

CHAPTER 3

Domestic Rodents

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the appearance, habits, and habitats of rats and house mice.
- Be familiar with rat- and mouse-spread diseases.
- Be able to describe monitoring procedures and tools used to inspect for rats and house mice.
- Be able to describe lethal and non-lethal methods of controlling rats and house mice.
- Know the various types of traps and baits used in rat and mouse control.

Rats (*Rattus* spp.) have caused more human suffering and more economic damage than any other vertebrate pest. From causing plague epidemics (the “Black Death” of Europe) to rat-bite fever, whether feeding on stored grain or gnawing electric wires, rats are enemies of humankind. Statisticians estimate that rats destroy 20 percent of the world’s food supply every year—directly by feeding and indirectly through contamination.

Yet rats’ adaptability can be admired. They have adapted to most human environments. They live in granaries, in fields, in city sewers, on ocean-going ships, on roofs, in attics, in basements, in street trees, on top of 30-story buildings, and inside subway tunnels.

In most instances, rats are very wary. Hundreds may be nesting in a city block—in underground burrows, in sewers, on roofs, inside buildings—with few people in the area realizing it. Populations are dynamic: rats moving in, rats moving out, rats giving birth, and rats dying. Within a population, some rats will be easy to control, some difficult.

Successful long-term rat control is not simple. The key is to control rat populations, not individual rats. Rat control requires an integrated approach that includes non-lethal tools such as careful inspection, upgraded sanitation, and rat-proofing structures. Lethal control often combines the use of rodenticides with non-toxic control measures such as snap traps and glue boards.

The **house mouse** (*Mus musculus*) easily adapts to life with people. It thrives in a wide range of climatic conditions in a great variety of habitats, feeding on most human food and reproducing at a remarkable rate.

House mice are found throughout the United States and in most areas of human habitation. House mice are also found living in the wild, competing with native fauna. They are common inhabitants of grassy fields and cultivated grain crops. House mice have even been captured in open tundra in Alaska, miles away from human settlements.

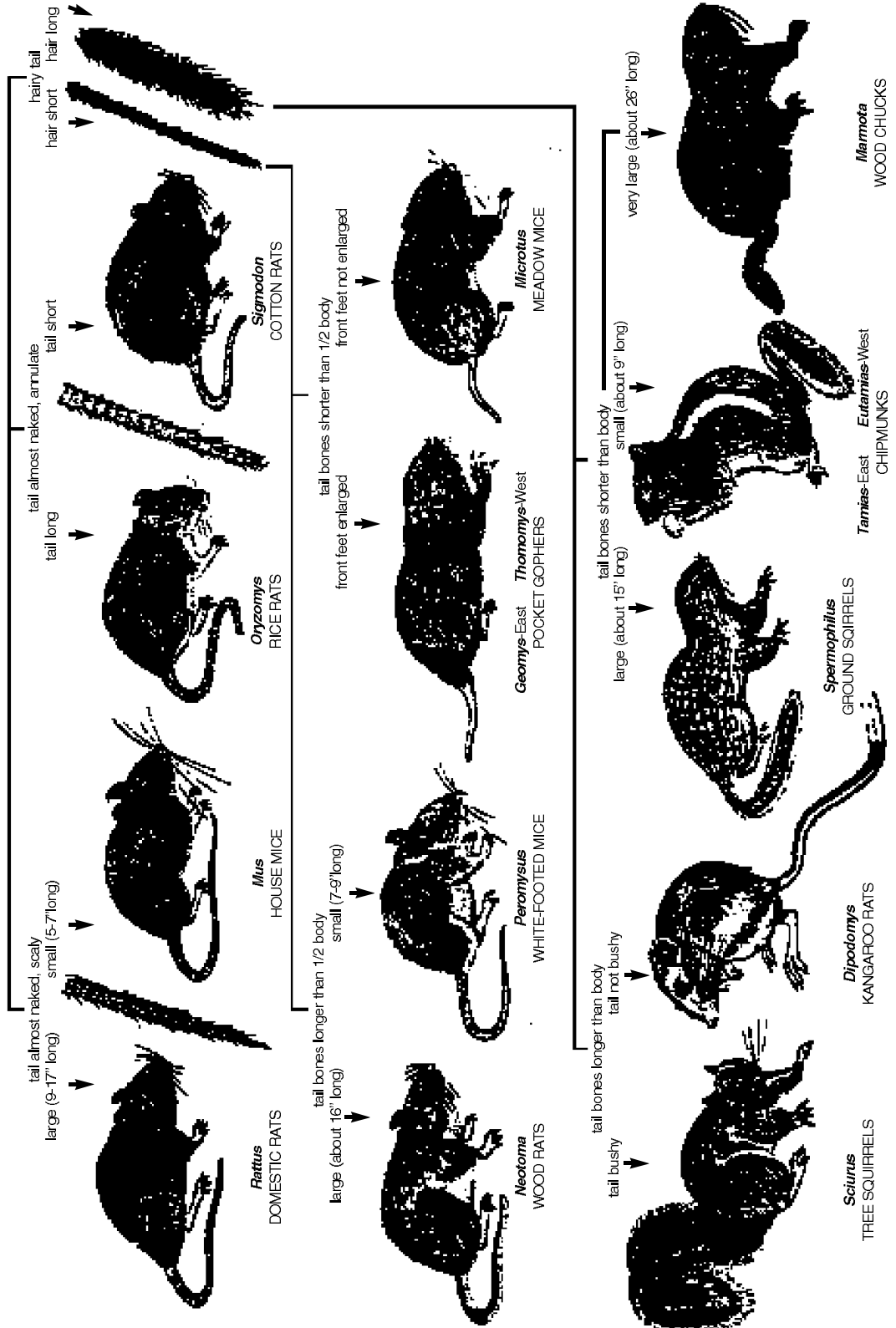
Technicians will find that the house mouse is the most troublesome and economically important rodent. House mice are a common problem in homes and in all types of businesses. Nearly everyone can remember times when they were irritated by mice. Mice are nuisances to rich and poor alike. The continual drain that house mice impose on stored food and fiber, and the damage they cause to personal possessions are the most serious economic threats. House mice also have the potential to transmit diseases and parasites to people and domestic animals.

