

New Brunswick
Nouveau Brunswick

**Structural Pest Control
Pesticide Safety Manual**

1st Edition
1995

Compiled and Edited

by

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Your Environmental Trust Fund at Work



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Acknowledgements

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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 determine 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 General Pesticide Safety Manual, contains the minimum amount of information that all structural pest control applicators must know in order to become a certified pesticide applicator.

The General Pesticide Safety Manual is divided into twelve sections covering such background information as legislation, toxicity, and safety as well as the steps and decisions which all applicators have to make in their daily routine on the job.

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 General Pesticide Safety Manual and this manual have been set up to help you prepare for the structural pest control applicator certification exam. Read the goals 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. A section titled "Answers to Chapter Questions" has been placed at the end of the manuals. This section is to help you obtain and understand the correct answers. These goals, 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.

For additional information on pesticide certification, please contact your local pesticide regulatory agency.

In New Brunswick:

New Brunswick Department of the Environment
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Pesticides are not for amateurs. To protect people and the environment, pesticide applicators must be professionals!

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Provincial Legislation

Pesticides are regulated in New Brunswick under the authority of the Pesticides Control Act and Regulations, administered by the New Brunswick Department of the Environment. The intent of the legislation is to ensure that pesticides are used, stored and disposed of in an appropriate manner. The legislation provides for fines and imprisonment if pesticides are used contrary to the Pesticides Control Act and Regulations. Only pesticides that are registered under the federal Pest Control Products Act may be considered for use in New Brunswick (see Chapter 4 of the General Pesticide Safety Manual for further information on federal legislation.) It is important that structural pest control applicators have a clear understanding of the provincial Pesticides Control Act and Regulations.



Goals of This Chapter

- Understand the Pesticides Control Act and Regulations.
- Be familiar with insurance requirements.
- Know the signage requirements.

Pesticides Control Act and Regulations - Operational Requirements

Commercial Users

Chapter 5 of the General Pesticide Safety Manual details the operational requirements that must be met by individuals and/or businesses who apply pesticides for fee or reward. As a review, the following is an overview of those requirements, specific to structural pest control.

Operator's Licence

Any business that applies pesticides for fee or reward is required to hold a Pesticide Operator's Licence.

- **Pesticide Operator's Licence** - This licence recognizes the operation of a business for the purpose of carrying out pesticide applications for fee or reward. To obtain an Operator's Licence, you must complete form 21-1070 (Application for Pesticide Operator's Licence) and submit it, along with the appropriate fee and proof of adequate insurance (including pollution liability), to your local pesticide regulatory agency, the New Brunswick Department of the Environment. Form 21-1066 (Pesticide Storage Notification) must also be completed and the original sent to your local fire department with copies of this form being sent to the local Department of Health and a copy accompanying your Operator's Licence application. An Operator's Licence is renewable on an annual basis. To renew an Operator's Licence, the applicant must complete forms 21-1067 (Application for Renewal of Licence/Certificate) and 21-1066 (Pesticide Storage Notification) and submit the forms along with the appropriate fee and proof of adequate insurance. Form 21-1071 (Annual Record of Pesticides Used), which details the

total quantity of pesticides used in the previous year, must be received by your local pesticide regulatory agency, the New Brunswick Department of the Environment, prior to the issuance of a renewal licence.

Any person wishing to apply pesticides by ground on a commercial basis (for fee or reward), by air, to water, or for research purposes is required to obtain the appropriate certification.

Certification

- **Pesticide Applicator's Certificate** - This certificate recognizes the individual as having the appropriate education/training to apply pesticides, based on the particular certification received. New Brunswick has nine classes of certification available, with the classes having various levels. To apply for certification, complete form 21-1073 (Application for Pesticide Applicator's Certificate) and submit it, along with the appropriate fee, to your local pesticide regulatory agency, the New Brunswick Department of the Environment. The class and level of certification you receive will be based on your qualifications, experience, certificates held in other jurisdictions and any pesticide related courses you have taken. Based on the information received, an examination may be required prior to the issuance of a certificate. A pesticide applicator's certificate must be renewed on an annual basis. Complete form 21-1067 (Application for Renewal of Licence/Certificate) and send it and the appropriate fee to your local pesticide regulatory agency, the New Brunswick Department of the Environment.

Structural pest control applicators must hold a Class E Level 1 (E1) Applicator's Certificate. Should an applicator wish to be involved in pest control in waste disposal sites, and fogging and misting in structures, they must also hold a Class F, Level 1 (F1 - pest control in waste disposal sites) and a Class G, Level 2 (G2 - fogging and misting) designation on their certificate.

In order to obtain a Structural Pest Control Pesticide Applicator's Certificate, you will be required to write a structural

pest control exam. This exam is a three hour closed book exam which can be written at any Department of the Environment Office throughout the province.

Permits

Any person or business wishing to apply pesticides by ground on a commercial basis (for fee or reward), by air, to water or for research purposes is required to apply for a permit authorizing the application.

- **Pesticide Use Permit** - Before any pesticide application can take place in the province of New Brunswick, a permit must be issued by the Minister of the Environment. In order to obtain this permit, the applicant must submit to the Department a detailed permit application indicating information such as the type of application, the product or products to be used, where in the province the application will take place and the purpose of the application. The application is reviewed and recommendations are made to the Minister. When a permit is issued, it contains guidelines under which the Operator must ensure that all applicators abide by, specific to the type of application. Monitoring by departmental staff helps to ensure that pesticide application takes place within permit conditions. These provincial guidelines are in place to provide additional measures to ensure that if pesticides are to be used, they are used in the safest way possible.

In order to obtain a permit, it is necessary first to provide the information requested by form 21-1074-75-76 (Application for Pesticide Use Permit) and send it to your local pesticide regulatory agency, the New Brunswick Department of the Environment. Additional information may be required.

Four types of permits may be issued for structural pest control. They are as follows:

1. PRIVATE AND PUBLIC PROPERTIES. One permit will be issued to encompass pesticide applications to both private (i.e residential) and public (government owned

property - including federal, provincial and municipal) properties. With this permit, a list of public property sites must be submitted in writing to the Director of Pesticides Control prior to applications occurring on these properties. Additional sites may be added at any time by submitting a written request to the Director of Pesticides Control.

2. **WASTE DISPOSAL SITES.** One permit will be issued to encompass pesticide applications for rodent control in and around waste disposal sites. Again, a list of waste disposal sites requiring rodent control must be submitted in writing to the Director of Pesticides Control. Additional sites may be added at any time by submitting a written request to the Director of Pesticides Control.
3. **BIRD CONTROL.** One permit will be issued for pesticide applications involving the use of avicides (bird toxicants). Prior to any pesticide applications taking place for bird control, the Director of Pesticides Control must receive, in writing, information pertaining to the site to be treated. If the site is approved, the Director of Pesticides Control will notify the permit holder in writing. No work is to be conducted under a bird control permit until such approval has been granted.
4. **FUMIGATION.** One permit will be issued for pesticide applications involving the use of fumigants. Prior to any pesticide applications taking place for the purposes of fumigation, the Director of Pesticides Control must receive, in writing, information pertaining to the site to be treated. All sites requiring fumigation must receive prior written approval from the Director of Pesticides Control. Note that for any fumigation applications, applicators require a Class G, Level 1 designation on their Applicator's Certificate. A Class G, Level 1 designation is not covered under structural pest control.

Permits expire on or before December 31 of each year. Operation without a valid permit is a violation under the Act. Permit applications for the subsequent year must be

submitted no later than 60 days prior to the commencement of the application to ensure that a valid permit is in place for the new year. This also applies to licence and certification applications.

Insurance Requirements

In order to obtain a Pesticide Operator's Licence, insurance in the form of public liability and property damage insurance is required. Included in this must be environmental damage (pollution liability) coverage. A **Certificate of Insurance** must be submitted to the Department of the Environment with the application for an Operator's Licence or for the application to renew a licence.

The Certificate of Insurance must indicate the following:

Type of Policy: Commercial General Liability Policy

- Either occurrence basis or claims-made basis
- Products and/or Completed Operations must be included
- Pollution Liability Coverage Extension must be included

Recommended Limits

- \$1 000 000.00 per occurrence for all ground applications of pesticides except Lawn and Landscape
- \$500 000.00 for Lawn and Landscape pesticide applications.

The "Note Section" of the Certificate of Insurance must include the following:

There can be no interruption in coverage (cancellation/non-renewal) under this Policy except upon thirty days

prior written notice to the Director of Pesticides Control, Department of the Environment, P.O. Box 6000, Fredericton, N.B., E3B 5H1.

Posting Requirements

One of the conditions stated on Waste Disposal Sites permits is the posting of approved signs. Structural pest control applicators are required to post approved signs prior to conducting pesticide applications at waste disposal sites.

An approved sign must meet several requirements. The sign must be a minimum of 30 cm x 40 cm in size, rain resistant with type or letters of sufficient size and clarity to be easily read together with a symbol of a cautionary raised hand inside a symbol of a stop sign. The information on the sign must be bilingual and must contain the words "ATTENTION", "Pesticide Application", and the name of the pesticide and Pest Control Products Registration number, name of the applicator, permit number and operator name or logo and phone number.

The applicator must ensure that signs are posted at all ordinary points of access in the treatment area and that the signs are removed when the permit authorizing the pesticide applications has expired.

An example of an approved sign is shown on the following page.



ATTENTION

Pesticide Application
Application de pesticide

Pesticide

Registration No.
No. Enregistrement

Permit No.
Permis N°

Applied by
Appliqué par

Telephone
Téléphone

OPERATOR LOGO
LOGO D'EXPLOITANT

Questions for Self Study - Chapter 1

1. What is the intent of the Pesticides Control Act and Regulations?
2. List the steps an applicant must take to obtain a Pesticide Operator's Licence.
3. Is it necessary to renew an Operator's Licence?
4. What class(es) and level(s) of certification must a structural pest control applicator hold?
5. Describe 4 types of permits which may be issued for structural pest control.
6. What information must a Certificate of Insurance contain?
7. Does a structural pest control applicator need to post signs for pesticide applications at waste disposal sites?
8. List 5 requirements of an approved sign.

