprayers offer good control of pesticide placement. They can be used to apply pesticides to a variety of surfaces over broad areas. With certain formulations, little or no residues remain. Applications may be made with minimal site preparation and disturbance.

Disadvantages

Sprayers require the applicator to mix and load pesticide concentrates. There is a chance of spray drift at pressures over 140 kpa or in windy conditions. Spray mixtures should be used within 24 hours of preparation for maximum effectiveness and to avoid disposal problems. Sprays can leave unpleasant odours.

Ready to-Use Pressurized Containers

Some pesticide products for insect and other arthropod control are formulated for commercial use in ready-to-use pressurized containers. Some containers produce very tiny droplets (aerosols) which float in air for a time before settling on surfaces. Other products are designed to produce larger droplets (coarse sprays) that are meant to be deposited directly on surfaces. These products require no mixing or sprayer clean-up.

Dusters

Dusters are used for the application of insecticides or rodenticides. Dusts are applied with hand operated or mechanical power dusters.

Hand-operated dusters are designed for applying small amounts of dust in cracks and crevices, wall and other void spaces such as utility pipes, behind or under furnishings, etc. Hand dusters are available in three basic styles:

- the bulb duster
- the bellows duster
- the plunger duster.

These dusters consist of a holding container for the dust andan extension tube to direct the dust to the target area. The dust is moved through the tube by squeezing the duster or by means of a plunger apparatus.

Power dusting equipment is available in a variety of styles.Most operate with an electric blower fan, while others use compressed air generated from an external or built-in electric pump. Power dusters are most practical when dusting large areas such as attics or crawl spaces.

Advantages

Dusts are ready to use, no mixing is required. In most voids, dusters allow for good product dispersal. Dusts have a long residual characteristic and they present little or no odour.

Disadvantages

It is difficult to control dispersal of dust particles in open areas. Visible residues are likely on exposed surfaces. Dusts become ineffective if they get wet.

Ultra Low Dose (ULD) applicators

ULD applicators are used to perform space treatments. The term ULD refers to the application (as a fine suspension in air) of small volumes of concentrated insecticide in uniform-sized droplets. ULD applicators are made with mechanical aerosol generators, also called cold foggers, or cold aerosol generators.

Ready-to-use products are also available in aerosol or pressurized containers with ULD nozzles attached, or with separate attachment equipment.

Advantages

ULDs control flying insects. The insecticide can be applied to high areas in buildings. ULDs use a low volume of product.

Disadvantages

ULDs require that the area to be treated be closed down. The applicator must undertake considerable site preparation prior to application.

Foggers

Foggers are also used for space treatments (fogging). Fogging can be defined as the opposite of ULD in that it refers to the application (as a suspension in air) of larger quantities of diluted insecticide in uneven sized droplets. Specially formulated pesticides are made for application by fogging equipment. The pesticide is applied as tiny droplets, usually in the 1- 30 micron diameter size range that can be carried by air currents through buildings such as warehouses, farm facilities or restaurants. The small droplets are produced by spinning discs or fine nozzles and high pressures in the fogger. This type of application is often referred to as ultra low dose (ULD) application, where a small amount of a relatively concentrated pesticide is released within a large volume. Foggers can be effective in controlling insects exposed to the fog during application, but the tiny droplets do not penetrate well into cracks and crevices, equipment or boxes and typically need to be used in conjunction with sanitation and/or residual sprays.

Thermal foggers, also called hot aerosol generators, create an insecticide fog by introducing an oil-based formulation into a heated chamber which causes immediate vaporization of the oil. The heat source used is either an electrical source or by the exhaust steam of an internal combustion engine.

Advantages

Foggers can be used to control insects. The insecticide can be applied in high areas.

Disadvantages

Only oil-based products can be used. Fogging solvents may lead to contamination of commodities.

Foggers

Crack and Crevice Injectors

There are various types of equipment used to place a pesticide into cracks and crevices. One type uses a separate pressurized air line to introduce a thin stream of fogged insecticide into deep harbourages. Another type consists of an injector tube attached to the nozzle of a ready-to-use pressurized container or hand-operated compressed air sprayer. Syringe or piston type applicators may also be used to inject pesticides into cracks and crevices.

Baiters

Baiters are containers designed for delivering bait to pests and are available in a variety of styles for use under different conditions.

Insecticide Baits

A few pesticides for structural insect control are formulated into baits pastes or gels for application using a spatula or squeeze tube. They are injected or scraped into cracks and crevices. Other insecticide baits are manufactured in an enclosed bait station so the insect must enter to access the bait. Bait stations should be placed in locations that are inaccessible to children or pets.

Rodenticide Baits

Rodenticide baits, which often contain a grain material as a feeding attractant, are available in a wide variety of ready to-use formulations including pellets, loose meal, seeds and paraffin blocks.

Rodenticide baits may be purchased in small bags (i.e., place packs) or other type of container (i.e., baiters) that contain a fixed amount of bait. These bait formulations do not require any preparation or handling of the rodenticide. Bait bags are left unopened for the rodent to find and open so the bait is kept fresh, intact and safely contained. Unopened bags can be used to monitor rodent activity.

Some commercial rodenticides are purchased in bulk form and require some preparation. This involves determining the amount of rodenticide required and placing it into appropriate bait stations.

A few rodenticides are available in concentrated forms and require mixing with a food attractant, or as liquid baits that require mixing with water to provide a toxic water source for rodents.

Each type of bait has advantages or disadvantages, depending on the circumstances. For example, paraffinized- block baits offer the advantages of protecting the bait from moisture and providing an attractive gnawing surface for rodents. Also, they are easy to handle and can be easily secured inside a tamper resistant bait station. However, they may also present a disadvantage by being more attractive to non- target animals such as pets. Pellet, meal and seed baits provide rodents with food that is easy to handle and similar to their natural foods. However, loose baits are more easily scattered and therefore, accessible to non-target species.

Baiters used to apply bulk rodenticides are available as either open or covered trays, and tamper-resistant bait boxes. Covered bait boxes offer the advantage of protecting the bait from spillage and the elements, and provide an attractive feeding place for rodents.

The disadvantage is their light construction (thin plastic or cardboard). They may be easily opened or destroyed, making it necessary to use them in areas inaccessible to non-target species.

Tamper-resistant bait boxes are constructed of heavier material and may be locked or anchored in place.