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

RODENTS

PICTORIAL KEY TO SOME COMMON UNITED STATES GENERA

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RATS AND MICE AS DISEASE CARRIERS

Rats are responsible for the spread of many diseases. Sometimes they transmit the disease directly, by contaminating food with their urine or feces. Sometimes they transmit disease indirectly—for example, when fleas first bite an infected rat, then a person. Below are some of the more important diseases associated with rats and mice. These diseases often share similar symptoms, and medical professionals must perform the proper diagnoses.

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

Rat-bite Fever

Rats bite thousands of people each year. Most bites occur in inner cities. In some cases, victims, particularly infants and bed-confined elderly persons, are bitten in the face while sleeping. A small percentage of those bitten develop rat-bite fever. The bacterium that causes the disease is carried in the teeth and gums of many rats. Though the disease, in most cases, exhibits mild symptoms similar to those of flu, it can be fatal. It is of particular risk to infants. Rat-bite fever can also be transmitted by house mice.

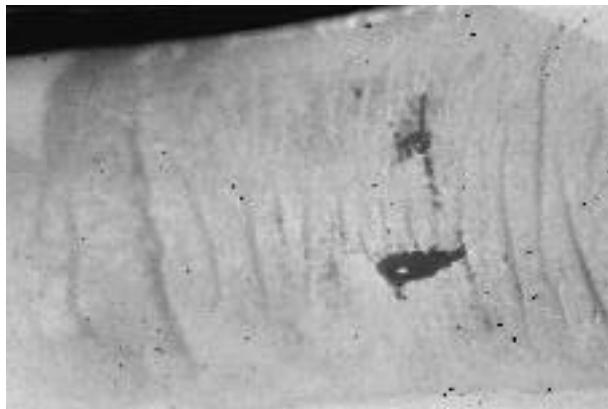


Figure 3.1. Rat bite

Salmonella Food Poisoning

Bacterial food poisoning, salmonellosis, can be spread when some foods are contaminated with infected rodent feces. Mice are probably more responsible than rats for the spread of this disease. Symptoms of food poisoning may include headache, stomach pain, diarrhea, and low-grade fever.

Leptospirosis or Weil's disease

Human cases of this disease are seldom fatal. The disease organisms are spread from rodent urine into water or food, and they enter humans through mucous membranes or minute cuts and abrasions of the skin. The dis-

ease may be so mild as to be unnoticed or may cause mild aches, pains, and fever. More serious cases, often referred to as Weil's disease, can result in high fever, jaundice, aseptic meningitis, acute kidney failure, internal bleeding, and occasionally death. The mouse can be a major carrier of leptospirosis, although human cases are more commonly caused by rats.

About Rabies

Rats in native habitats have not been found infected with rabies. Rabies transmission from rats to humans has never been documented in the United States. The U.S. Public Health Service recommends **against** anti-rabies treatments in the case of rat or mouse bites.

RAT-SPREAD DISEASES

Plague

The Great Plague of London killed half of the city's population. The Black Death of Europe in the 14th century lasted 50 years and killed 25 million people. In the first quarter of this century, an estimated 11 million people died in Asia from plague. The disease is transmitted to humans primarily by the Oriental rat flea. The flea bites an infected rat and then, feeding on a human, inoculates him/her with the bacterium that causes the disease. Although no major urban outbreak of plague has occurred since 1924, this is not a disease of the past. A reservoir of plague exists in some populations of wild rodents in several western states. Humans contacting these rodents could contract the disease. In the bubonic form of plague, symptoms include the sudden onset of fever with painful swelling of the lymph nodes. If the infection spreads to the lungs (pneumonic plague), it produces pneumonia that is highly contagious and often fatal. As suburbia expands into undeveloped areas, wild rodents can transmit the disease to urban rats. An outbreak of urban plague could occur in the United States.

Murine Typhus Fever

Murine typhus occurs in California and in southeastern and Gulf Coast states. It is a relatively mild disease in humans. As with plague, murine typhus is transmitted from rats to humans by a rat flea. In this case, however, the disease organism enters the bloodstream when feces of infected fleas are scratched into a flea-bite wound. Symptoms may include fever, severe headache, and rash.

Trichinosis

Trichinosis results from a nematode, a tiny round-worm, that invades intestines and muscle tissue. Both people and rats get the disease from eating raw or undercooked pork infected with the nematode. Rats help spread trichinosis when hogs eat food or garbage contaminated with infested rat droppings. Symptoms may include vomiting, diarrhea, and abdominal pain.

MOUSE-SPREAD DISEASES

Rickettsial pox

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

Meningitis

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

Dermatitis

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

Ray Fungus and Ringworm

Mice can transmit ray fungus, *Actinomyces muris*. Certain tapeworms are spread in house mouse droppings, and ringworm, a skin fungus disease, can be carried to humans by mice or contracted indirectly from mice through cats. Tularemia has also been linked to house mice.

THE NORWAY RAT

The most commonly found rat pest in Michigan is the Norway rat (*Rattus norvegicus*). The Norway rat is also called brown rat, house rat, sewer rat, and wharf rat. The adult Norway rat generally weighs between 12 and 16 ounces, and the head and body are 6 to 8 inches long. The fur is coarse and varies in color, but it is often brownish or reddish gray above and whitish gray on the belly. The nose is blunt and the eyes and ears are small. The scaly tail is shorter than the head and body. The Norway rat is generally considered the most important rat in the United States. It is found in every state.