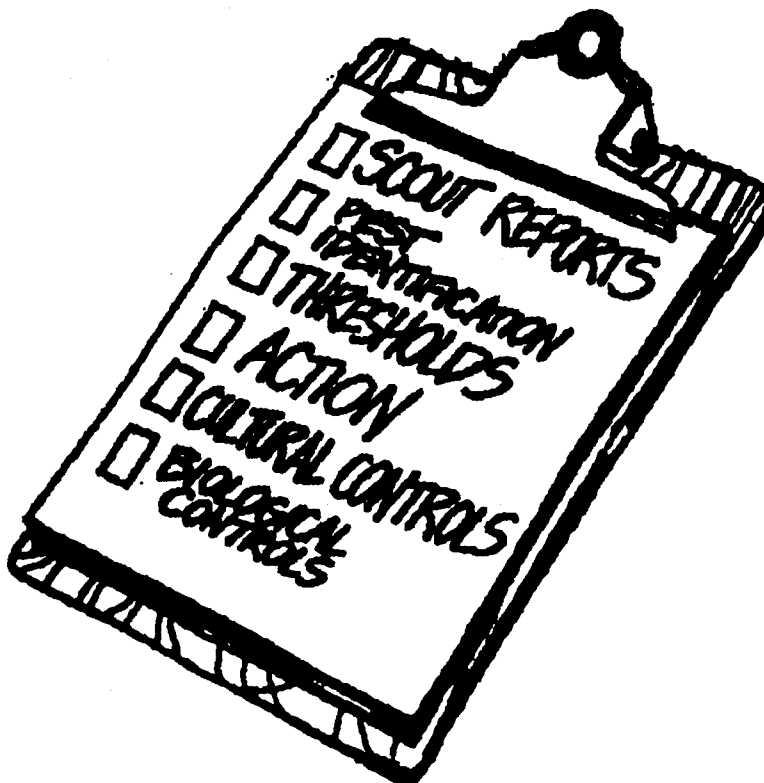


Integrated Pest Management

2

Integrated Pest Management, IPM, is not a new issue facing structural pest control applicators. IPM has been practised in structural pest control for many years.

Some people believe that IPM means using no pesticides or using pesticides as a last resort when faced with a pest control problem. A simplified definition of IPM could be stated as using all available means to control a pest. This may or may not include the use of pesticides. Structural pest control applicators should strive to include IPM techniques in every pest control situation they face.



Goals of This Chapter

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

Integrated Pest Management

Integrated Pest Management (IPM) is a process that considers all available information and control methods when managing pest populations. IPM is a program that maintains pest populations below economically damaging or socially unacceptable levels, using cultural, biological and chemical techniques (or a combination of), so as to minimize adverse effects to the public or the environment.

The General Pesticide Safety manual has an entire chapter devoted to the topic of Integrated Pest Management (IPM). Make sure you are thoroughly familiar with the techniques involved in IPM.

The following are IPM techniques that should be practised by structural pest control applicators on a routine basis.

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.

No area in a structure should be exempt 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 may be 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 such as droppings, nesting material and infested items, or repairing pest damage, may also be used to determine ongoing pest activity. A record of monitoring data should be maintained.

In any IPM program, it is extremely important to the success of the pest control program that there be good communication between the structural pest control applicator and the client. Communication must be an ongoing activity involving training, education and a routine review of the goals of the pest control program.

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.

Exclusion techniques involve methods that maintain an environment free from pests. Exclusion could involve **mechanical, physical (cultural)** or **biological** control methods.

Mechanical and **physical** control methods work by making a structure unattractive to pests. Mechanical control in-

Communication

Sanitation

Exclusion

cludes setting traps or creating barriers like caulking cracks and crevices in foundations or weatherstripping doors and windows, preventing pests from entering. Physical control uses such techniques as heat and cold to manage pests.

Biological methods can involve the use of IGRs (insect growth regulators). IGRs are used to suppress a pest populations growth as they prevent larvae from maturing into reproductive adults. Another example of biological control is the use of insects which are parasites of certain pests.

Pesticides

In order to control certain pests, or in certain situations, the structural pest control applicator must use a pesticide. As 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 and that an appropriate pesticide has been chosen to treat the pest. Make sure 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 of a 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.

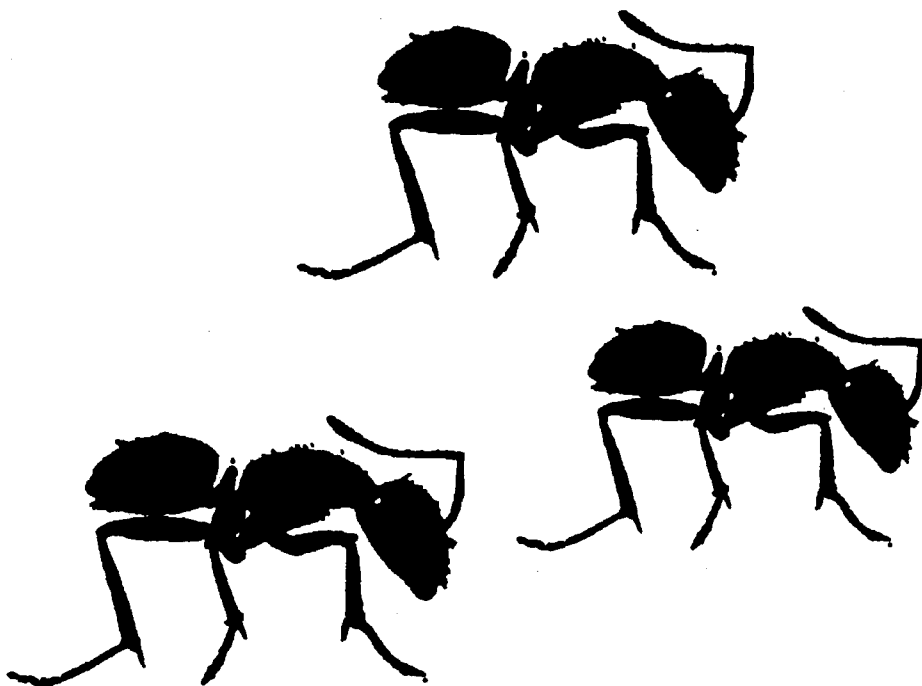
Questions for Self Study - Chapter 2

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. Describe each.

Ants

3

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.



Goals of This Chapter

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

Introduction to Ants The Ant Colony

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. At this time, if her wings are not already broken off, she tears them off. She then produces eggs. When the tiny, white, legless grubs (larvae) hatch, they are fed with salivary secretions from the female's stored fat cells and the breakdown of her now useless wing muscles.

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

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

- Other specialized groups may arise from the worker caste in certain species (eg. soldiers).

Foraging

Ants eat a wide variety of food, including other insects, seeds, nectar, meats, fats, sugars, and honeydew. Honeydew is a liquid produced by plant sucking insects, such as aphids, mealy bugs, scale insects, and plant hoppers. These insects feed in groups on plant stems and leaves. Many species of ants protect these aggregations from other insects. Ants are a part of this pattern; they also take drops of honeydew continuously produced by the small sap-sucking individuals.

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 other workers. Many species lay down a pheromone chemical along the path from the food source to the nest, thus giving alerted workers a clear odour trail to follow to the food.

A complete understanding of ant identification is necessary before a successful control program can be initiated. The species of ant identified will be the guide to successful control. 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.

Ant Control and Management

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 for information regarding the ant infestation. Observe ant worker movement and identify the focus of 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 meters, 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 items must be corrected first. If insecticides are only used to control the ants, then the program will ultimately fail and the ants will return.

Indirect 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" principles to follow:

- Store food properly to eliminate access by ants.
- Ants are foragers and will seek out food wastes - by ensuring the living space is free of food debris, ants do not have access to a food source.
- If ants are entering a structure through a crack seal it with silicone caulk.

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. 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. They are effective when blown into cracks and all voids before they are sealed.

Sprays

Sprays may also be used in crack and crevice treatments. Apply wettable powders and microencapsulated 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 repellent 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 an extension of a yard problem. Consider spot treatments and perimeter spraying carefully; drawbacks to these reactive treatments include; nest areas can be completely missed, and ants tend to 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.

It is also important to strongly consider a least toxic or integrated approach to ant control. This may include such steps as:

- Try to tolerate some ants - ants are beneficial.
- Use soapy water to kill invading ants.
- Store food and food waste in tight containers.
- Caulk or seal cracks where ants may enter the structure.

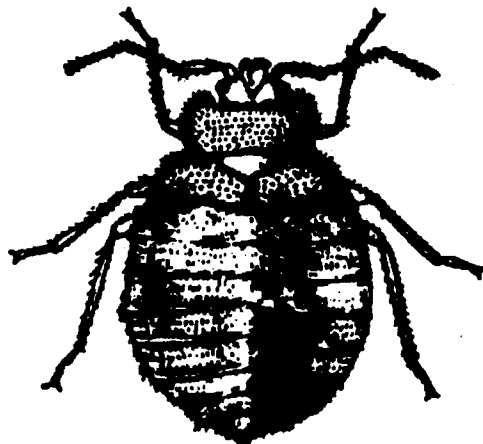
- Use dusts in cracks, wall voids, and other hard to get areas before caulking.
- Flood flower pots with water to move ants away from the house.
- Select formulations with low toxicity, such as insecticidal soap, boric acid, and pyrethrum for baits, dust, and sprays.

Questions for Self Study - Chapter 3

1. List two reasons why ants are considered pests.
2. Describe the ant caste system.
3. List three "good housekeeping" principles to follow in managing ants.
4. Describe three types of insecticides commonly used to treat ants.