Tamper Resistant Bait Stations

- Constructed of high strength material resistant to destruction by children or pets. eg. metal or injection moulded plastic
- Entrance designed so children and pets can't reach bait.
- Designed so bait can't be shaken loose.
- Access panel that fastens securely or locks
- Metal screw or padlock
- Capable of being fastened securely. Eg. Nailed down
- Clearly labelled: "Warning Poison

Avicide Bait Stations

Avicide baits contain grains as feeding attractants. The grain which is used will be attractive to specific bird pests. The bait may be formulated as a ready to use product or may have to be mixed to obtain the correct proportion of toxicant in the bait.

Sprayer Terminology

Nozzle output: the volume of spray produced by a nozzle per minute.

Pesticide rate the amount of pesticide to be applied as stated on the label, Most pesticide rates for structural insect pests include a dilution rate (mix a specified amount of pesticide with a water

or oil carrier) and instructions on how to cover the treatment area (e.g., apply only enough spray to cover surfaces and avoid runoff). For a few types of structural treatments (e.g., fly control on walls) the pesticide rate may be given as the amount of pesticide to apply per unit area (e.g., ml/10 m^2

Spray width: for broadcast sprays using a single nozzle, spray width is the width from the center of one pass to the center of the next.

Sprayer application rate: The amount of spray mix that a sprayer applies per unit of area conducted in typical treatment conditions, (e.g.,100 mL/10 m^2.

Carrier: the liquid that is added to the pesticide product to prepare the spray mix to permit the pesticide to be delivered to the target site through the appropriate application equipment. A carrier added to a pesticide product to dilute it, is usually called a diluent.

Sprayer Calibration

Sprayer calibration is required when the pesticide rate is given as an amount of pesticide per area. The purpose of calibration is to determine the sprayer application rate, usually expressed as spray volume per unit area (L/ha), and if necessary to adjust the sprayer application rate to label requirements. Sprayer application rate must be determined in order to determine the correct amount of pesticide to add to the spray tank.

The basic steps for sprayer calibration are:

- check sprayer set-up to ensure nozzles, pumps, lines, agitation and filters are operating properly
- determine the sprayer application rate by measuring the volume of water applied to a test area.
- make adjustments if necessary to correct sprayer application rate.

Checking sprayer set- up involves the following:

- before starting a motorized sprayer check all strainers are clean
- check that nozzles are the correct type
- with sprayer running and with water in spray tank, check for leaks and
- that valves and agitation in tank is working
- adjust pressure regulator, check pressure gauge
- check that pattern from nozzle is not distorted, replace if necessary

The volume of water applied to a test area is determined as follows:

- mark a test area and measuring its size (e.g., 5 m x 5 m)
- fill the sprayer with a measured volume of water

- spray the test area evenly, moving the nozzle over the area at a
- constant speed (to be used during pesticide application)
- measure the quantity of water left in the spray tank
- determine the volume sprayed on the test area.

To calculate sprayer application rate for a standard area such as 100 m2 use the following type of formula:

$$\text{sprayer application. rate (L/100 m}^2\text{)} = \frac{\text{volume applied to test area (L) x 100}}{\text{size of test area (m}^2\text{)}}$$

If the sprayer application rate must be adjusted to meet label specifications, small changes can be made by changing the speed the nozzle is moved across the test area. If large changes in application rate are required, nozzles should be changed. Obtain assistance in nozzle selection from a supplier if required. Reapply to the test area if speed or nozzles are changed.

Spray Calculations

Structural pesticide applicators routinely prepare spray mixtures from concentrated products. Most structural pesticide labels have a spray dilution chart to simplify the process. The label must be kept in readable condition or a copy must be obtained. Applicators should mix enough for each specific treatment so that no unused pesticide is left over to be disposed of. Structural applicators must be able to determine the volume of concentrate required to prepare a correct dilution. Where the recommended sprayer application rate is a dilution, calculate the amount of pesticide concentrate to make the required amount of spray as follows:

Pesticide Concentration (L) = Required spray (L) x Dilution rate (L/L)

Some structural pesticide labels also indicate you are to apply a specified amount of spray per unit area (e.g., to floors or walls). Applicators should be able to calculate the area to be treated, the total pesticide required and the amount of pesticide required to make up a selected amount of spray in the spray tank. To determine the amount of pesticide required to make up spray, you need to first calculate the area that can be sprayed by a given volume in the spray tank based on your calibrated sprayer application rate (see previous discussion on calibration). Then you use the area sprayed by your spray tank to determine the amount of pesticide to make up the spray.

- **Area to be treated:** Treatment area (m^2) = Length (m) x Width (m)

- **Total pesticide required for treatment area:** Pesticide required (L) = Area (m^2) x Pesticide rate (L/m^2)

- **Area covered by selected amount of spray in tank:** Area covered (m^2) = $\frac{\text{Spray volume in tank (L)}}{\text{Sprayer application rate (L/m}^2\text{)}}$

- **Pesticide required to make specified volume of spray:** Pesticide req. (L) = Pesticide rate (L/100 m^2) x area covered (m^2)

Calculations For Baits

Many rodent and bird control baits are packaged ready to use. Some rodenticides and avicides can be purchased as concentrates and are mixed with untreated bait in the proportion specified on the label. The amount of pesticide concentrate to add to make the required amount of treated bait is calculated as follows:

Amount of Pesticide (L or kg)
= Mass of required bait (kg) x Concentration of pesticide in the bait (L/kg or kg/kg)

Calculations for Space Treatments

To perform accurate space treatments, the applicator must be able to determine the volume of various structures such as a building with a peaked roof and a flour bin), and the volume of product and length of time required to complete the application.

For space treatments the following calculations are required:

1. Volume of building

Volume from floor to top of wall = Length x Width x Height (from the floor to top of wall)

plus

Volume under ridged (peaked) roof (when present)
= length x width x height (from top of wall to ridge of room

$$m3 = \frac{(m \times m \times m) + (1/2\ m \times m \times m)}{2}$$

2. Volume of cylindrical flour bin with cone top or bottom

Cylindrical barrel = 22/7 x (radius of cylinder)^2 x height of cylinder

plus

$$\text{Conical top or bottom} = \frac{22/7\ (\text{rad. of cylind.})^2 \times \text{height of cone}}{3}$$

$m^3 = (22/7 \times m^2 \times m) + (1/3 \times 22/7 \times m^2 \times m)$

3. Required quantity of pesticide to treat a structure

Required pesticide = Volume of structure x Pesticide rate $L = m^3 \times L/m^3$

4. Length of time required to treat a structure with a fogger

Time = Required pesticide / Fogger application rate
Min = L / L per min

Before beginning any application, evaluate conditions at the application site to determine if there are sites or objects of concern nearby (e.g., food preparation surfaces, bedding, clothing and open windows of nearby residences). Certain objects (such as food, dishes or toys) may have to be removed, spray or vapour drift may have to be minimized and buffer zones may have to be used.