Figure 3.2. Norway rat, *Rattus norvegicus*

HABITS OF RATS

Rats must be understood to be controlled. Knowledge of their life histories, habitat and food requirements, patterns of behavior, range, and other factors is essential to their management.

Life Cycle

A mature female rat can give birth to about 20 young in a year (four to six at a time), if she lives that long. The average life span of a rat in the field is less than one year; females live longer than males. The young are born in a nest. They are hairless, and their eyes and ears are closed. Within two weeks their eyes and ears open, they become furry and ratlike, and they begin exploring the nest area. In the third week, they begin to eat solid food and imitate their mother to forage, escape, and watch for danger.

If the mother rat has become wary of rodenticides or traps, many of her young will learn to avoid them. This learning experience can make control difficult in sites where long-term rodent control programs have been unsuccessful in the past. Young are totally weaned at 4 or 5 weeks old. They then weigh about 1 1/2 ounces. At 3 months, the young are independent of their mother. They will mate and continue the cycle in the same location or will migrate to a new, unoccupied nest area.

Social Behavior

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

Rats are aggressive, and social conflicts are most common at feeding sites, prime resting areas, and territorial boundaries. Females fiercely defend their nests and young from other rats.

Senses of Rats

Rats have poor vision. They are nearly color-blind, and they react to shapes and movement rather than identifying objects by sight. The limit of their vision is 30 to 45 feet. Their eyes are adapted to dim light.

Other senses, however, compensate for poor vision. They use their sense of smell to locate food, follow pathways, tell whether another rat is friend or foe, and identify new objects in their territory. They use long whiskers and guard hairs to “touch” their way through dark burrows, pipe chases, wall voids, and other runways. Their ears detect faint sounds that signal danger. Rats can taste certain chemicals at a parts-per-million concentration. This explains why rats often reject baits or avoid traps that have been contaminated with insecticides. Finally, rats have an excellent sense of balance that allows them to walk on wires and always land on their feet in a fall.

Fear of New Objects (Neophobia)

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

Physical Abilities

Adept athletes, rats can leap 3 feet straight up and 4 feet horizontally. They can scramble up the outside of a pipe 3 inches in diameter, and climb inside pipes 1 1/2 to 4 inches in diameter. They can walk between buildings on telephone or power lines, and scramble on board a ship on its mooring line. Rats can swim a half-mile of open water, tread water for up to three days, swim against a strong current in a sewer line, and dive through a sewer trap to come up inside a toilet. They can fall more than 50 feet and survive.

Rats gnaw constantly. Their teeth are extremely hard. They commonly chew through building materials such as cinder block, aluminum siding, sun-dried adobe brick, wall board, wooden cabinets, lead sheathing, and plastic or lead pipes. After gnawing a hole, an adult rat can compress its body and squeeze through an opening only 1/2 inch high.

Food and Water

Rats need about 1 ounce of food daily. Norway rats prefer protein-based foods such as meat, fish, insects, pet food, nuts, and grain. Household garbage is ideal food for Norway rats. However, they will feed on non-preferred food if nothing else is available.

Rats often cache or hoard food in hidden areas. This food may or may not be eaten when other food supplies run short. Hoarding is important for two reasons. First, rats may be moving toxic bait into a location where the label does not permit it to be. Second, rats may be hoard-

ing poison bait while feeding on their regular food. Thus, a baiting program becomes ineffective.

Rats need water every day. The amount varies, depending on the moisture content of their food, but is usually around 1/2 to 1 fluid ounce. Rats prefer to nest where water is easily available.

Range

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

Nests

Outdoors, Norway rats usually nest in burrows dug into the ground. The burrows are shallow (less than 18 inches) and usually short (less than 3 feet), with a central nest. Extra “bolt holes” are used for emergency escapes. They are hidden under grass or boards or lightly plugged with dirt. Burrow openings are 2 to 4 inches in diameter. Indoors, Norway rats nest inside walls, in the space between floors and ceilings, underneath equipment, between and under pallets, and in crawl spaces, storage rooms, and any cluttered area that is normally unoccupied. Norways prefer to nest in the lower floors of a building.

They also nest in sewers and storm drains, and on occasion they can be found in highly unusual nest sites. Norway rats can have several “hotel” nest sites in an area. A rat may spend a week in its home base and then move for a day or two into a secondary “hotel” nest site. Norway rats have been shown on occasion to have a home range of up to 20 acres when these secondary nest sites were included in the calculations.



Figure 3.3. Rat burrow

INSPECTION

Rats give many signs that they are infesting an area. Inspection will determine if a site is infested and will identify where rats are feeding and nesting, their patterns of movement, the size of the population, and the extent of the infestation. This helps the pest control technicians decide what control measures to use, where and how to use them, and how much effort is needed to put the program in place.

Flashlight

An inspection using a powerful flashlight just after dark is the best way to see rats. Dead rats are signs of a current or past infestation. If all that are found are old, dried carcasses and skeletons, it may mean an old infestation. Many fresh carcasses are an indication that someone may be baiting the area currently. If rats are actively observed during the day, the rat population is probably high.

Sounds

When a building is quiet, squeaks and fighting noises, clawing and scrambling in walls, or gnawing sounds may be heard.

- Use a stethoscope or electronic listening device to help pinpoint activity.

Droppings

A single rat may produce 50 droppings daily. Norway rat droppings are 3/4 inch long. The highest number of droppings will be found in locations where rats rest or feed.

- Determine if a rat population is active by sweeping up old droppings, then reinspecting a week later for new droppings.
- Look at the appearance of the droppings to determine if rats are currently active. Fresh rat droppings are black or nearly black, they may glisten and look wet, and they have the consistency of putty. After a few days or a week, droppings become dry and hard, and appear dull. After a few weeks, droppings become gray and dusty, and crumble easily. Note that old droppings moistened by rain may look like new droppings; however, if crushed, they will crumble and do not feel like soft putty.