Bed Bugs

Bed bugs are a species of insects of the order Hemiptera (true bugs). As true bugs, bed bugs feed by piercing their host's tissue with slender thread-like stylets and sucking the host's blood. These insects are pests of humans as well as domestic animals. The bed bug's adaptations to humans is so complete their bites are nearly painless. They have been one of the most important urban human pests; they were disliked more than cockroaches.



Cimex lectularius

Goals of This Chapter

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

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

Adults

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

Under normal conditions, bed bugs feed at night. Flat bodies allow them to hide in cracks in beds, bedside furniture, dressers, wall boards, door and window frames, behind pictures, under loose wall paper, and in rooms near host sleeping areas.

If a room is heavily infested, there will usually be a strong characteristic odour originating from glands, or the bed bug's body which secretes an oily, odorous material. 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 centre of infestation. All dark cracks and crevices are potential harbourage.

Habitat Alteration

Since bed bugs have alternate hosts besides humans (eg. rodents, some birds, etc.), excluding these animals from areas is very important.

There are a number of things that should be done inside the home:

Harbourage

Control Methods

- 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 harbourage inside, such as wall voids.

Outside the home:

- 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 depressed 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 reinfested. Keep good records on pesticide use and application methods.

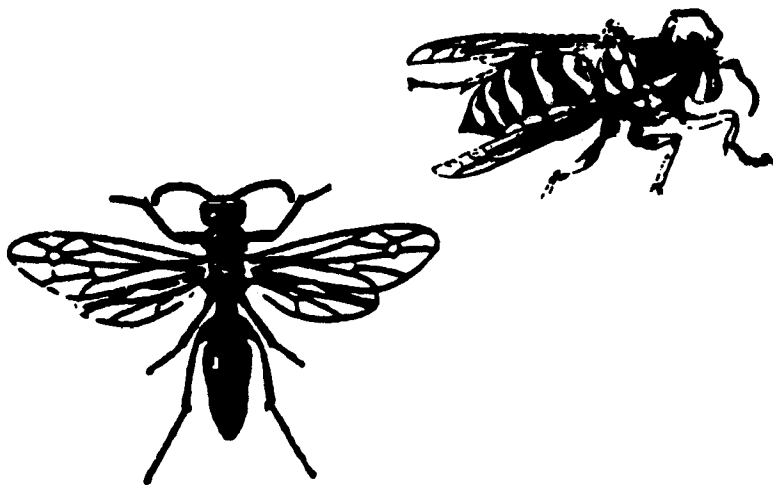
Questions for Self Study - Chapter 4

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?

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.



Goals of This Chapter

- 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; if so, 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 somewhat 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.

The Paper wasp queen, like other Vespidae nest mothers, is the lone female reproductive, who begins her nest by attaching a thick paper strand to an overhanging structure. She then builds hollow 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 (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, hanging head down.

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

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

Management and Control of Paper Wasps (Polistes)

Paper wasps nests are often found near doorways and other human activity areas. 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.

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 yellowjackets 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 yellowjackets 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 and other 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.

Management of Yellowjackets

Problems with yellowjackets commonly occur when:

- People step on or jar a colony entrance.
- A colony invades a structure in such a way that it threatens the inhabitants.
- They are a nuisance in competing for food.

Management of outdoor food is very important in a yellowjacket control program. Some sanitation tips to keep in 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 yellowjackets returning to the nest.

An ongoing monitoring program is vital in a yellowjacket control program.

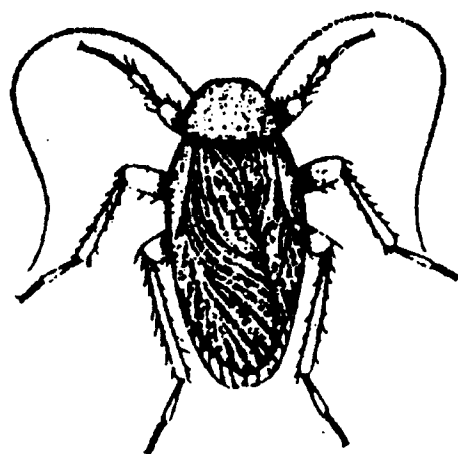
Questions for Self Study - Chapter 5

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.

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. Worldwide there are approximately 3500 species of cockroaches. Most live wild in the tropics; a few, called urban cockroaches, 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.



Goals of This Chapter

- Be able to identify common species of cockroaches.
- 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 adulthood, 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 cockroaches. However, once a colony of cockroaches has estab-

lished 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.

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 prepared to use more than one technique to bring the infestation under control.

German Cockroach *Blattella germanica*



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 tan

stripe appears down the middle from front to rear. This stripe divides the nymphal markings into two dark, long stripes. The stripes remain as two dark streaks on the adult's pronotum, while the rest of the body is covered by the tan or brown wings.

Life Cycle

Eggs. The egg capsule of the German cockroach is about 0.6 cm (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 up

of 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 bathrooms, 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-brown 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 dark

areas where she can find brown-banded cockroach egg capsules in which to lay her eggs. The tiny wasp larvae eat the roach eggs, then emerge from the 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.

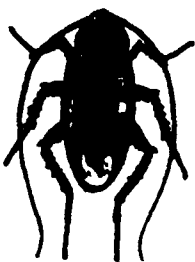
Nymphs. Nymphs molt six to eight times before becoming mature for a total of five to six months at around room temperature. At higher temperatures the nymphal period is nearly halved.

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 *Periplaneta americana*



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

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 produce egg capsules throughout the year, they produce more of them in the summer. An egg capsule can form in about one week, so from 12 to 24 capsules can be produced in the warm months. An average of 14 eggs per capsule hatch in 30-50 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 20 months 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 cockroaches, the female does not develop wings, but produces only short triangular wing pads. The male has wings, but they are short and broad, leaving about 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, base-

ments and their floor drains, and other such moist places. These cockroaches frequently live in floor drains that drain directly outside; these drains are also used as entrances to homes. The Oriental cockroach prefers starchy food, and builds up populations around garbage cans. They tolerate lower temperature ranges than other roaches and may winter in rock walls or other protected sites. These cockroaches are more sensitive to lack of water than other roaches.

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.

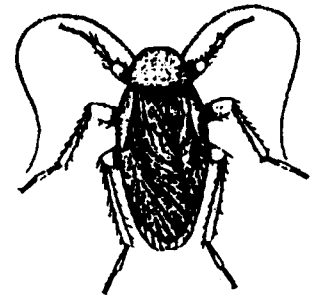
Nymphs. Nymphs hatched in summer overwinter.

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

Smoky-Brown Cockroach *Periplaneta fuliginosa*



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 cockroaches, 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 cockroach 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. Cockroaches 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.

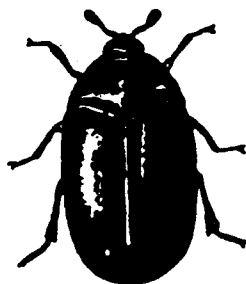
Questions for Self Study - Chapter 6

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.

Fabric Pests

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

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



Goals of This Chapter

- 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

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

Textile pests are generally secretive and develop on food that decomposes slowly. As populations of textile pests increase, individual adults and mature larvae migrate away from the infestation to mate or pupate in protected solitude. This activity often is the only signal that a pest infestation is present.

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 top surface 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 Carpet 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 extends 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



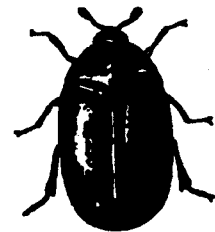
These beetles (from which the entire family takes its name) are larger than other Dermestids, but rather than feeding on fabrics or grains, their larvae commonly eat bird and mammal flesh. They feed in dark places preferring their food dry rather than spoiled. These beetles will attack cured meats, like 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.

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 Incinerator
Beetle**

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.

**The Black Carpet
Beetle**
Attagenus



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.

**Common, Furniture
and Varied Carpet
Beetles**
Anthrenus

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.)

**Warehouse and
Cabinet Beetles**
Trogoderma

Control Methods for Carpet Beetles

Inspection

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 programs for curatorial staff and storage management personnel in critical facilities.

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 and

Clothes Moth Species



front 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 Clothes Moth larvae is between 0.6 cm (1/4 inch) to less than 1 cm (1/2 inch) at most with a white, shiny body. It has a brown head and a brown segment behind the head. It is often found in loose, silk webbing.
- The Casemaking Clothes Moth larvae are slightly longer than larvae of the Webbing Clothes Moth. It is very light or white, with a dark brown head. The segment behind its head is dark brown. The caterpillar constructs a case about its body which it carries about when feeding. Mature larvae after leaving the infestation attach to ceilings and walls and pupate inside the case.

Control Methods for Clothes Moths

Inspection

All woolens should be inspected where clothes moths have been sighted, especially clothing that is stained or has been worn and not cleaned. Brush 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 microorganisms 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 moth balls 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. Review records regularly and provide educational programs to curatorial staff and those in textiles storage businesses.

Questions for Self Study - Chapter 7

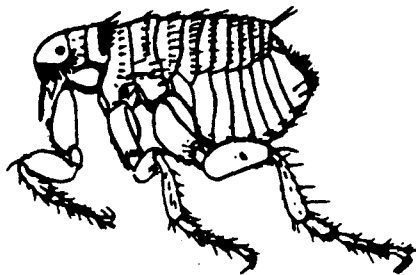
1. Name two types of insects which are considered fabric pests. Describe each.
2. What is the name of the protein that only insects can digest?
3. What do the larvae of Larder beetles prefer to feed on?
4. Are Clothes moths attracted to light?
5. Can Clothes moths live on wool that has been cleaned?

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 inhabitants.

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.