Spray drift may be minimized by using sprays with no fine droplets, holding the spray gun closer to the target and ensuring air movement from wind or air circulation fans will not carry droplets to areas of concern. It may be necessary to leave a buffer zone (no treatment zone) between the treatment area and an area of concern to ensure no pesticide contacts

Pesticide vapour concentrations may be a concern inside residences and work areas when people reenter. Minimize vapour concentrations by using pesticides that have low vapour release rates, by ensuring an adequate reentry period has elapsed and by maximizing air exchange in structures before occupancy

Self-Test Questions

Answers are located in Appendix A of this manual.

1. Name six types of application equipment available to the structural pest control applicator.

2. List the three major components of a sprayer.

3. What are spray tanks usually made of?

4. What is the main difference between hand and power operated sprayers?

5. Name three types of dusters.

6. What does "ULD" stand for?

7. Explain the difference between fogging and ULD.

Chapter

20

Pesticide Safety

Learning Objectives

Completing this chapter will help you to:

- Know general pesticide safety procedures.
- Know general safety procedures for ultra low dose and fogging treatments.
- Know additional general safety procedures for rodent and bird baiting
- Know safety precautions for hand held sprayers

General Safety Procedures for Most Pesticide Applications

The following are general safety procedures that should be used for most types of structural pesticide applications:

1. Applicators must understand how the building ventilation systems work and know how air moves in and out of a building.

2. For many dwellings, windows are the only source of ventilation so they should be:
   - closed if cross drafts will cause pesticide drift during application.
   - be opened afterward to adequately vent the building or rooms of pesticide vapours.

3. In buildings with sealed ventilation systems, building management staff must be available to shut off exhaust or ventilation fans to prevent pesticides moving through the ventilation system to untreated areas.

4. Spraying ULD fogging or dusting treatments applied in areas where heating systems are located may create a fire hazard. Applicators should ensure that all heating systems that use open flames and/or non grounded fans are shut off to eliminate the fire hazard.

5. Before a pesticide is used, notification should be provided to people who may be exposed to the pesticide,. Some provinces or municipalities have specific notification requirements including content of notices, the size of signs and when they are to be posted

6. In general, a written notice should be given to residents who live in or workers who use areas to be treated. Notices should be posted at entrances to areas that may be entered by people who do not receive a written notice. It should remain posted until the appropriate re-entry time has been reached.

7. Notices should include the treatment date, start time and completion time, re-entry information, a contact person's telephone number for additional information and other appropriate product specific precautions.

8. Know how ventilation systems affect applications and how to adequately vent a building following treatments.

9. Know that heating systems may cause a fire hazard and what should be done to prevent the hazard.

10. Know how to notify building occupants and the public prior to treatments.

11. Determine and use required and safe re-entry times. The re-entry time is the amount of time that people must stay out of treated areas. The concern over re-entry is the exposure of people to pesticides through:

    - inhalation or ocular exposure of pesticide vapours, dusts or mists,
    - dermal exposure by touching pesticide residues on treated surfaces, or,
    - ingestion when contaminated food has been eaten. Contamination could occur during the application (when unprotected food absorbs pesticides) or contaminated when individuals contact contaminated surfaces with their hands then handle food.

12. Label instructions for re-entry vary. Some give specific times such as no re-entry before 4 hours, some indicate that treated surfaces are not to be contacted until a pesticide spray has dried. Drying time depends on factors such as the amount of ventilation, the temperature and humidity. In cases where re-entry intervals have not been specified on the label, the manufacturer should be contacted to provide re-entry instructions.

13. Ensure also that any requirements or guidelines are followed for re-entry of workers into treated areas set by provincial authorities (e.g., occupational health authorities). Generally re-entry after treatment with any pesticide releasing vapours should only be after substantial ventilation of rooms with fresh air.

14. Ensure that people are warned to keep themselves and pets away from the treatment area during treatment and for the required re-entry time. Cover aquariums and plants as may be necessary.

15. Ensure doors are locked and/or signs posted to keep people out until re-entry is allowed. Pesticide sprays must not be mixed in sinks or near floor drains or in carpeted areas, but rather in areas where spills can be contained and cleaned up appropriately.

16. Before treatment with sprays, food (human and pet), children's toys and other personal use items such as clothes, soaps and magazines should be removed from the treatment area.

17. Whenever possible, pesticides should not be applied directly to food preparation surfaces. If they are sprayed, all food must be removed prior to the application and written notice should be given to residents or staff to clean surfaces with soap and water while wearing chemical resistant gloves, before using again for food preparation.

18. Follow label precautions for respirators – if not specific, a full face canister respirator should be worn if the applicator is required to enter a spray cloud (instead of avoiding the spray cloud by releasing the spray as the applicator moves toward the exit).

General Safety Procedures for Ultra Low Dose and Fogging Treatments

1. Exhaust fans must be turned off, and windows and doors closed before treatment.

2. Applicator exposure should be minimized by starting the treatment at furthest point from planned exit. A full face canister respirator should be worn if it is necessary to enter the spray cloud.

3. Exhaust fans must be turned on and or windows and doors opened to ensure adequate ventilation before re-entry.

Safety Procedures for Rodent & Bird Baiting

1. Baits must be placed according to label directions in areas inaccessible to humans and other non-target animals, or in tamper-resistant bait stations. They should also be placed in locations where they can be retrieved after the treatment/program is completed.

2. Bait stations should be labelled with words such as “Rodent Bait Station-Do Not Touch” with a contact name and phone number on the container.

3. Baits should be placed so that food and food contacting surfaces will not be contaminated.

4. The number and location of bait points should be recorded for retrieval of baits.

5. Baits should be removed before they become stale (e.g., after 3 - 6 months or when mouldy) or when the baiting program is completed.

6. Dead animals must be removed to prevent risk of secondary poisoning.

Safety Precautions for Hand Held Sprayers

Hand sprayer use may, without care, expose an applicator to repeated sub-lethal doses of pesticide. The valve trigger may have a tiny leak and if gloves are not also checked for leaks, an applicator’s hands may be exposed to spray. Such exposure is of particular concern with organophosphate pesticides. Check the trigger valve and gloves at regular intervals. Routine cholinesterase testing should be done to check whether an applicator has had exposure, if using organophosphates.