Figure 3.4. Rat droppings

Urine

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

- Use portable ultraviolet lights developed by the food industry to identify rat urine on food items. Other substances besides rat urine also glow, so proper use of this inspection method takes practice.

Grease Marks

Oil and dirt rub off of a rat's coat as it scrambles along. The grease marks build up in frequented runways and become noticeable.

- Look along wall/floor junctions, on pipes and ceiling joists, and on sill plates where rats swing around obstacles. Grease marks are also found at regularly used openings in walls, floors, and ceilings.



Figure 3.5. Rat droppings and grease marks

Runways

Outdoors, rats constantly travel the same route. Their runways appear as beaten paths on the ground. Look next to walls, along fences, and under bushes and buildings. Indoor runways (harder to identify) may appear as well polished trails, free of dust.

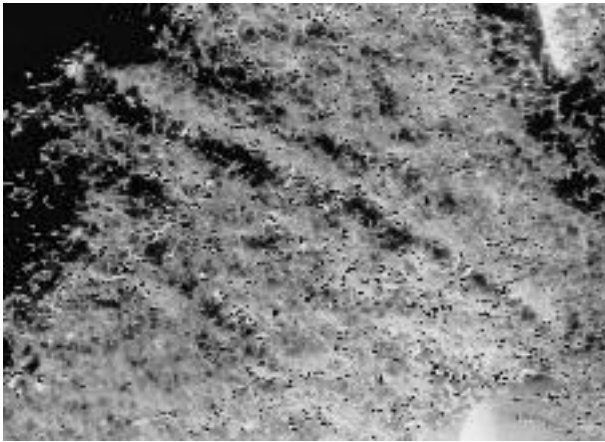


Figure 3.6. Rat runway in turf

Tracks

A rat's footprint is about 3/4 inch long and may show four or five toes. Rats may also leave a tail dragline in the middle of their tracks.

- Look in dust or soft, moist soil.
- Place a **tracking patch** in suspected rat areas to show footprints. A tracking patch is a light dusting of an inert material such as clay, talc (unscented baby powder), or powdered limestone. Don't use flour, which may attract insect pests. A good patch size is 12 by 4 inches. Apply patches in suspected runways and near grease marks. When inspecting tracking patches, shine a flashlight at an angle that causes the tracks to cast a distinct shadow. Note that a tracking patch is not the same as tracking powder. **Tracking powders** are diluted rodenticides in dust form; tracking patches use non-toxic dust. **Do not use a tracking powder to make a tracking patch.**

Gnawing Damage

A rat's incisor teeth grow at a rate of about 5 inches per year. Rats keep their teeth worn down by continuously working them against each other and by gnawing on hard surfaces.

- Look for gnawing damage as evidence of a rat infestation. Gnawed holes may be 2 inches or more in diameter.
- Inspect floor joists, ceiling joists, door corners, kitchen cabinets, and around pipes in floors and walls.



Figure 3.7. Rat teeth



Figure 3.8. Rat gnawings on trash can

Burrows

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

- Look for a burrow opening that is free of dirt, leaves, and debris, often with smooth, hard-packed soil.
- Look for rub marks at the opening and soil pushed out in a fan-shaped pattern.
- Fill the opening with a small amount of wadded-up newspaper or a few leaves and cover it with loose soil. If the rats are still using the burrow, they will reopen and clear the hole overnight.

Pet Excitement

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

Odor

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

Estimating Rat Numbers

It is not easy to tell how many rats are infesting a site. As a rough guide, you can use rat signs to characterize the population as low, medium, or high.

- In rat-free or low-infestation conditions, no signs are seen. The area either has no rats or was invaded recently by a few.
- With medium infestation, old droppings and gnawings can be observed. One or more rats are seen at night; no rats are seen during the day.
- When there is a high infestation, fresh droppings, tracks, and gnawings are common. Three or more rats are seen at night; rats may be seen in the daytime.

CONTROL AND MANAGEMENT OF RATS

Most successful rat control programs use a combination of tools and procedures to knock down the rat population and to keep it down. Methods used combine habitat alteration and pesticide application. Some of the tools, such as baiting and trapping, are lethal to the rat. Some tools are not—rat-proofing, for example. Sometimes applicators recommend changes that their customers need to make, such as increasing the frequency of garbage pickup or making building repairs.

The following sections describe some of the major techniques and tools used in controlling rats:

Sanitation

Food. Like all animals, rats need food to survive. Baiting programs often fail because the bait can't compete with the rats' regular food. The rats simply ignore the baits or cache them. Reducing the availability of rats' normal food encourages them to feed on any rodenticide baits placed in their territory.

- Close or repair dumpsters and garbage containers that are left open or damaged.
- Clean up food spills.
- Do not allow food to be left out overnight.
- Outdoors, remove seeds spilled under bird feeders or food around doghouses.
- In warehouses and food plants, look for spills around railroad tracks and loading docks. Ensure that food in storage is rotated properly (first in, first out) and is stored on pallets, not on the ground or against walls. The pallets should be 18 to 24 inches from side walls and placed so that aisles permit inspection and cleaning around the stored food.

Eliminate Hiding Places

Outdoors:

- Remove plant ground covers such as ivy near buildings.
- Remove high grass, weeds, woodpiles, and construction debris that permit rats to live and hide adjacent to a building.



Figure 3.9. Typical rat habitat

Indoors:

- Reduce clutter in rarely used rooms—basements, storage rooms, equipment rooms.
- Organize storage areas.

Rat-proofing (Exclusion)

In the long term, the most successful form of rat control is to build them out. Also called rat-proofing, this approach makes it impossible for rats to get into a building or an area of a building. Rat-proofing prevents new rats from reinfesting a building once it has been cleared.