Ctenocephalides felis

Goals of This Chapter

- 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 when 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 build up 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 pesti-

cides. 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 (IGRs) have proven very effective in flea control. Growth regulators interfere with or replace natural hormones essential for the flea larvae to change into pupae. IGRs have long residual times and leave a good margin of safety for humans. Since IGRs do not affect the pupa or adults, fleas that have reached those stages complete their development. The "pre-adult" 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 overlapping 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 IGRs are to be used alone, they should be applied before spring flea activity gets underway - at least one month before flea problems even begin to be noticed (depending on the local climate). IGR application can be repeated according to predicted need.

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

Kennels, dog runs, and dog houses are also obvious areas to treat. Perimeter fences where pets and wild hosts roam may be the 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 microencapsulated insecticides can be applied as spot treatments where labels permit. Emulsifiable concentrates of many pesticides have a short residual when exposed to outside light and weather 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 reinfesting 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 com-

pletely carried out, a reinspection and possible retreatment should be scheduled before a rebounding population cancels out all of the previous work and co-operative effort.

Questions for Self Study - Chapter 8

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?



Domestic Flies (Non-Biting)

9

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.



Goals of This Chapter

- 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 Calliphoridae) are about 0.6 cm (1/4 inch) long. Their thorax and abdomen are shiny black, metallic green or bronze, or they have a metallic blue abdomen with a dull thorax. They live on dead animals, meat scraps in garbage, and wet mixed garbage.

The cluster fly (*Pollenia rudis*) is also in the family Calliphoridae. It is slightly more than 0.6 cm (1/4 inch) long. Its thorax is covered with grey or yellowish hairs; it has no stripes. 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

Control Methods

and blow flies in 3-9 days. They live in refuse only from the egg laying to the mature larval stage. Then the mature larvae crawl away to pupate, emerging as adults later.

Habitat Alteration

Caulk and tighten around all openings such as screens, doors, windows, ventilators, and eaves. 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).

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.

Attic Flies, Cluster Flies

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.

Control Methods

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.

Structure Infesting Small Flies

Fruit Flies and Phorid Flies

Drosophila and the family Phoridae

These small flies (from two different fly families) often are mistaken for each other. They are about 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.

Control Methods

Habitat Alteration

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

Phorid Flies

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

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

Control Methods

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. Over time, however, cast skins from these filter flies can slow down water drainage. When sewage treatment plant filter beds malfunction or become "out of balance", the moth flies can become problems in nearby 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.

Moth Flies or Drain Flies *The Family Psychodidae*

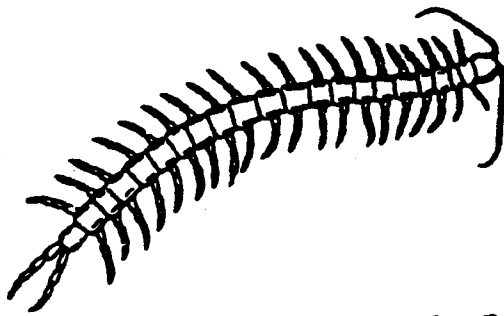
Questions for Self Study - Chapter 9

1. Describe how the treatment of fruit flies and phorid flies differ.
2. What is one outstanding characteristic of flies?
3. Can domestic flies carry diseases?

Occasional Invaders

10

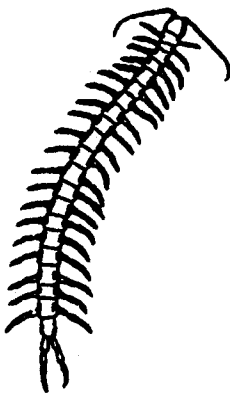
Occasional invaders do not regularly occur inside buildings. However, when they do appear in a building, they are easily recognized and are disliked by many people.



Goals of This Chapter

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

Centipedes *Class Chilopoda*

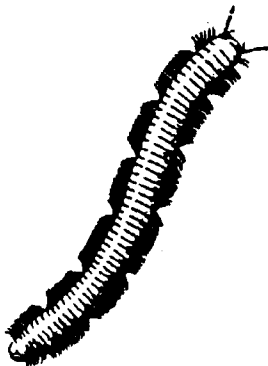


Centipedes are sometimes combined with millipedes in the large group Myriopoda. Centipedes are many-segmented arthropods with one pair of legs attached to each segment and somewhat long antennae. Except for one group, centipedes live outside under stones and logs. The centipede that lives inside is known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

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 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

Control Methods

Crickets *Order Orthoptera* *Family Gryllidae*



Field Crickets *Acheta assimilis*

injected into soil by the female using a long, straight appendage called an ovipositor. The eggs overwinter and hatch in spring.

Crickets feed on plants, and mature in July and August. When weeds begin to harden and die and rain is sparse, crickets often leave their ditches and fields; they move out in massive invasions. This is the time they come into homes and buildings. Entry into structures is most always under doors and through opened windows.

Field cricket populations are cyclical. Some years great numbers find their way across parking lots and into malls and office buildings. Many years of low cricket populations may follow. Other crickets like the house cricket, and the very small dark brown *Nemobius*, also have cycles of build up and movement into structures.

Camel or Cave Crickets *Ceuthophilus*

This humpbacked insect is more closely related to katydids than to crickets. It is mottled brown and wingless with very long legs and antennae. Cave crickets are often compared to spiders, but the resemblance is only superficial. Cave crickets prefer dark damp or cool places like basements, crawl spaces, and garages. They seldom cause damage.

Control Methods

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 places for 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.

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.

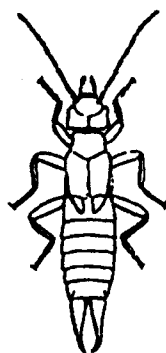
**Sowbugs and
Pillbugs
Class Crustacea
Order Isopoda**



Habitat Alterations

- Remove places where sowbugs and pillbugs can develop near the house, such as boards on the ground, flower pots, and flat stones.
- Remove mulch and replace with gravel, if necessary.

Earwigs *Order Dermaptera*



Earwigs are conspicuous and easily recognized relatives of cockroaches. They are flattened insects with forceps or pinchers at the tail end; the forceps grasp insect prey. At first glance, earwigs appear to be wingless; in fact, their wings fold up many times under the small front wing covers; some fly to lights. Earwigs feed on other insects and often scavenge in garbage and moist plant material. They also feed some on plant tissue, and at least one is a pest in greenhouses. They are dependent on high moisture. Earwigs are active at night; they shelter together and are quiet during the day.

Earwig females tend their young. They place their eggs in moist depressions or holes, guard them, groom them until they hatch, and take care of the early stage nymphs. Earwigs grow with gradual metamorphosis; older nymphs and adults 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.

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 earwig infestations are very high.
- Spray in cracks next to the foundation and under shrubbery.
- Sprays of detergents are known to quickly kill earwigs. Use pesticidal soaps when labelled for this use.
- Dust in dry basement areas to kill earwigs there.

Control Methods

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 20°C (69°F) on sunny, late fall and early, spring days; general air temperatures are lower. As general air temperature increases, the temperature in the mites' habitat grows to high. Both egg and mite development and activity suspend when temperatures exceed 24°C (75°F) or fall below 7°C (45°F) in their ground level habitat on grass or house foundations and siding.

When active, mites move from the grass area onto foundations, up under sheathing, or into wall cracks and spaces around windows that lead indoors. Mites that reach interior wall voids in the fall may contribute to the following early spring invasion.

Clover mite populations 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' wellbeing; lack of shade allows uniform temperatures across the sunny lawns and buildings. Scraped, bare soil is devoid of predatory mites and insects; it encourages the free build up of clover mites on new, fertilized grass. As the lawn matures and the plant, shrub, and tree community diversifies, a diversified

insect population is supported and clover mite invasions essentially cease.

Habitat Alterations

Whenever infested buildings and yards meet criteria that support clover mites, habitat alteration should be strongly recommended.

Outside:

- Place bare earth covered with gravel or gravel over plastic as a barrier strip about two feet wide on the sunny side of buildings to stop clover mite migrations.
- Plant shrubs in front of this strip; shrub mulching will add to the barrier's effectiveness by diversifying the habitat and breaking up the even temperature gradient near the foundation.
- Close-mow the lawn in a 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.

Control Methods

- Apply pesticide to the barrier area and the mowed grass adjacent to it unless mite activity is also obvious elsewhere.
- Place pesticides near the building being invaded.
- 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.

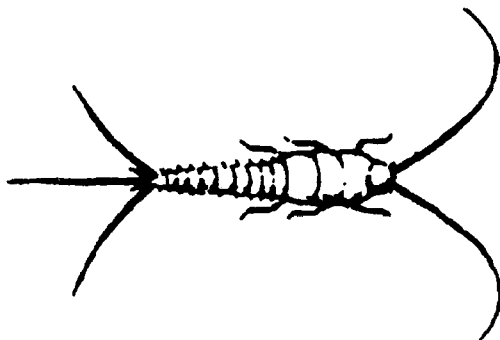
Questions for Self Study - Chapter 10

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?

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.

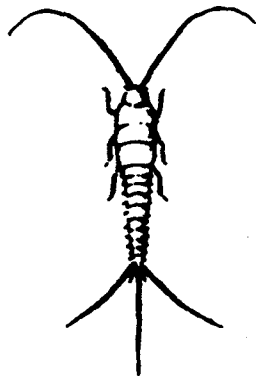


Goals of This Chapter

- 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 21°C to 27°C, 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 and papers, but they can also digest cellulose fibres.

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.

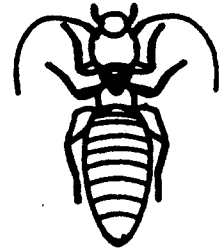
Firebrats

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 32°C 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 percent. 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.



Inspections

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 Alterations

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. Clean 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 in areas of infestation to kill newly hatched bristletails and

Control Methods

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.