Appendix A: Answers to Self-test Questions

Chapter 1 - Provincial Legislation

1. Pesticides are **regulated in Nova Scotia** under the authority of the Environment Act and the Pesticide Regulations, administered by the Nova Scotia Department of the Environment and Labour. It is the responsibility of the structural pest control applicator to be fully aware and to have a clear understanding of provincial legislation. **STRUCTURAL APPLICATORS MUST BE PREPARED TO ANSWER QUESTIONS ON PROVINCIAL LEGISLATION WHEN WRITING THE STRUCTURAL CERTIFICATION EXAM.**

2. False

3. Bird and wildlife control programs

Chapter 2 - Integrated Pest Management

1. Inspection involves searching for evidence of an infestation.

2. Tools - flashlight, hand lens, hand tools, collecting vials, sticky traps, mechanic's mirror, stethoscope.

3. Trapping, sighting and recording observations.

4. Mechanical and physical - making the structure unattractive to pests; biological - use of IGRs or parasites.

5. Broadcast or general; spot; crack and crevice; space; and bait.

Chapter 3 - Ants

1. They forage inside structures; they nest in structures.

2. Workers (all females), reproductive females, reproductive males.

3. Store food properly to eliminate access by ants, keep areas clean and free of food debris, caulk all possible entry ways.

4. Baits, dusts or sprays.

Chapter 4 - Bed Bugs

1. They bite humans.

2. For a year or more.

3. Bedrooms.

4. Tighten, caulk and screen route of entry, store mattresses in protected areas, do not fold cot mattresses, open protective harbourages.

5. No.

Chapter 5 - Bees and Wasps

1. Aerial nesters; Underground nesters.

2. After dark when workers are in the nest

3. They live in areas used for recreational purposes, form large colonies, create a nuisance.

Chapter 6 - Cockroaches

1. German cockroach, Brown-banded cockroach, American cockroach, Oriental cockroach and Smoky-Brown cock-roach.

2. German cockroach.

3. Kitchens and bathrooms.

American and Oriental larvae.

5. They flourish in human environments, thy use human clutter and buildings as harbourage, they feed on wide variety of food.

6. They have quick reproductive cycles.

Chapter 7 - Fabric Pests

1. Carpet beetles; Clothes moths.

2. Keratin.

3. Bird and mammal flesh.

4. No.

5. No.

Chapter 8 - Fleas

1. Life cycle of the flea.

2. No.

3. Yes.

4. Egg, larva, pupa, adult.

5. Tissue swelling and an itching sensation. The bite has a small, central red spot surrounded by a red halo and swelling.

6. Vacuuming is required.

7. IGRs interfere with the hormones essential for the flea larva to change into the pupal stage.

Chapter 9 - Flies

1. Their infestations are very specific to their preferred habitats. Treatment must be based upon the sites of infestation.

2. Flies have only one pair of wings.

3. Yes.

Chapter 10 - Occasional Invaders

4. Centipedes have one pair of legs attached to each segment; millipedes have two pairs.

5. When weeds die and rain is minimal.

6. No.

7. Following the installation of new lawns.

Chapter 11 - Paper Pests

1. Silver fish, Firebrats and Psocids.

2. Most common pest when wallpaper became popular and when coal furnaces had glued, taped, insulated pipes.

3. Firebrats.

Chapter 12 - Spiders

1. Cephalothorax, four pairs of legs, eyes in front, no antennae.

2. Ballooning - "flying" by releasing a thread of silk which the wind picks up and carries the spiders away.

3. Black Widow and Brown Recluse spiders.

4. Skin will show two small red marks (from the fangs).

5. It readily bites when touched or pressed.

6. Aggressive house spider.

7. No.

8. Faeces cause discolouration problems

9. Crab spiders.

Chapter 13 - Stored Pest Products

1. Rice weevils can fly; Granary weevils cannot.

2. Seed beetles or Pea and Bean Weevils.

Cigarette and Drugstore beetles.

4. Psocids.

5. Cereal, grain, spices and nuts.

Chapter 14 - Ticks

1. Ticks feed on human blood and transmit diseases.

2. Soft ticks; Hard ticks.

3. Seed ticks, nymph, adult.

Chapter 15 - Vertebrate Pests

1. Vertebrates are pests when they damage property, crops, feed, food or livestock- they carry diseases affecting humans or animals.

2. Eight methods to control vertebrate pests are:
   - removing the pest from a feeding or breeding location
   - destroying their habitat
   - encouraging natural predators
   - frightening away or repelling the pest
   -shooting - trapping
   - preventing reproduction with chemical sterilants
   - chemical control

3. The control measure depends on: the legal status, the cost, the effectiveness

Chapter 16 - Birds

1. Pigeons, Starlings and Sparrows.

2. Birds are pests when they:
   - create health hazards
   - roost in large numbers on or in structures
   - contaminate food
   - create a nuisance

3. Control Methods include:
   - sanitation
   - exclusion
   - nest removal
   - live trapping
   - shooting
   - chemical control

4. D. all of the above

5. True

6. E. None of the above

Chapter 17 - Rodents

1. Norway rat *(Rattus norvegicus),* roof rat *(Rattus rattus)* and the house mouse *(Mus musculus).*

2. No.

   Fear of new objects. Only rats exhibit neophobia.

   Rats - 30 to 45 m. Mice - 10 m.

5. Rat droppings - fresh rat droppings are black or nearly black, they may glisten and look wet and they have theconsistency of putty. Week old droppings become dry, hard and appear dull. After a few weeks, droppings become grey, dusty and crumble easily.

6. Mice droppings - fresh droppings are not usually as softin texture as rat droppings and in a few days become quite hard.

7. A tracking patch consists of a light dusting powder, such as unscented talc. Don't use flour

which may attract insect pests. Tracking powder is a rodenticide in the dustform.

8. Food baits, water baits and tracking powder.

9. 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.

Chapter 18 - Wood Destroying Insects

1. True powderpost beetles

2. No.

3. Two ways to identify infestations are by piles of very fine sawdust and small holes in wood

4. Furniture beetles.

5. Keep wood dry.

Chapter 19 - Application Equipment

1. Sprayers; dusters; ULD applicators; foggers; crack and crevice injectors; and baiters.

2. Tank, pump unit and application wand with hose.

3. Stainless steel.

4. Pump system.

5. Bulb duster, bellows duster and plunger duster.

6. Ultra-low dosage.

7. ULD - small volumes of concentrated insecticide applied in uniform-sized droplets; fogging - quantities of diluted insecticide applied in uneven-sized droplets.