Building Exterior:

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



Figure 3.10. Rat entry point

Building Interior:

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

Traps

Snap Trap. The snap trap is an effective method of killing rats when used correctly. Trapping is advised for use in places where rodenticides are considered too risky or aren't working well, if the odor of dead rats in wall or ceiling voids would be unacceptable, or when there are only a few rats infesting a limited area.

Trapping has several advantages. There is less non-target risk from traps than from a toxicant. The technician knows instantly whether the trap has been successful. Traps also allow for disposal of the carcass so that there are no odor problems.

Careful attention to detail is necessary to ensure proper placement in adequate numbers or rats will simply pass them by.

The best traps are those with expanded triggers (treadles) set for a light touch.

- Leaving the traps baited but unset for a few days may increase the catch by reducing the chance that wary rats will trip the traps without capture.
- Set traps with bait, if food for rats is in short supply, or without bait, if food is plentiful. Good baits for Norway rats include peanut butter, hot dog slices, bacon, and nutmeats.
- Tie movable bait to the trigger using string or dental floss, or the rat may simply remove the bait without triggering the trap.
- Sprinkle cereal, such as oatmeal, around traps to make them more attractive.
- Set unbaited traps along runways, along walls, behind objects, in dark corners where the rat is forced through a narrow opening. Place the trigger

side of the trap next to the wall. (Rats will step on the trap during their regular travels.)

- When runways are located on rafters and pipes, set expanded trigger traps directly across them, fastening them to pipes with wire, heavy rubber bands, or hose clamps, and to rafters with nails.
- Set traps where droppings, gnawing damage, grease marks, and other evidence of activity are found.
- Use enough traps. A dozen may be needed for a house; a hundred for a small warehouse. Set five or ten traps in an active corner of a room. Set three traps in a row so a rat leaping over the first will be caught in the second or third. If unsure about sites of activity, set traps along possible runways spaced 10 to 20 feet apart.
- Camouflage traps when left with only a few rats that become very difficult to capture. Set traps in a shallow pan of meal, sawdust, or grain. (Place a small piece of cloth or plastic over the trigger to prevent the meal from jamming the mechanism.)
- In stubborn cases, expose food in shallow pans until the rats readily feed on it. Then add a buried trap.
- Move boxes and objects around to create narrow runways to the traps.
- Avoid spraying insecticide on the trap or even storing traps with application equipment. The odor of insecticide can make a rat steer clear. The odor of other rats, however, improves a trap's effectiveness.
- Inspect traps frequently to remove dead rodents and change old bait.

Glue Boards. Another way to trap rats is with glue boards. Glue boards use a sticky material that captures rodents. Although most often used against mice, they are sometimes effective against rats. Be sure to use larger glue boards designed to trap an animal the size of a rat. Be aware that some people consider glue boards inhumane because the rodents are not killed instantly.

- Place glue boards in the same locations as you would place snap traps. Place them lengthwise flush along the wall, box, or other object that edges a runway. Overhead runways along pipes, beams, rafters, and ledges are good sites, too.
- Do not place glue boards directly over food products or food preparation areas.
- Secure the glue board with a nail or wire so a rat can't drag it away.
- Install glue boards in bait stations if people might be upset to observe a struggling rat, where children or pets could come in contact with the glue, or in areas with excessive dust or moisture.
- Check glue boards frequently and dispose of rodents humanely.
- Adding a dab of bait to the center of the glue board may improve its effectiveness.
- Do not use any bait containing a vegetable oil—e.g., peanut butter—this is a solvent for the glue.

Rodenticides

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

Food Baits. Rat baits combine a poison effective against rats with a food bait attractive to rats. At one time, applicators mixed their own baits. Now baits are mostly purchased ready-made and packaged as extruded pellets, in a dry meal, or molded into paraffin blocks for wet sites. Baits may be obtained in 45-pound bulk tubs, in “place packs” containing less than 1 ounce of bait, or anything in between.

Some baits kill rats after a single feeding; some require multiple feedings. Some are anticoagulants (causing rats to bleed to death), some affect respiration, and others have totally different modes of action. Some are only slightly toxic to people or pets, some are moderately toxic, and some are very toxic.

Many ancient poisons that are toxic to humans have been 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 1940s that reduced the clotting ability of the blood. This material, warfarin, became the first anticoagulant rodenticide. Others followed: warfarin, coumafuryl, chlorophacinone, diphacinone, pindone, valone. The anticoagulants were effective and did not cause bait shyness. Several factors overcame the risks of acutely toxic poisons. Though the anticoagulants could be lethal to any warm-blooded animals, many species—including poultry, farm animals, pets, and humans—would have to consume large quantities over several days for fatalities to occur. Also 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 bromethalin or cholecalciferol, have been proven effective. Zinc phosphide, a single-dose non-anticoagulant, is somewhat poisonous to all vertebrates. It is often used as a tracking powder, which the rodents lick from their fur during grooming. 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-resistant bait boxes.” Evaluate each case to determine what are safe, inaccessible areas. Ask questions such as:

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

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

Bait Boxes. A tamper-resistant bait box is designed so that a child or pet cannot get to the bait inside but a rat can. Bait trays and flimsy plastic or cardboard stations are not tamper-resistant bait boxes. Tamper-resistant boxes vary in 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-resistant unless they can be secured to the floor, wall, or ground.