Questions for Self Study - Chapter 11

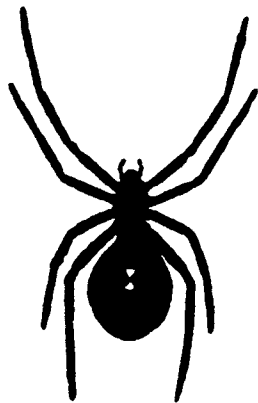
1. Name three common paper pests. Describe them.
2. Why are silverfish, firebrats and psocids referred to as "paper pests"?
3. Which prefers to live in higher temperatures - silverfish or firebrats?

Spiders

12

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.



Black Widow Spider

Goals of This Chapter

- 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 leglike 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 appendages called the spinnerets. Silk webbing threads out from these spinnerets.

All spiders produce silk, and they use silk in more interesting ways than most other silk producers. Spiders make silk retreats such as tubes and funnels, they make irregular

cobwebs as well as the evenly spaced, 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 abdomens usually decorated with two touching red triangles on the belly. They hang upside down in the web and the red hourglass is obvious. Sometimes dull red dots appear on the back, and occasionally the triangles don't touch, but this 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
Latrodectus mactans

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 indoor 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 it was slapped by the victim. The spider should be killed and taken to a physician, along with the victim.

Inspection

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.

These spiders are about 0.6 cm (1/4 inch) long with legs and cephalothorax darker than the abdomen. It has been reported 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 not

Control Methods

**Yellow House
Spider**
*Chirocanthium
mildei*

reached the adult stage, and they weave protective, white, silken cocoon-like webs in which to overwinter and molt into the adult stage in spring. The Yellow House spider will bite if pressed or accidentally 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 transition period. Other sites are gas stoves and refrigerators in recreational vehicles, gas air conditioners and through-the wall gas furnaces. (The silken obstructions interfere with gas flow; operational failure can be an indication of their presence.)

Habitat Alterations

- Close gaps around outside entry doors and ground floor windows that may be entry points for 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.

- Apply pesticides carefully, in small amounts and at low pressure to suppress drift and obnoxious odours.
- Ventilate the rooms after treatment.

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.

The Aggressive House Spider *Tegenaria agrestis*

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.

Control Methods

Orb 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

Web Weaving Spiders

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 cobweb 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

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.

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.

Wandering Spiders

Pest Management of Wandering Spiders

- Tighten under door and around window screens.
- Caulk door and window frames and all wall penetrations.
- Remove vegetation and litter from the foundation, doorways, and window wells.
- Turn off house, building, or area lights that attract flying insects, especially midges.
- Advise clients to look carefully at flowers brought in from the garden and from 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 gaps around entrances, and observe material being brought into the facility), spiders will reenter.

Questions for Self Study - Chapter 12

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?

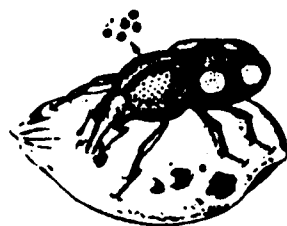
Stored Product Pests

13

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 provide the greatest potential for infestation and reinfestation.



Goals of This Chapter

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

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

Habitat Alterations

- Institute a good ongoing cleaning program. 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 (eg., 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 insects.
- Install insect electrocuters properly to attract flying insects.
- Investigate pheromone trapping for killing in conjunction with other methods.

Follow-up

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

Pests of Whole Grains and Seeds

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

These two similar snout beetles are found in stored whole grain. Adult beetles have snouts with jaws (mandibles) at the tip. With these jaws, females chew holes in the grain and deposit eggs. Larvae devour the inside of the seeds, pupate, and later, emerge to renew the cycle. **Rice weevils** 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.

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

Stored Food Pests

Rice Weevils and Granary Weevils *Sitophilus oryzae* and *Sitophilus granarius*



Angoumois Grain Moth *Sitotroga cerealella*



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.

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 indoors. 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 package (often for long distances; from a room in lower levels, through holes in the floor into upper areas, from a pantry to the ceiling); they may dangle from ceilings on silk strands. Their numbers, wandering habits, and large size easily distinguish Indian Meal Moth larvae from the tiny Clothes moth larvae that do not wander openly. A pheromone that specifically attracts the flying Indian Meal Moth is a very effective monitoring tool to use in warehouses and food service or retail sale food stores; in large areas, pheromone trap results reveal infested areas.

Indian meal moths infest most milled or ground cereals such as flour and cornmeal; all starchy processed products such as crackers, cake mixes, pasta, dog food, and rodent bait. They particularly respond to nut 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 that for 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.

**Cabinet or
Warehouse Beetles**
Trogoderma species

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.

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

Inspection

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

Habitat Alteration

- Advise intensive cleaning of warehouses and storage rooms.

Pesticide Application

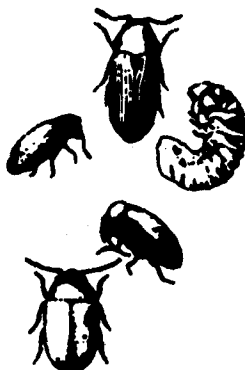
- Limit use of pesticides registered for food areas to applications in cracks and crevices.
- Fumigate mills or warehouses as needed.

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).

Control Methods

**Cigarette and
Drugstore Beetles**
*Lasioderma
serricorne,*
Stegobium paniceum

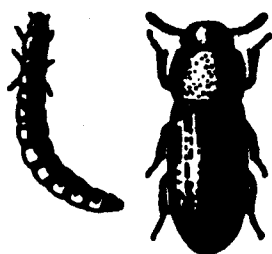


These beetles are similar in appearance; while related to some wood borers or Powderpost beetles, their habits are quite different. Adult Cigarette and Drugstore beetles are oval, about 0.3 cm (1/8 inch) long and reddish-brown in colour; they can fly. The Cigarette beetle is covered with tiny hairs that give it a golden sheen. The Drugstore beetle appears dull and darker because of deeper lines on its wing covers.

Larvae are tiny, white, curved, and covered with infested material causing them to look like tiny lumps of the stored product. They are difficult to detect unless the product is dumped and sifted. These beetles are commonly found in spices (paprika, ground pepper, ginger), milled cereals (flour and cornmeal), dry dog food, cosmetics, drugs, as well as some 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.

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 Beetles

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

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

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

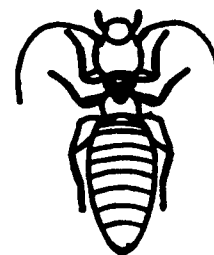
- A monitoring program using sticky traps should be followed until the population is eliminated.

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 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 Psocids, discard the starchy source of mold and dry out the storage area.

Psocids



The most common grain mite is called *Acaras siro*. These tiny tick relatives look like dust with a slightly brownish tinge. A constant humidity level is even more important to Grain mites which prefer relative humidities between 75 and 85 percent. Grain mites are almost 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.)

Grain Mites

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.

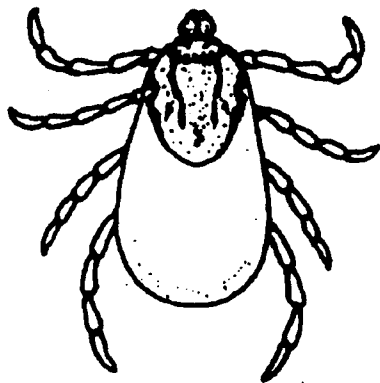
Questions for Self Study - Chapter 13

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.

Ticks

14

Ticks are members of the Arachnid order Acarina. Unlike many other members of this order, ticks can be identified without using a microscope. Ticks are pests as they feed on human blood as well as transmit diseases. Because of the fact that ticks are parasites on humans, 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.



Goals of This Chapter

- 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.

Life Cycle

Seed Ticks: Normally, thousands of tiny larvae hatch from a batch of eggs and crawl randomly in the surrounding area; fortunate ones attach to a small mammal or lizard. These ticks, called **seed ticks**, suck blood. Being small, their feeding (or **engorgement**) time lasts only hours or a day or so. While feeding, the host wanders and seed ticks are distributed away from the site of the initial encounter. When the engorged seed ticks drop off, they are still usually in or near an animal run.

Nymph: After molting, the engorged nymph climbs grass leaves or a plant stem. Ticks climb progressively higher as they develop; different stages reach different layers of vegetation. Because of this, developing ticks usually find a larger host than they had during the previous stage. After several days feeding, the engorged nymph drops off its host and molts.

Adult: The adult climbs vegetation; stretches its front pair of legs, and waits for vibrations or a shadow announcing a nearby host. Ticks sometimes wait for months or more than a year for a suitable host. According to one report, a soft tick lived for eleven years without feeding!

If heat or carbon dioxide is detected (eg. from a feeding mouse), the tick will seek it out. As the host passes by, claws located at the tips of the tick's legs grab hold of the host; the tick moves in the fur (or feathers) to a place where it can engorge.

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

Attachment and Feeding

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.

Deer ticks, or *Ixodes*, 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 transmis-

sion 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.

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.

Chemical Control

A considerable reduction in the numbers of both hosts and vector can be realized through elimination of 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.

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.

Control Methods

Questions for Self Study - Chapter 14

1. Why are ticks pests?
2. Describe the two types of ticks.
3. Describe the tick's life cycle.

Vertebrate Pests

15

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.

Be careful to weigh the benefits and the drawbacks to the damage caused when planning pest control programs for these pests.



Goals of This Chapter

- 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 before 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, shoot or poison a vertebrate pest can depend upon finding:

- the den
- the burrow or nest and exits
- the regularly travelled routes
- the feeding areas

Once you have identified the pest problem, you will be able to consider a **Pest Management Program**.

Vertebrate pests may be controlled by:

Vertebrate Control

- 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.**

Questions for Self Study - Chapter 15

1. When are vertebrates pests?
2. Name 8 methods to control vertebrate pests.
3. What are 3 factors that determine the chosen control method?