APPENDIX B:

PESTICIDE REGULATIONS

Citation

1 These regulations may be cited as the "Pesticide Regulations".

Interpretation

2 In these regulations

(a) "Act" means the Environment Act;

(b) "Administrator" means a person appointed pursuant to Section 3 of these regulations, and includes an acting Administrator;

(c) "animal" includes vertebrates, invertebrates and micro-organisms whether wild, domestic, living or dead, but does not include humans;

(d) "buffer zone" means an area where a pesticide shall not be directly applied;

(e) "certification" means a type of pest management activity for which a person can become certified by obtaining a certificate of qualification;

(f) "certified applicator" means a person who has obtained a certificate of qualification under these regulations to apply a pesticide;

(g) "commercial applicator" means a person, other than a private applicator, who uses or supervises the use of a pesticide;

(h) "commercial class" means a class of pesticides designated by the Federal Regulatory Authority;

(i) "contamination" means

(i) any significant adverse effect which the Minister believes on reasonable and probable grounds is or may be causing harm to any part of the environment, or

(ii) the presence of a hazard to an organism, other than the target organism, which the Minister believes on reasonable and probable grounds is or may be detrimental to the normal physiological functions of human, animal or plant life;

(j) "Department" means the Department of Environment and Labour;

(k) "Federal Regulatory Authority" means the Federal Minister responsible for regulating pest control products;

(l) "fumigant" means a chemical that, for uses regulated by the Federal Regulatory Authority, can exist in a gaseous state at a required temperature and pressure that is lethal to a given pest;

(m) "land" means surface land, land covered by water, subsoil, matter beneath the subsoil or any combination thereof, but does not include land inside a building or structure;

(n) "micro-organism" means a microscopic plant or animal, including a bacterium, virus, fungus, alga and protozoon;

(o) "Minister" means the Minister of Environment and Labour;

(p) "pest" means any plant, animal, micro-organism or any organic functions of a plant, animal, or micro-organism, including any insect, nematode, rodent, predatory animal, parasite, bacterium, fungus, weed, or other form of plant or animal life or virus, the Minister believes is or may be injurious, noxious or troublesome, but does not include a virus, parasite, bacterium or fungus in a living person or animal;

(q) "pesticide" or "pest control product" means

(i) any substance that is sold or represented for use in preventing, destroying, repelling, attracting, or mitigating, directly or indirectly, any pest,

(ii) any substance that is a pest control product within the meaning of the Pest Control Products Act (Canada) or is intended for use as a pest control product,

(iii) any substance that is a plant growth regulator, a defoliant or a plant desiccant,

(iv) a fertilizer within the meaning of the Fertilizers Act (Canada) that contains a substance referred to in subclauses (i), (ii), or (iii), or

(v) any other substance designated as a pesticide in the regulations, but does not include a substance that is intended for sale, sold or represented for use in potable water to prevent or destroy bacteria, parasites or viruses if the substance is not a pest control product within the meaning of the Pest Control Products Act (Canada);

(r) "pesticide research" means a limited pest control program authorized by the Federal Regulatory Authority;

(s) "pesticide storage facility" means a facility that is used to store pesticides and meets the requirements prescribed in these regulations;

(t) "plant" means an organism which usually derives part of its sustenance by photosynthesis and part by root sorption, and includes a parasitic plant, tree, shrub, weed, grass, fern, moss or micro-organism;

(u) "private applicator" means a person who applies or supervises the application of a pesticide on property owned, leased, or rented

(i) by the applicator,

(ii) by an employer of the applicator, or

(iii) by another person, if the pesticide is applied without monetary compensation or reward to the applicator other than trading services;

(v) "restricted class" means a class of pesticides designated as a restricted class by the Federal Regulatory Authority;

(w) "sell" includes sale, offer for sale, expose for sale, display or advertise for sale, or have possession of for the purpose of sale or distribution;

(x) "treatment site" means the area to which a pesticide is applied;

(y) "vendor of a pesticide" means a person who for hire or reward, sells, supplies or distributes directly to a user, or stores a pesticide, but does not include a farmer or other person who stores a pesticide for their own use and not for resale or distribution.

Administrator

3 The Minister may appoint an Administrator to administer these regulations.

Exemption from regulations

4 These regulations do not apply to the use or sale of a germicidal, disinfectant, veterinary, or sanitizing product registered under the Pest Control Products Act (Canada).

Application of federal statutes

5 The requirements of these regulations are in addition to any applicable federal legislation, including the Fertilizers Act (Canada) and the Pest Control Products Act (Canada) and regulations made pursuant to those statutes.

Part I - Certificates of Qualification

Prohibitions

6 (1) No person shall apply a commercial class or restricted class pesticide unless that person holds a valid certificate of qualification.

(2) No person shall sell or store for gain or reward a commercial class or restricted class pesticide unless that person holds a valid certificate of qualification.

Certificates of qualification

7 (1) The Minister or an Administrator may issue the following classes of certificates of qualification:

(a) Class I - Vendor's Certificate which authorizes the holder to sell, supply, or distribute a pesticide directly to a pesticide user or to store, for hire or reward, a commercial or restricted pesticide;

(b) Class II - Structural Certificate which authorizes the holder to use a pesticide, other than a herbicide or fumigant, for the prevention or control of pests in or around a structure, excluding plant pests in a greenhouse;

(c) Class III (A) - Forestry Certificate which authorizes the holder to use a pesticide by ground application including site preparation, brushing, crop tree release, thinning, insect control, disease control and vertebrate control in a forest management operation, forest seed orchard, outdoor nursery, or plantation;

(d) Class III (B) - Greenhouse Certificate which authorizes the use of a pesticide, other than the use of a restricted class fumigant gas in a greenhouse during the storage, display or production of an agricultural crop including vegetables, ornamental trees, mushrooms and forest tree seedlings and the use of pesticides on areas immediately surrounding a greenhouse;

(e) Class III (C) - Industrial Vegetation Certificate which authorizes the use of a herbicide by ground application to control weeds in an industrial area including a roadside, powerline, pipeline, right-of-way, railway, well site, equipment yard, or non-crop land;