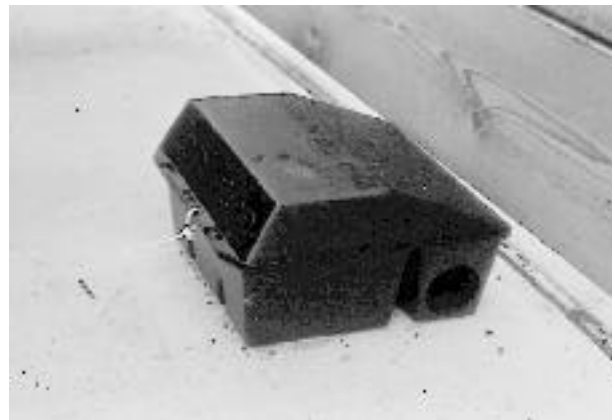


Figure 3.11. Tamper-resistant plastic bait box

- Ensure that bait boxes are clearly labeled with a precautionary statement.
- Check stations or boxes periodically to make sure that rats are taking the bait and that the bait is fresh. Rats will rarely feed on spoiled bait.
- Bait boxes should be placed wherever the rats are most active, as indicated by droppings and other signs (near burrows, along walls, at other travel sites, etc.).
- Put bait packs in burrows, wall voids, and similar protected sites. If a site is damp, use paraffin bait blocks or other water-resistant formulations. 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 your baits may not be taken for a few days or a week.

- Once bait is taken, leave the box in place for some time. The rats now consider it to be part of their normal surroundings.
- Good bait placements can be effective even when placed 15 to 50 feet apart. Bait placed outdoors around a commercial building can kill rats that are moving in from nearby areas.

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

Tracking Powders. Rats groom themselves by licking their fur. Tracking powder makes use of this behavior. This formulation is a rodenticide carried on a talc or powdery clay that is applied into areas where rats live and travel. The powder sticks to the rats' feet and fur and is swallowed when the rats groom themselves. The major advantage to tracking powders is that it can kill rats even when food and water are plentiful, or if rats have become bait- or trap-shy.

- Apply tracking powders more heavily than an insecticide dust but never deeper than 1/8 inch. Best application sites are inside wall voids, around rub marks, along pipe and conduit runs, and in dry burrows (when permitted by label). Apply with a hand bulb, bellows duster, or with a (properly labeled) flour sifter or salt 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 slower acting poisons.

THE HOUSE MOUSE

The house mouse is a delicate, agile little rodent. Adult weights vary from region to region and may be linked to the suitability of habitat, but they usually range from 1/2 to 1 ounce. Adult house mice vary in color from light brown to dark gray but most often are a dusky gray or medium brown over most of their bodies, except the belly, which may be a slightly lighter shade of their general color but never white.



Figure 3.12. House mouse, *Mus musculus*

The mouse has moderately large ears for its body size. The tail is nearly hairless and about as long as the body and head combined (2 1/2 to 4 inches). The feet are small in proportion to its body. The eyes are also relatively small (see Rodent Chart, page 185).

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

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

LOSSES DUE TO MICE

When mice infest stored food, the greatest loss is not what mice eat but what is thrown out because of real or suspected contamination. In six months, one pair of mice can eat about 4 pounds of food and deposit about 18,000 droppings. The amount of food contaminated by the mice is estimated to be about 10 times greater than the amount eaten.

So common are mice that the government permits a certain number of rodent hairs, and sometimes droppings, to remain in food commodities destined for human consumption. Yet food inspectors often have to condemn food products and fine manufacturers because of house mouse contamination in excess of that permitted.

Losses are not connected only with food. Family bibles or heirlooms stored in a trunk in the attic or garage that are damaged by mice are irreplaceable, as are original paintings and manuscripts stored in museums. Mouse-riddled documents in the bottom file drawer of an office cannot generally be valued in dollars and cents, but these losses can be costly.

Electrical wiring gnawed by rodents has started many fires. Many fire-related incidents listed as “cause unknown” are probably rodent-related. House mice frequently take up residence in electrical appliances and end up chewing into the power supply. This is particularly costly when computer systems are disrupted.

HABITS OF HOUSE MICE

Life Cycle

Under optimum conditions, house mice breed year round. Outdoors, house mice may tend toward seasonal breeding, peaking in the spring and fall. Environmental conditions, such as the availability and quality of food, can influence frequency of pregnancies, litter sizes, and survival. Under ideal conditions, females may produce as many as 10 litters (about 50 young) in a year. At very high densities, however, reproduction may nearly cease despite the presence of excess food and cover.

Newborn mice are quite undeveloped, weigh between 0.02 and 0.03 ounce and are nearly hairless. Eyes and ears are closed, but by the end of two weeks, the body is covered with hair and the eyes and ears are open. At about 3 weeks, the young begin short trips away from the nest and begin taking solid food.

Social Behavior

Though mice are active primarily at night, some day activity occurs. Movements of house mice are largely determined by temperature, food, and hiding places. Home ranges of mice tend to be smallest where living conditions are good.

Mice tend to travel over their entire territory daily, investigating each change or new object that may be placed there. They are very aggressive. Unlike rats, they show no fear of new objects. They dart from place to place, covering the same route over and over again. This behavior can be used to advantage in control programs. Disturbing the environment at the beginning of a control program by moving boxes, shelves, pallets, and other objects can improve the effectiveness of traps, glue boards, and bait. Mice will investigate the changed territory thoroughly.

Senses of Mice

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

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

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

Curiosity

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

Physical Abilities

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

- For their size, they are excellent jumpers, with some of the more agile individuals jumping 12 inches (30.5 cm) high from the floor onto an elevated flat surface.
- They can jump against a wall or flat vertical surface and use it as a springboard to gain additional height.
- They can run up almost any vertical surface—from wood and brick walls to metal girders, pipes, weathered sheet metal, wire mesh, and cables—without much difficulty if the surface is rough.
- They can run horizontally along insulated electrical wires, small ropes, and the like, with ease.
- They can squeeze through openings slightly more than 1/4 inch (6 mm) in diameter.
- They can easily travel for some distance hanging upside-down from 1/4-inch (6 mm) hardware mesh.
- They are capable swimmers, though they generally do not take to water as well as rats do and tend not to dive below the surface.
- They can walk or run along ledges too narrow for rats.
- They can jump from a height of 8 feet (2.5 meters) to the floor.
- They can survive at a constant -24 degrees F (-30 degrees C) temperature for 10 generations.
- They have been reported 1,800 feet below the ground in a coal mine.
- They are quick to explore any physical change in their environment.