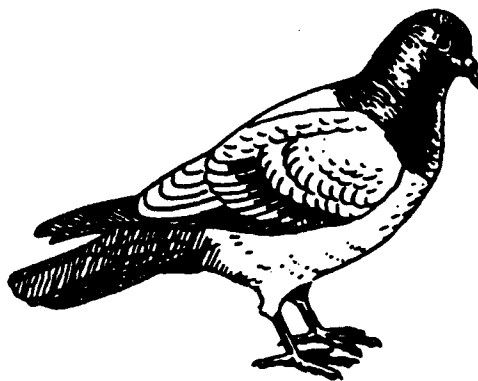


Birds

16

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.



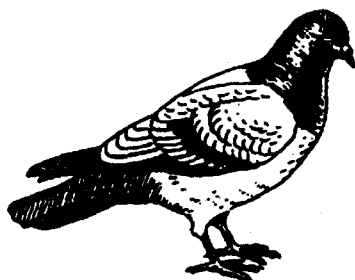
Goals of This Chapter

- 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 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 *Sturnus vulgaris*



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. Another 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.

Bird droppings under window sills, "whitewashing" down a building face or accumulating on sidewalks and steps are the most common obvious problems associated with birds

Defacement and Damage

roosting in large numbers. Clean up of these droppings is labour intensive and expensive. Bird droppings are corrosive and damage automobile finishes, many types of metal trim, electrical equipment and machinery. Downspouts and vents on buildings can become blocked with feathers, droppings and nest materials. Accumulation of this debris can also attract many insect pests.

Control Methods

The first step the pest control applicator must take when faced with a bird control problem is to assess the situation and inspect the area. The applicator must be able to identify the pest bird and determine an effective method of control.

Sanitation

Ensuring the affected area is clean and tidy is of the utmost importance in a bird control program. By removing all sources of food and water, this will aid in keeping bird populations to a tolerable level or maybe even to a non-existent level. Garbage is an excellent source of food to a bird and therefore, all garbage must be removed or kept in inaccessible containers.

Exclusion

Attempts should be made to exclude birds from buildings. Through various exclusion techniques, the pest control applicator should try and prevent the birds from nesting or roosting. Any small openings should be covered with netting or screens should be placed over larger openings. As eaves are favourable places for birds to make nests or to roost, netting should be used in these areas as well.

Ledges where birds prefer to roost can be made unfavourable by covering the area with wire netting. Another method to ensure birds will not roost on a ledge is to modify the structure of the ledge in such a fashion that birds cannot roost on the ledge. As an example, the ledge can be changed from a flat surface to an angled surface.

Repellants such as noise makers, sound vibrators and sticky substances have also been found to be effective methods in excluding birds from areas. Sticky repellants are tacky gels or liquid products that 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 will stop trying to land on treated surfaces. Repellants are registered under the Pest Control Products Act; ensure that all label requirements are met during the use of these products as well as any provincial regulations. A few tips to keep in mind when using a sticky repellent:

- Ensure the area to be treated with the repellent is clean.
- For areas to be treated that are porous, apply a sealant, paint or shellac to the area first. Sticky repellants are absorbed into porous materials.
- For easy removal and replacement, apply waterproof sticky repellent tape down first.

The effectiveness of sticky repellents is affected by environmental conditions at the treatment site. The use of sticky repellents will remain effective for a longer period in areas with little or no dust than in dusty locations.

Nest Removal

Birds rely on their nests for a number of reasons. The nest is where the young are raised and protection is offered by the nest. By removing the nest, the pest control applicator may be able to reduce the bird population.

In order to be effective, nest removal must be carried out every 2 weeks in the spring and summer. A long pole with a hook attached at one end is a useful nest removing tool. Another manner in which nests can be removed is through the use of pressurized water aimed at the nests.

Live Trapping

Trapping appears to be especially effective against pigeons. The best time to trap pigeons is in the winter when food is at a minimum. Traps should be placed in inconspicuous areas where pigeons commonly roost or feed. Trap placement is extremely important.

Prebaiting is required to get the birds feeding in one area. Ensure that bait and water is placed inside the traps. A few decoy birds in the traps may be helpful in luring the birds to the trap. Trapped birds should be removed on a regular basis and taken to an area where they will not present problems.

Shooting

Check with your local Natural Resources and Energy office as well as local municipal authorities prior to shooting any pest birds. It may be necessary to obtain a permit to conduct such a control method.

This method of control is very time consuming and may present hazards to both humans and structures if the shooting is carried out in a careless fashion.

Chemical Control

Chemical control of birds involves the use of avicides. Avicides are pesticides used to control birds. Only avicides registered under the Pest Control Products Act are to be used to control birds and they must be used according to label directions. Prior to using an avicide, check with your local Pesticides Regulatory Agency for any provincial regulations that must be met.

Avicides can be broken down into a number of different categories, depending upon their mode of action. The following are categories of avicides a pest control applicator will need to know.

Chemical Repellants

Repellants are available as gels, pastes and sprays. Repellants do not contain chemicals which are toxic to birds but rather the chemicals produce a "warm-foot" sensation to the birds when they come in contact with a treated surface. The birds find the treated area undesirable and they will move on to an untreated area.

When using repellants, it is advisable that areas to be treated are free from any debris. (For further information, refer to the section on Exclusion.)

Toxic Baits

The treated bait is mixed with untreated bait, such as grain or other food preferred by the pest bird, and left in a feeding area. Prebaiting with untreated bait is carried out to increase the number of birds feeding in the area. The toxic baits may be used as a bird frightening agent or as a toxicant. If used as a bird frightening agent, birds show distress symptoms and erratic behaviour, which frightens other birds away. Toxicants work by actually reducing the bird population in the treated area.

When using toxic baits, the pest control applicator must ensure that the baits are placed and used in such a way so as to minimize impact on non-target species. Dead birds must be disposed of daily for sanitation purposes as well as minimizing the chance of secondary poisoning.

Toxic Perches

Toxic perches are perches which are treated with a toxicant. The bird lands on the perch and the toxicant is absorbed through the bird's feet. When considering the use of toxic perches, the pest control applicator must ensure that they are not used in areas where protected birds prevail.

Removal of Bird Droppings

Pest control applicators should follow these precautions when removing large quantities of bird droppings to minimize the risk from potential disease organisms in the droppings:

- Wear an appropriate respirator.
- Wear protective gloves, hat, coveralls and boots.
- Wet down the droppings to keep the spores from becoming airborne.
- Put droppings into plastic bags and seal them tight.
- Dispose of the droppings according to provincial requirements.
- Have a shower.

For any area requiring bird control, it is important to first investigate all factors associated with the problem. From this information, you will be able to chose the most effective control program.

Chapter Questions for Self Study - Chapter 16

1. Name three species of birds which are considered common pests.
2. Why are birds pests? List and describe three situations in which birds are considered pests.
3. Describe 6 control methods for birds.
4. Describe 3 types of avicides and how they work.

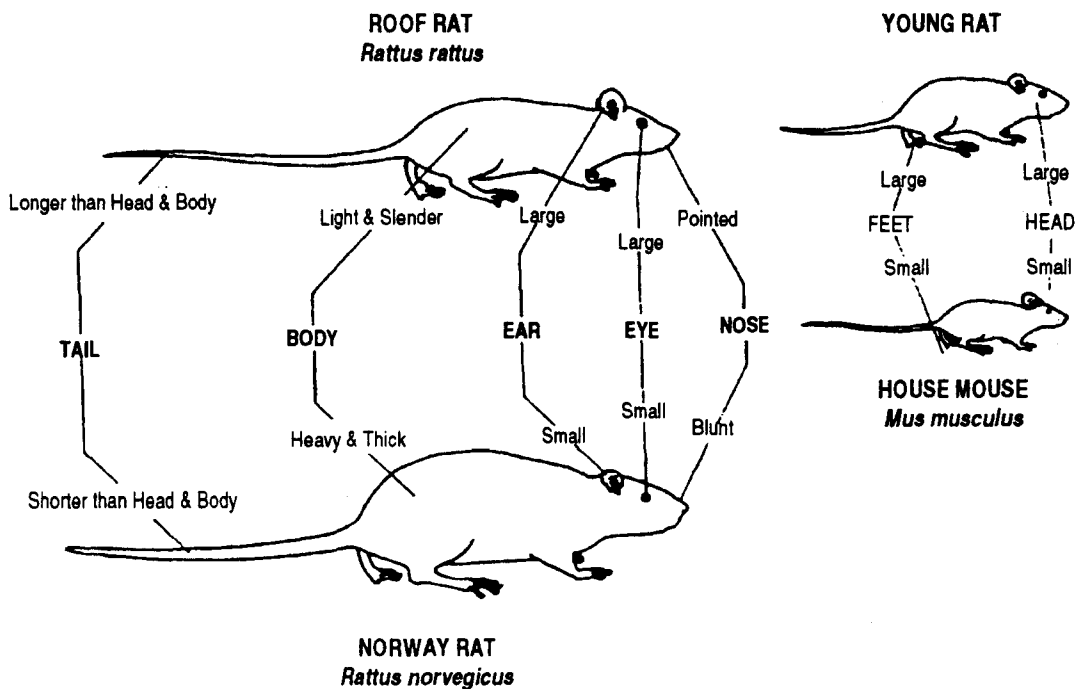


Rodents

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.

Field Identification of Domestic Rodents



Goals of This Chapter

- 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.

Rats

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 understanding 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. Rats are 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 food gathering 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 escapes. The nest openings are hidden under grass, boards or are plugged with dirt. Indoors, Norway rats build their nests inside 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. An inspection will identify if an area is infested, and will identify where the rats are feeding and nesting, their patterns 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 to use, 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 the old 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 droppings are black or nearly black, they may glisten and look wet and they have the consistency of putty. Week old droppings 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 an ultraviolet 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.

Rats are responsible for the spread of many diseases. Sometimes 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

From history, you will recall the "Great Plague" which killed large numbers of people in Europe. Although no major outbreak of plague has occurred since the 1920's, there is still a danger.

The disease is transmitted to people by the oriental rat flea. The flea bites an infected rat and then, feeding on the human, inoculates them with the bacteria that causes the disease.