(f) Class III (D) - Landscape Certificate which authorizes the use of a pesticide, other than a restricted class fumigant gas, for the maintenance of ornamentals, shrubs, flowers and turf on outdoor residential, recreational, commercial and public land, including the use of a pesticide in an outdoor nursery for propagation of landscape and garden plants;

(g) Class IV - Mosquito and Biting Fly Certificate which authorizes the use by ground application of an insecticide for control of mosquitoes or biting flies;

(h) Class V - Aquatic Vegetation Certificate which authorizes the use of a herbicide by ground application for the control of aquatic weeds in standing or running water in areas left exposed during periods of low water, including the use of a herbicide in a lake, river, irrigation canal, or ditch;

(i) Class VI - Fumigation Certificate which authorizes the use of a fumigant for soil fumigation or fumigation in an enclosed structure, including a grain bin, elevator, building, railcar, truck, or closed vault;

(j) Class VII - Aerial Certificate which authorizes the use from an aircraft of a pesticide on any land or water;

(k) Class VIII - Agriculture Certificate which authorizes the use of a pesticide, other than a restricted class fumigant gas, by ground application for the protection of an agricultural crop or livestock, including use for control of noxious weeds, birds and rodent control in a farm pond with no outflow, use on a Christmas tree plantation, use on livestock and poultry pests, use in farm seed treatment, use for soil fumigation and use around farm buildings associated with crop and livestock production, but not including use in a greenhouse or commercial seed treatment;

(l) Class IX - Business Operator's Certificate which authorizes the holder to carry on a commercial pesticide business or enter into contracts to handle, use, store or sell to a user a commercial class or restricted class pesticide; and

(m) Class X - Special Certificate which authorizes the use of a pesticide for a purpose not included in Classes II to VIII.

(2) A limited class [may] be created by the Minister or an Administrator for the application of a pesticide restricted to a certain activity within one certification class.

(3) A Class III or Class VIII certificate of qualification may be issued by the Minister or an Administrator to a private applicator or a commercial applicator.

(4) Subject to subsection (3), a certificate of qualification under subsection (1) may only be issued to a commercial applicator.

Application process

8 (1) An applicant for a certificate of qualification shall complete an application in a form approved by an Administrator.

(2) An applicant for a certificate of qualification shall complete an examination and achieve a minimum standard of performance established by the Minister.

(3) A certificate of qualification shall be valid for a period of 5 years from the date of issuance with the exception of a Class IX Certificate which shall be valid for 1 year from the date of issuance.

(4) The holder of a certificate of qualification may be retested once in every 5-year period from the date of the issuance of the initial certificate of qualification.

(5) A certificate of qualification shall entitle the holder to perform only those uses that the class of certificate of qualification authorizes the holder to perform and no other uses.

(6) No certificate of qualification issued pursuant to these regulations is transferable.

(7) Unless agreed otherwise in writing by an Administrator, no person shall apply for a certificate of qualification under these regulations unless that person is at least 18 years of age.

Supervisory restrictions

9 (1) A private applicator who is a certified applicator in Class III or VIII may directly supervise a non-certified applicator where

> **(a)** the non-certified applicator performs the same use as authorized in the certificate of qualification held by the certified applicator; and
>
> **(b)** the non-certified applicator is at least 18 years of age.

(2) A commercial applicator who is a certified applicator may directly supervise a non-certified applicator where

> **(a)** the certified applicator holds a valid Class II, III, or VIII certificate of qualification;
>
> **(b)** the certified applicator is present at the treatment site at all times while the non-certified applicator is applying a pesticide; and

(c) an Administrator is notified when the supervision of the non-certified applicator will occur.

(3) A non-certified applicator may only be supervised by a commercial applicator under subsection (2) for one 30-day period.

(4) A certified applicator referred to in subsections (1) and (2) is responsible for all actions respecting the application of pesticide by the non-certified applicator.

Business operator

10 The holder of a valid Class IX Business Operator's Certificate shall ensure that

(a) a person who is employed by the business operator and who is responsible for handling or applying a commercial class or restricted class pesticide has a valid certificate of qualification;

(b) a commercial class or restricted class pesticide is sold only to

(i) an applicator or business who holds a valid certificate of qualification, or

(ii) a person who has hired another person who holds a valid certificate, qualification;

(c) any activity of a person employed by the business operator complies with the pesticide label instructions for the proper and safe use of pesticides; and

(d) any instruction to a person employed by the business operator is in accordance with the Act, these regulations or any other requirements set forth by an Administrator.

Records

11 An Administrator may require the holder of a Class IX Business Operator's Certificate to submit a record of the application or sale of a pesticide.

Part II - Pesticide Approvals

Approvals

12 (1) Pesticide application activities that require an approval under the Act are designated in the Activities Designation Regulations.

(2) Unless authorized in writing by an Administrator, an applicant for an approval shall apply at least 60 days prior to the intended starting date of the application of the pesticide.

(3) An approval holder shall keep and maintain equipment or supplies readily available to minimize the impact of any release of a pesticide.

(4) An approval holder shall notify an Administrator before commencing a spray program under an approval.

(5) An approval holder shall adhere to weather condition restrictions stipulated on an approval respecting the application of a pesticide.

(6) An approval holder shall ensure that the approval or a copy of the approval is available at the loading, mixing, or application area when the pesticide is being used.

(7) All boundaries of a treatment site where pesticide is used or applied and buffer zones shall be marked or identified so that they are known and visible to the applicator.

(8) An approval holder for aerial spraying of a pesticide shall either personally accompany, or provide a contractor or agent to accompany, a pilot on a pre-spray aerial inspection of a treatment site to ensure that the pilot is fully aware of the area to be sprayed, any buffer zones involved and the property boundaries of the treatment site.

(9) An approval holder shall keep and maintain a record of the information the Minister or an Administrator requires of each pesticide used or applied.

(10) Where there is no evidence that an adverse effect may occur or will occur, the Minister may waive or modify in writing the requirements prescribed in subsections (5), (6), (7), (8) and (9).

Part III - General

Public notification

13 (1) An approval holder shall undertake a public information and notification program as a term and condition of the issuance of an approval.

(2) Except for spot treatments to a utility corridor, utility right-of-way, street or highway right-of-way, no person shall apply a pesticide under an approval by any method unless the person gives public notification through a local newspaper or other means approved by the Administrator at least 20 days before the application commences identifying where and when the pesticide will be applied.

(3) No person shall apply a pesticide under a pesticide research program unless that person

(a) posts signs approved by an Administrator identifying that pesticide research is en at the treatment site before the application commences; and

(b) keeps the signs referred to in clause (a) in place for 20 days after the last application at the treatment site.