Food and Water

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

Mice are nibblers, feeding 20 or more times during evening rounds. Mice have two main feeding periods, at dusk and just before dawn. In any territory, there will be one or two feeding sites, dark and protected, where mice will eat more than at other places. Mice tend to hold grain kernels, such as oats or wheat, nibbling on them like people eating corn on the cob. They often drop portions of the kernels as they get smaller.

Range

Mice are territorial and seldom travel more than 30 feet from their nest. Their range is much smaller than the rat's range of 100 to 150 feet. When food is nearby, mice may restrict their activity to a few feet. Males average slightly larger ranges than females.

Nests

House mice may nest in any dark, sheltered location. Nests are constructed of fibrous, shredded materials such as paper, cloth, burlap, insulation, or cotton and generally look like a loosely woven ball. They are approximately 4 inches in diameter.

Outdoors, house mice sometimes dig and nest in small burrows.

The small range of mice, the way they feed, and their food preferences are the characteristics that set house mice apart from rats. Keep these in mind when controlling mice. Many failures in mouse control can be blamed on applicators using rat control techniques.

INSPECTION

Sounds

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

- Listen for squeaks, scrambling, and sounds of gnawing.

Droppings

A house mouse produces about 70 droppings per day. Fresh droppings are not usually as soft 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* spp.) and meadow mice (*Microtus* spp.) may produce droppings similar to those of house mice.

- Look along runways, by food, near shelters, and in other places mice may frequent.

Urine

House mice occasionally make small mounds known as "urinating pillars." These consist of a combination of grease, urine, and dirt and may become quite conspicuous.

- Look for many small drops of urine.
- Use a blacklight. Urine stains will fluoresce under ultraviolet light.

Grease Marks

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

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

Runways

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

Tracks

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

Gnawing Damage

Recently created gnawings on wood are light colored; they turn 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 those of coarse sawdust around baseboards, doors, basement windows and frames, and kitchen cabinets.

Visual Sightings

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

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

Nest Sites

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

Pet Excitement

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

Mouse Odors

- Smell for the characteristic musky odor produced by mice. It can easily be differentiated from that of rats.

Estimating Numbers of Mice

Estimates are more difficult to get than for rats. The number of mice observed or food consumed is not highly reliable as a census technique with house mice. Unlike rats (which may travel widely within a building, leaving tracks on many patches of dust), house mice do not range widely.

- Read natural signs such as droppings, urine stains, tracks, and damage.
- Make non-toxic tracking patches of talc at 20- to 30-foot intervals (5 to 10 meters) throughout a building. The more tracks seen in each patch, and the more patches showing tracks, the larger the population.
- The percentage of patches showing tracks will reflect the extent of the local infestation.

Tracking patches are also an excellent means to evaluate a control operation. Compare the number of tracks or patches with mouse tracks before and after a control program.

CONTROL AND MANAGEMENT OF HOUSE MICE

Control of house mice is a three-part process:

- Sanitation.
- Mouse-proofing.
- 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 who 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 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 for 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 the floor. A 12- to 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 because mice are reported to be able to squeeze through an opening as little as 1/4 inch in diameter.

- 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 farther than 30 feet from the nest; more often about 10 feet. If mice are sighted throughout a building, it means that there are numerous discrete locations where you will have to set traps. Place snap traps not only wherever you see obvious signs of mice, but look for good trap locations in a three-dimensional sphere about 10 feet in diameter around those signs.
- Mice can be living above their main food supply in suspended ceilings, attics, inside vertical pipe runs, and on top of walk-in coolers. Or they can be below, in floor voids or crawlspaces, or under coolers and/or processing equipment.

- The best sites are those with large numbers of droppings—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, funneling the mice into a limited area.

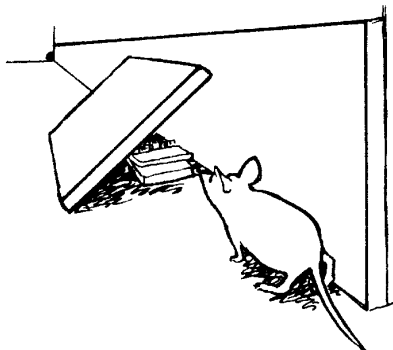


Figure 3.13. Place snap traps along walls and cover them with a board. This will force rodents to walk over the trap.

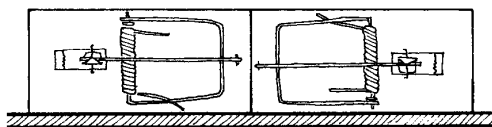


Figure 3.14. For greater effectiveness, place traps in pairs along walls to prevent rodents from jumping over a trap to avoid being caught.

- Good mouse baits increase a trap's 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 effective.

Multiple-catch Traps. Multiple-catch mousetraps catch up to 15 mice without requiring resetting. Some brands are called “wind-up” traps; the wind-up mechanism kicks mice into the trap. Others use a treadle door. Live mice must be humanely killed.

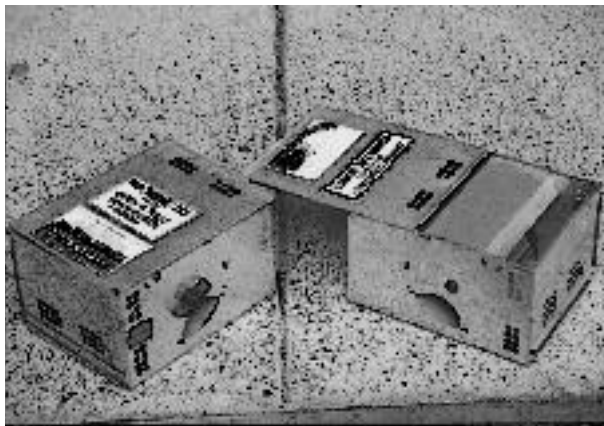
Mice like to investigate new things. They enter the small entrance hole without hesitation. Odor plays a role, too. Traps that smell “mousy” catch more mice. Place a small dab of peanut butter inside the tunnel entrance to improve the catch.