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 people bitten 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 to the 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 a rat'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 organisms are spread from rat urine into water or food and enter humans through mucous membranes or minute cuts and abrasions of the skin.

Trichinosis

Trichinosis results from a nematode, or tiny roundworm, that invades intestines and muscle tissue. Both people and rats 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.

Control Methods - Rats

Successful long term rat control is not simple. The key is to control rat populations, not individual rats. Rat control requires an integrated approach including inspection, sanitation, "rat-proofing" and the use of either chemical or non-chemical mechanisms.

Sanitation

Like all animals, rats need food to survive. Baiting programs often fail because the bait cannot compete with the rat's regular food. Removing food sources will help in controlling rat populations.

Some common sanitation tips that may prove helpful in a rat control program include:

- Close or repair dumpsters and garbage containers that are left open or are damaged.

- Clean food spills.
- Do not leave food out overnight.
- Outdoors, remove seeds spilled under birdfeeders or food around doghouses.
- Inside buildings, ensure any food is stored on pallets, not on the floor or against walls.

Pallets should be spaced in such a way to permit inspection and cleaning around the stored food.

Elimination of hiding places is also effective in controlling rodents. Around the perimeter of buildings, hiding places can be eliminated by:

- Removing any plant ground cover.
- Removing weeds.
- Keeping grass mowed.
- Ensure area is free from wood piles or debris.

Within a building, hiding areas are eliminated by reducing clutter in rarely used rooms and by keeping rooms organized and clean.

Exclusion

Excluding rats from an area is the long term goal in a rodent control program. Exclusion is also referred to as “rat-proofing” and involves making a building or structure impossible for rats to enter.

Some exclusion techniques for the exterior of a building may be:

- 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.
- Repair breaks in the foundation below ground level.

“Rat-proofing” the interior of a building may involve:

- Seal spaces between walls and pipes.
- Repair gnaw holes or stuff them with copper wool.
- Equip floor drains with sturdy metal grates held firmly in place.

Trapping

Trapping is an effective control method to use when the use of a rodenticide is risky or isn't working too well, if the odour of dead rats would be unacceptable, or where there are only a few rats infesting a contained area.

Trapping has many advantages in that there is less nontarget risk associated with a trap as compared to a rodenticide, the pest control applicator knows instantly if the trap is successful and disposal of the carcass is possible, thereby avoiding any odour problems.

The snap trap is an effective type of trap for rats. It is very important that traps be properly placed and in adequate numbers in order to be effective.

Some useful trapping tips are:

- Leave the traps unset for a few days.

- Set traps with food if food is not readily available. Peanut butter, hot dogs, bacon, nuts or meats are good baits for Norway rats; dried fruit and nuts, or fresh fruit will attract roof rats.
- Use movable baits.
- Sprinkle cereal around the baits 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 traps during their regular travels.)
- Set traps where droppings, gnawing damage, grease marks or other signs of activity are noted.
- Use enough traps. Set three traps in a row so that a rat, leaping over the first, will be caught in the second or third.
- Camouflage traps when left with only a few difficult rats to trap.
- Move boxes and objects around to create narrow runways to the traps.
- Inspect traps frequently to remove dead rodents and change old bait.

Another way to trap rats is with glue boards. Glue boards use a sticky material that traps rodents. Glue boards are most often used against mice but they are sometimes effective against rats. Larger glue boards have been designed to trap animals the size of rats.

Tips for the use of glue boards include:

- Place the boards lengthwise flush along the wall or any object that edges a runway

- Do not place glue boards directly over food products or food preparation areas.
- Secure the glue board with a nail or wire so the rat cannot drag it away.
- Install glue boards in bait stations in high traffic areas, areas where children or pets can come in contact with the glue, or in areas of excess dust or moisture.
- Adding a dab of bait to the centre of the glue board may prove helpful.

Chemical Control

Rodenticides

A rodenticide is a pesticide designed to kill rodents. There are three major formulations of rodenticides used to control rats: food baits, water baits, and tracking powder.

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 20 kilogram bulk tubs, in place packs containing less than 30 grams 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 pests, some moderately toxic, and some very toxic.

Many of the old, ancient poisons that were toxic to humans were also used to poison rodents. Experimentation with poisons for killing rodents, produced rodenticides made of arsenic, cyanide, strychnine, etc.: stomach poisons, that were mixed with food and had such extreme toxicity that they killed any animal that ingested them in sufficient amounts. Rats that did not eat a lethal dose, however, recovered,

became "bait shy" and communicated their preference - or revulsion - to others in the colony. Because of this, these poisons were undependable.

A new type of rodenticide was developed in the 1940's that reduced the clotting ability of the blood. This material became Warfarin, the first anticoagulant rodenticide. Others followed: warfarin, chlorophacinone, diphacinone, pindone. The anticoagulants were effective and did not cause bait shyness. Several factors overcame the risks of acutely toxic poisons. While the anticoagulants could be lethal to warm-blooded animals, many species including poultry, farm animals, pets and humans would have to consume large quantities over several days to cause fatalities. As well, an antidote, vitamin K, was developed.

Evidence of resistance to anticoagulants and a desire for quicker results drove the successful search for single dose anticoagulants - brodifacoum and bromadiolone. In recent years non-anticoagulant rodenticides with different modes of action, such as cholecalciferol, have been proven effective. Zinc phosphide, used as a single dose non-anticoagulant, is somewhat poisonous to all vertebrates. It is often used as a tracking powder and is licked from the fur when rodents groom themselves. It is also incorporated in dry baits. Zinc phosphide should never be mixed with bare hands nor applied without wearing gloves.

Remember, rodenticides must be used very carefully: they are made to kill animal species of the same class as humans.

Several general guidelines should be followed when using a poison bait. First and foremost, protect children, pets, wildlife, and domestic animals from eating the bait. All rodenticides have warnings on the label telling the applicator to place the bait "in locations not accessible to children, pets, wildlife, and domestic animals, or place in tamper-proof bait boxes." What are safe, inaccessible areas is determined by evaluating each case. Ask yourself questions like these:

- Is it possible for a child or pet to reach under a refrigerator to grab a place pack that you hid underneath?
- Could a guard dog at a warehouse find and eat the bait blocks you placed under a loading dock?

If so, change your placement or put the bait inside a tamper-proof bait box.

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

- Ensure that bait boxes are clearly labelled 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 will consider it to be part of their normal surroundings.
- Good bait placements can be effective even when placed 4 to 15 m (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-fountains 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 behaviour. 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' feed and fur and is swallowed when the rats groom themselves. The major advantage to tracking powder 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 0.3 cm or 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 labelled) 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 non-target 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 slow acting poisons.

Mice

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.

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 hairless. 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.

Sounds

Sounds are common at night where large numbers of mice are present.

- Listen for squeaks, scrambling and sounds of gnawing.

Droppings

A house mouse produces about 70 droppings per day. Fresh droppings are not usually as soft in texture as rat droppings and in a few days become quite hard. Mouse droppings are frequently the first evidence that mice are infesting. Large cockroaches, bats, and other species of mice such as deer mice (*Peromyscus* sp) and meadow mice (*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 ultraviolet light.

Grease Marks

Like rats, mice produce greasy smears where dirt and oil from their fur marks pipes and beams. House mouse spots are not as easy to detect.

- Expect markings to cover a smaller area than those made by rats.

Runways

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

Tracks

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

Gnawing Damage

Recent gnawing on wood are light in colour, turning darker with age.

- Look for enlarged cracks beneath doors.
- Look for small tooth marks. (Such evidence frequently helps to distinguish between mice and rats).
- Look for wood chips with a consistency like coarse sawdust around baseboards, doors, basement windows and frames, and kitchen cabinets.

Visual Sightings

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

- Use a powerful flashlight or spotlight at night in warehouses and food plants to confirm house mouse presence.

Nest sites

- Look in garages, attics, basements, closets, and other storage places.
- Be alert to fine shredded paper or other fibrous materials; these are common nest-building materials.

Pet Excitement

- Follow up when cats and dogs paw excitedly at a kitchen cabinet door, the floor at the base of a refrigerator, or at the base of a wall, especially if mice have invaded the premises only recently.

Mouse 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 may travel widely within a building leaving tracks on many patches of dust) house mice do not range widely.

- Read natural signs such as droppings, urine stains, tracks, and damage.
- Make nontoxic tracking patches of talc at 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 30-45 centimetre (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 0.6 centimetre (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 10 metres (30 feet) from the nest, and more often is about 3 metres (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 or mice, but look for good trap locations in a three-dimensional sphere about ten feet in diameter around those signs.

- Mice can be living about 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, funnelling 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. Odour play a role too; traps that smell "mousy" catch more mice. Use a small dab of peanut butter inside the tunnel entrance to improve the catch.

- Check traps frequently. Mice are captured alive but may die in a day or two. Some traps have a clear plastic end plate or lid so you can see if any mice have been captured.
- Place the traps directly against a wall or object with the opening parallel to the runway, or point the tunnel hole towards the wall, leaving 2 to 5 cm (one or two inches) of space between the trap and the wall.
- If mice are active, place many traps 2-3 metres (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 centre of the board.
- Place the glue boards 1 to 3 metres (5 to 10 feet) apart in infested areas (closer if the population is large).
- If no mice are captured in three days, move the board 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 labelled for mouse control.
- Place the baits in favourite 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 3 metres (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 labelled 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 of 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 0.2 cm (1/16 inch) deep.
- Do not allow tracking powder to drift into nontarget areas.

Remember - when faced with a rodent control problem, first identify whether you are controlling a rat or a mouse. Knowing the pest will help you devise an effective control program.

Questions for Self-Study - Chapter 17

1. Name three species of rodents which are common pests.
2. Are rats a major carrier of 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 their nests? A mouse?
5. Describe rat and mice droppings.
6. Describe the difference between tracking powder and a tracking patch.
7. What are the three types of rodenticides used to control rodents?
8. List three ways in which mouse control programs differ from rat control programs.