(4) No person shall apply a pesticide under an approval for crop tree release, site preparation or forest insect control unless

(a) at least 30 days before the application commences, the person

(i) posts signs approved by an Administrator identifying when and where the pesticide will be applied,

(ii) ensures that the signs referred to in subclause (i) contain a space for coloured fluorescent decals which shall be applied to the signs when spraying commences at the treatment site, and

(iii) ensures that the signs referred to in subclause (i) are placed on all access roads leading to the treatment site and at the edge of the treatment site;

(b) at least 30 days before the application commences, the person delivers a written notice approved by an Administrator to the owner or occupier of any dwelling, business, school, public building, or any other inhabited structure which is located within 500 m of the treatment site, identifying when and where the pesticide will be applied; and

(c) at least 20 days before the application commences, when the total area under an approval or the area of the individual treatment site exceeds 200 ha, the person publishes a notice approved by an Administrator through a local newspaper identifying when and where the pesticide will be applied.

(5) If the applicant can provide reasons which are considered acceptable to the Minister or an Administrator, the Minister or the Administrator may waive, modify, or alter the notice requirements provided in this Section.

(6) No person shall remove or alter any sign required to be posted under these regulations unless authorized by these regulations or by an Administrator.

(7) Subject to subsection (9), no sign posted under these regulations shall be removed for a period of 7 days after the last application at the treatment site.

(8) Unless agreed in writing by an Administrator, any sign posted pursuant to an approval under these regulations must be removed by the approval holder no later than November 1st in the year that the approval was issued unless there is a conflict with subsection (7) in which case the approval holder shall remove any signs immediately after 7 days have elapsed from the last application at the treatment site.

(9) Unless agreed in writing by an Administrator, every person who for hire or reward applies a commercial class or restricted class pesticide to a lawn, tree or other area that surrounds a domestic residence, an apartment, a commercial building, or that is located in a public area, shall

(a) post a sign approved by an Administrator indicating that a pesticide application has taken place on the treatment site immediately after the last application of the pesticide; and

(b) not remove a sign posted under clause (a) for a period of 24 hours after the last application at the treatment site.

Prohibitions

14 (1) No person shall apply, handle, use, abandon or dispose of any pesticide, a mixture containing a pesticide or seeds treated with a pesticide unless the handling, use, abandonment or disposal is conducted in conformance with the product directions or limitations shown on the manufacturer's product label or in a manner approved by the Minister or an Administrator.

(2) Despite subsection (1), no person shall apply, handle, use, abandon or dispose of a pesticide, a mixture or a device containing a pesticide or a material treated with a pesticide in a manner that results or may result in contamination of the environment.

Pesticide research

15 Any pesticide research shall be reported by the researcher to an Administrator in writing 15 days before application commences under the pesticide research authorization.

Filling/flushing

16 No person shall fill, flush or clean a sprayer or equipment used for or in association with the application of a pesticide in a manner that results or may result in contamination.

Contingency plan

17 The Minister or an Administrator may require contingency plans respecting a release of a pesticide to be prepared for approval by the Minister or the Administrator by a person who holds a Class IX

certificate of qualification or by an approval holder who applies a commercial class or restricted class pesticide.

Pesticide containers

18 (1) No person shall dispose of a container that was used to hold a commercial class or restricted class pesticide except

(a) at a container collection site; or

(b) in a manner approved by the Minister or an Administrator.

(2) All pesticides shall be stored in the labelled containers supplied by the manufacturer unless otherwise authorized in writing by an Administrator.

Buffer zones

19 Where the Minister believes on reasonable and probable grounds that a treatment site may be sensitive to the application of a pesticide, the Minister may require a buffer zone be set aside in which no spray is to be directly applied, may determine the size of the buffer zone to be maintained, and may outline how the buffer zone is to be marked or identified.

Cancelled registered pesticides

20 (1) Where the registration of a pesticide has been cancelled under the Pest Control Products Act (Canada), the person to whom the pesticide was registered shall

(a) collect or accept return of all such pesticide supplied by the person to others; and

(b) dispose of all such pesticide in a manner acceptable to an Administrator.

(2) No person shall use, apply, display, or sell a pesticide if its registration has been cancelled under the Pest Control Products Act (Canada).

Protected water area

21 No person shall apply a pesticide within a protected water area designated under Section 106 of the Act unless the person complies with any regulations regarding the use of pesticides within the protected water area.

Part IV - User Pesticide Storage Facilities

User pesticide storage

22 (1) Part IV of these regulations applies to a private individual or the owner, operator or person responsible for a commercial business who stores a commercial class or restricted class pesticide in excess of 25 l in liquid form or 25 kg in solid form, whichever is applicable, for their own use or business use in a user pesticide storage facility, but does not store the commercial class or restricted class pesticide for resale.

(2) No private individual or owner, operator or person responsible for a commercial business described in subsection (1) shall store a commercial class or restricted class pesticide unless the following conditions are met:

(a) the pesticide is stored in a facility that prevents the uncontrolled release of the pesticide;

(b) a list of pesticides stored in the facility and the estimated quantities normally held in storage is, upon request, supplied to the chief of the local fire department or the chief's designate;

(c) a placard is affixed and maintained on the outside of each door leading into the room where the pesticide is stored bearing the words "WARNING - CHEMICAL STORAGE - AUTHORIZED PERSONNEL ONLY" or words to like effect in block letters which are clearly visible; and

(d) emergency telephone numbers are displayed in the facility, including telephone numbers of the fire department, hospital, poison control centre, Department, police and Emergency Measures Organization.

Part V - Vendor Pesticide Storage Facilities

Vendor pesticide storage

23 (1) Part V of these regulations applies to the owner, operator or person responsible for a commercial business who for hire or reward, or for resale, stores a commercial class or restricted class pesticide in a vendor pesticide storage facility.

(2) Any person storing commercial class or restricted class pesticides for hire or reward, or for resale, must do so in a facility that meets a standard established, approved or recognized by the Minister under subsection 8(2) of the Act.

Storage approval

24 (1) No person shall construct a new vendor pesticide storage facility or extend or modify an existing pesticide storage facility to store a commercial class or restricted class pesticide for hire or reward, sale, resale, or wholesale distribution unless the person receives an approval from an Administrator.

(2) An approval under subsection (1) shall be processed under the Approvals Procedure Regulations.

General restriction on facility location

25 No person shall construct or extend a vendor pesticide storage facility

(a) within 30 m of the bank of any surface watercourse or the ordinary high water mark of any surface watercourse, whichever distance is greater, unless approved in writing by an Administrator; or

(b) within 60 m of a well or surface watercourse used as a private water supply, unless approved in writing by an Administrator.

Construction requirements

26 (1) The construction requirements described in this Section are in addition to all applicable federal, provincial, and municipal laws and regulations, including building, fire, and electrical codes and regulations.

(2) No person shall construct a vendor pesticide storage facility unless the following conditions are met:

(a) in the area where pesticides are stored, the floor surface shall be made of steel, concrete or other similar durable material which is impervious to an absorbable liquid;

(b) flooring in the area where pesticides are stored shall have a smooth surface and be capable of being cleaned and decontaminated of any pesticide stored in the facility;

(c) in the area where pesticides are stored, there shall be a continuous, non-combustible curb on the floor which is integral with the floor and is at least 10 cm in height around the perimeter of the area and is capable of retaining liquids;

(d) in the area where pesticides are stored, there shall be no floor drains, catch basins, sumps or other openings in the floor;

(e) the facility shall have adequate ventilation by either natural or mechanical means to the outside atmosphere to prevent the accumulation of toxic or flammable vapours;

(f) there shall be at least 2 entrances and exits to the facility located on opposite sides of the facility if the floor area of the facility exceeds 200 m^2;

(g) there shall be a separate room or area at or near the area in which the pesticides are stored that contains adequate washing facilities for personal decontamination; and

(h) a source of running water shall be readily available in or adjacent to the area where pesticides are stored.

Storage requirements

27 No owner, operator or person responsible for a vendor pesticide storage facility shall store a commercial class or restricted class pesticide unless

(a) the area where the pesticides are stored is a separate locked room or compartment that is partitioned from the floor to the ceiling with building materials that conform with fire and building codes and has no openings except those required for ventilation and entrances;

(b) all permanent storage racks or shelves are constructed of non-combustible material that can be easily cleaned;

(c) all pesticides are stored according to the label storage requirements provided by the manufacturer;

(d) all pesticides are stored at least 10 cm above the floor;

(e) all herbicides, insecticides and fungicides are stored separately from each other in the facility;

(f) all pesticides are separated from any flammable materials by a fire resistant barrier or enough space to minimize risk of combustion of the pesticides;

(g) all pesticides are stacked in a manner that enables the pesticides to be readily inspected; and

(h) foodstuffs, including feed, are not stored in the facility.

Access to site

28 No person shall own, operate or be responsible for a vendor pesticide storage facility unless

(a) the facility has sufficient outside lighting to be of use to emergency service personnel;

(b) any windows in the facility are locked to prevent unauthorized access when authorized personnel are not present;

(c) the facility has doors that remain closed and locked at all times when authorized personnel are not present; and

(d) access to the facility is restricted only to authorized personnel.

Safety measures

29 (1) No person shall own, operate or be responsible for a vendor pesticide storage facility unless

(a) protective clothing including gloves, hats, coveralls, boots, eye protection, a first aid kit and a respirator appropriate for use with the pesticide being stored are readily available, are properly maintained, and functional at all times at the facility and are free from pesticide contamination;

(b) eye wash and emergency showers are readily available at the facility;

(c) the chief of the local fire department or the chief's designate is provided annually with a list of pesticides stored in the facility and the estimated quantities normally held in storage and the chief or the designate is notified of any significant changes in stocks which occur during the year;

(d) a placard is affixed and maintained on the outside of each door leading into the room where the pesticide is stored bearing the words "WARNING - CHEMICAL STORAGE - AUTHORIZED PERSONNEL ONLY" or words to like effect in block letters which are clearly visible; and

(e) emergency phone numbers are displayed in the facility including the telephone numbers of the fire department, hospital, poison control centre, Department, police and Emergency Measures Organization.

(2) Every owner, operator or person responsible for a vendor pesticide storage facility shall ensure that "no smoking" signs are prominently displayed in an area where pesticides are being stored.

(3) No person shall use an open flame to conduct welding, burning, cutting, melting, heating or any other activity in a vendor pesticide storage facility unless appropriate safety measures are taken.

(4) Every owner, operator or person responsible for a vendor pesticide storage facility shall post or make readily available to employees or other persons any material safety data sheets that have been compiled and supplied by the manufacturer of the pesticide.

(5) No owner, operator or person responsible for a vendor pesticide storage facility shall place a pesticide in that facility unless it is equipped with

(a) a fully-operative fire alarm system;

(b) fire extinguishers which are approved by the fire department and are placed in strategic positions in and around the pesticide storage facility; and

(c) materials for containment and clean-up as required by an Administrator.

(6) Unless an Administrator directs otherwise in writing, every owner, operator or person responsible for a vendor pesticide storage facility shall ensure there is unobstructed access to the facility for emergency equipment and personnel.

Maintenance and inspection of facility

30 (1) Every owner, operator or person responsible for a vendor pesticide storage facility shall

(a) comply with all relevant legislation respecting pesticide storage and the use of personnel protection equipment and clean-up techniques;

(b) inspect monthly the facility and repair or replace any parts that may be damaged or defective; and

(c) immediately secure any container or package found leaking a pesticide and clean up the area.

(2) Every owner, operator or person responsible for a vendor pesticide storage facility shall keep and make available for review upon request by an inspector, a book or report of monthly inspections and any action taken under subsection (1).

(3) The book or report described in subsection (2) shall be kept while the facility is in operation and for 2 years after operations cease.

Abandonment

31 (1) No owner, operator or person responsible for a vendor pesticide storage facility shall abandon that facility or any part of that facility unless the person notifies an Administrator in writing at least 6 months before the date of the proposed abandonment.

(2) No owner, operator or person responsible for a vendor pesticide storage facility shall abandon that facility unless the facility is left in a condition approved by an Administrator.

(3) Unless approved in writing by an Administrator, an abandonment pursuant to subsection (1) does not relieve the owner, operator or person responsible for a vendor pesticide storage facility from any requirement contained in the Act, regulations made pursuant to the Act, or in an approval issued with respect to that facility.

Part VI - Effective Date

32 (1) Subject to subsection (2), these regulations shall come into force on, from and after April 11, 1995.

(2) With respect to private applicators, clauses 7(1)(c), (d), (e), (f), and (k), and clause 10(b) shall come into force on, from and after December 1, 1996.