Wood Destroying Insects

18

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

Goals of This Chapter

- 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.

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 damage is limited to one generation. These beetles however can work quickly and thoroughly on wood with a high starch content.

**False Powderpost
Beetle**
Family *Bostrichidae*

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.

The furniture beetle not only attacks furniture as its name applies but structural timbers as well.

Furniture Beetles
Family *Anobiidae*

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 any 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 of an 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 become 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 reinfestation, area under attack, speed of control needed and 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.

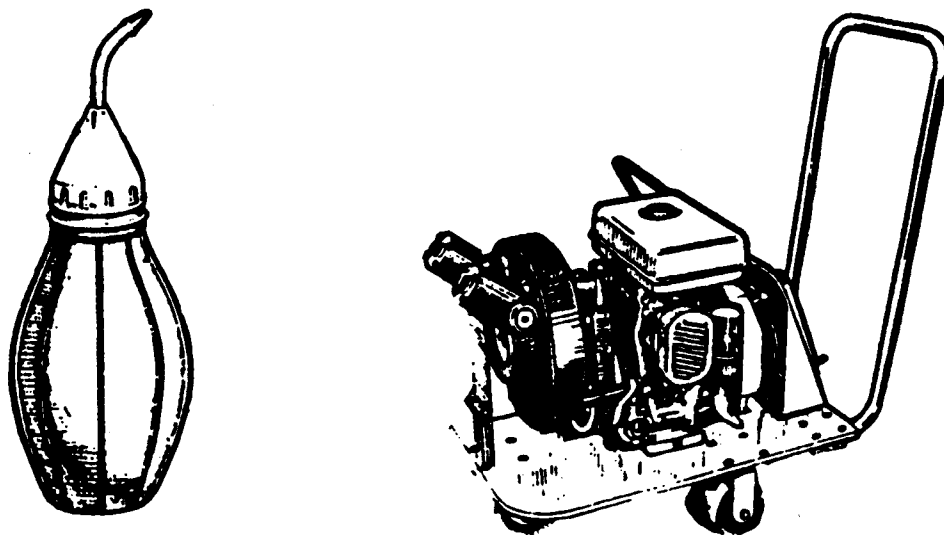
Questions for Self-Study - Chapter 18

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.

Application Equipment

19

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.



Goals of This Chapter

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

Application equipment detailed in this chapter is in addition to the information on equipment found in the General Pesticide Safety 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 General Pesticide Safety Manual.

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 μm (microns or micrometres; 1 μm = 1/1000 mm or 1/25000 inch)

for a fine spray and 400 + μm 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.

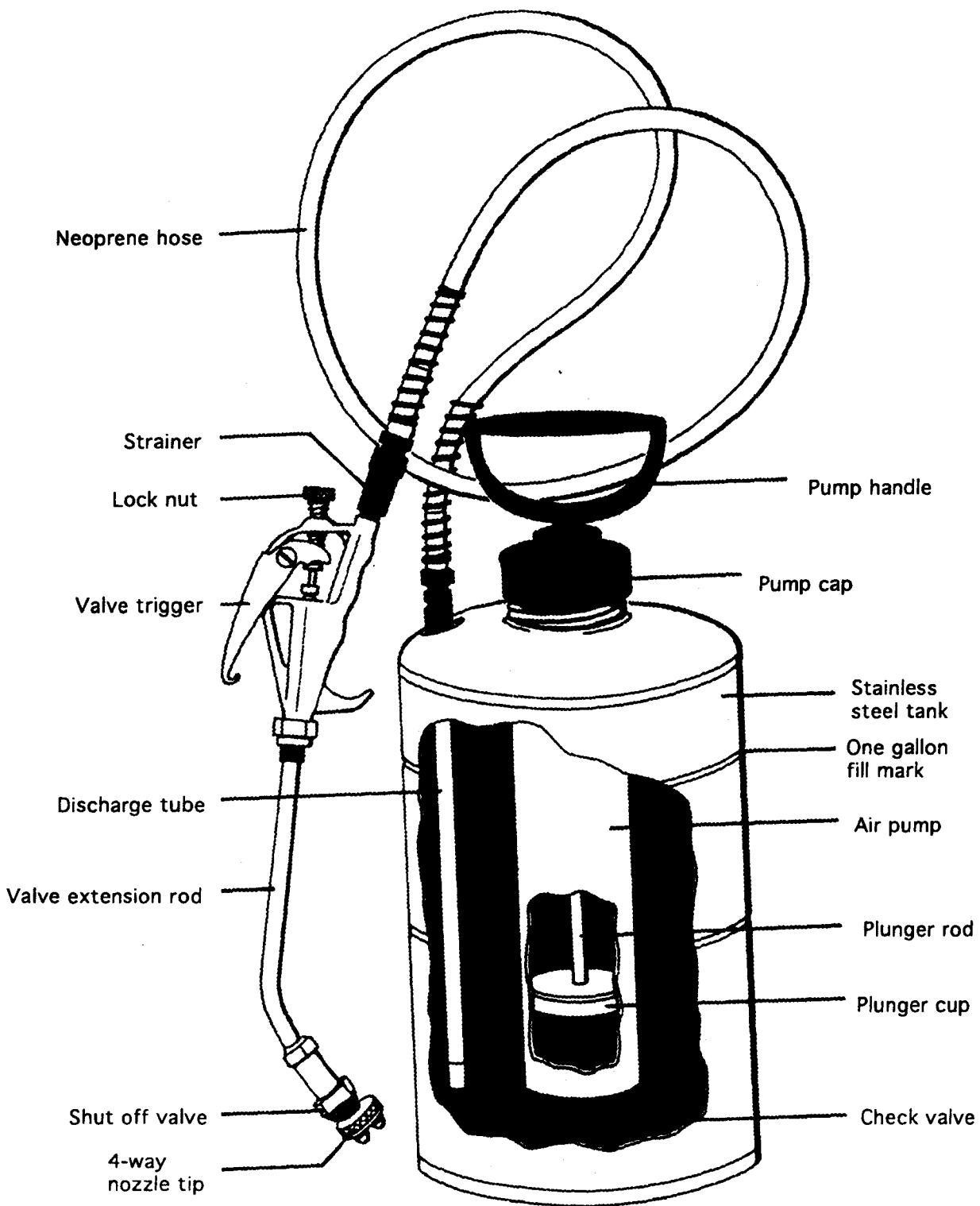
The hand-operated compressed air sprayer is the most widely used type of equipment in structural pest control. It offers adequate tank capacity, operating pressure and spray patterns for structural applications. It is used for broadcast, spot, and crack and crevice treatments both on the exterior and interior of structures.

This type of sprayer has three major components - tank, pump unit and application wand with hose. (Refer to the diagram.)

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



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

wand includes replacing the O-ring and valve seat in the nozzle tip assembly, and the valve packings 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 pinstream pattern. 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.

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.

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 and an 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 Dosage (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 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.

Foggers

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.

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 are available in enclosed baiters where the insect must enter to access the bait, or as a paste that is placed directly into insect harbourages such as cracks and crevices.

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.

Each type of bait has advantages or disadvantages, depending on the circumstances. 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 that they are easily 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.

Questions for Self Study - Chapter 19

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.

Answers

To Chapter Questions



Chapter 1 - Provincial Legislation

1. Ensure that pesticides are used, stored and disposed of in an appropriate manner.
2. Complete forms 21-1070 and 21-1066 and send these to the New Brunswick Department of the Environment along with the appropriate fee and proof of insurance; Form 21-1066 must also be sent to the local fire department and Department of Health.
3. Yes.
4. Class E, Level 1 (E1) - structural pest control.
Class F, Level 1 (F1) - pest control in waste disposal sites.
Class G, Level 2 (G2) - fogging and misting.
5.
 - 1) Private and public properties.
 - 2) Waste disposal sites.
 - 3) Bird control.
 - 4) Fumigation.
6. Type of policy; limits and a note section.
7. Yes.
8. Minimum size of 30 cm x 40 cm; be rain resistant; stop sign symbol with a hand; bilingual information; permit number; etc.

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.
 - 1) Store food properly to eliminate access by ants.
 - 2) Keep areas clean and free of food debris.
 - 3) 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.
 - 1) Tighten, caulk and screen route of entry.
 - 2) Store mattresses in protected areas.

- 3) Do not fold cot mattresses.
- 4) Open protective harbourages.
5. No.

Chapter 5 - Bees and Wasps

1. Aerial nesters; Underground nesters.
2. After dark as workers are in the nest.
3.
 - 1) They live in areas used by people for recreational purposes.
 - 2) When large colonies are formed.
 - 3) They create a nuisance as scavengers.

Chapter 6 - Cockroaches

1. German cockroach, Brown-banded cockroach, American cockroach, Oriental cockroach and Smoky-Brown cockroach.
2. German cockroach.
3. Kitchens and bathrooms.
4. American and Oriental larvae.
5.
 - 1) They flourish in human environments.
 - 2) They use human clutter and buildings as harbourage.
 - 3) They feed on a wide variety of food.
 - 4) 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

1. Centipedes have one pair of legs attached to each segment; millipedes have two pairs.
2. When weeds die and rain is minimal.
3. No.
4. 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 discoloration 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.
3. 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
- 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. Three types of avicides are:

- chemical repellants
- toxic baits
- toxic perches

Chapter 17 - Rodents

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

2. No.
3. Fear of new objects. Only rats exhibit neophobia.
4. 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 the consistency of putty. Week old droppings become dry, hard and appear dull. After a few weeks, droppings become grey, dusty and crumble easily.

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

6. 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 dust form.
7. Food baits, water baits and tracking powder.
8. 1) Sealing mice out of a building is difficult because mice are smaller.
2) Range is small. Identify each infested site in order to target control procedures.
3) 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
 - 1) piles of very fine sawdust;
 - 2) 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.