- Check traps frequently. Mice are captured alive but may die in a day or two. Some traps have a clear plastic end plate or lid so you can see if any have been captured.
- Place the traps directly against a wall or object with the opening parallel to the runway, or point the tun-

nel hole towards the wall, leaving 1 or 2 inches of space between the trap and the wall.

- If mice are active, place many traps 6 to 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.

Figure 3.15. These multiple-catch traps will catch up to 15



mice and do not have to be reset each time one is caught.

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 6 inches wide to increase the effectiveness of glue boards.
- Put a cotton ball in the center of the board.
- Place the glue boards 5 to 10 feet apart in infested areas; closer if the population is large.
- If no mice are captured in three days, move the boards to new locations.
- If a trapped mouse is alive, kill it before disposal. Replace the boards if they fill up with insects.

Rodenticides

Food Baits. Observe the same safety guidelines for mouse baits as discussed in the section on rat baits. Protect children, pets, wildlife, and domestic animals by putting the bait in inaccessible locations or inside tamper-proof bait boxes.

- Apply many small bait placements rather than a few large placements.
- Use baits labeled for mouse control.
- Place the baits in favorite feeding and resting sites, as revealed by large numbers of droppings.

- Place the baits between hiding places and food, up against a wall or other object to intercept the mice.
- Bait in three dimensions (see earlier discussion on trapping).
- Make bait placements 10 feet apart or closer in infested areas.
- If bait is refused, try switching to a different type and replacing the baits often.
- Use small bait stations—they are more attractive to mice than the larger rat-type stations.
- Practice strict sanitation so that other food is not outcompeting the baits.
- Place secure, tamper—proof bait boxes in safe locations near doors in late summer to intercept mice entering from the wild.

Liquid Baits. Mice get most of their water from their food. They also drink from a water container. Liquid baits that are labeled for mouse control can be effective in sites that do not have a ready supply of water. The same water bait dispensers used for rats can be used for mice. As with food baits and traps, many water stations will be necessary to put the bait into the territory of all mice infesting a building.

Tracking Powders. Tracking powders are especially effective against mice. Mice groom themselves more than rats, and they investigate enclosed areas that can be dusted with tracking powder.

- Apply inside infested dry wall voids.
- Dust tracking powder into voids in heavily infested apartment or office buildings.
- Place tracking powder in a bait station, a PVC tube, a cardboard tube, or any small, dark shelter that a mouse could enter. Mice will explore such a shelter. Apply the tracking powder in a layer less than 1/16 inch deep.
- Do not allow tracking powder to drift into non-target areas.

SUMMARY

Rats have adapted to most human environments. Along the way, they have caused more human suffering and economic damage than any other vertebrate pest. But they are marvelous athletes and successful survivors as well. Successful long-term rat control is not simple. The key is to control rat populations, not individual rats. To be controlled they must be understood. Two of the most important biological factors to help control rats are their fear of new objects and their large foraging range of 100 to 150 feet or more from their nest.

Successful rat control programs usually use a combination of tools and procedures to knock down a rat population and keep it down. In the long term, the most successful form of rat control is to build them out, also called rat-proofing. Other control tactics include trapping and poisons. People using rodenticide baits and tracking powders must take care to avoid risks to other people, children, pets, and non-target animals.

The house mouse is the most successful rodent in adapting to live with people. It is found almost anywhere people are, feeding on human food, sheltering in human structures, and reproducing at a remarkable rate. It is the most troublesome and economically important vertebrate pest, contaminating untold millions of dollars worth of food, damaging possessions, and causing electrical fires with its constant gnawing.

Many control failures against house mice are due to the applicator's lack of understanding of mouse biology and habits, particularly the major differences between mice and rats. Mice have a remarkable reproductive ability. A mated pair can produce 50 offspring in one year. They also have a foraging range much smaller than a rat's, usually only 10 to 30 feet. Baits, traps, glue boards, and the like must be placed close to the nest to be effective. Thus, good inspections are critical.

On the plus side, mice are curious and investigate new objects in their territory, so control measures can work fast when done correctly. Control of house mice is best when it is a three-part process: sanitation, mouse-proofing, and population reduction with traps and toxicants.

CHAPTER
3

Review Questions

Chapter 3: Domestic Rodents

- Rats are a major carrier of rabies.
 - True
 - False
- There is no chance of a modern-day outbreak of plague in the United States.
 - True
 - False
- 3-8. Match the following to the appropriate description:
 - Plague
 - Rat-bite fever
 - Salmonella food poisoning
 - Leptospirosis
 - Trichinosis
 - Murine typhus fever

_____ 3. Caused by a nematode spread by hogs eating food contaminated with rat droppings and humans subsequently eating undercooked pork.

_____ 4. Bacterial disease transmitted by the Oriental rat flea.

_____ 5. Disease caused by organisms spread by rat urine in water or food.

_____ 6. Bacterial disease causes mild flulike symptoms but can be fatal, especially to infants.

_____ 7. Disease organism enters bloodstream by scratching rat flea feces into flea bite wound.

_____ 8. Disease caused by bacterium from rodent droppings in stored food or on dishes.
- Mice are more likely to cause _____ than rats.
 - Leptospirosis
 - Trichinosis
 - Rat-bite fever
 - Salmonella food poisoning
 - Plague
- Mice, unlike rats, may also be responsible for the spread of:
 - Leptospirosis.
 - Meningitis.
 - Trichinosis.
 - Rickettsial pox.
 - B & D
- 11-14. Match the following to the appropriate description:
 - Dermatitis
 - Meningitis
 - Rickettsial pox
 - Ringworm

_____ 11. A rash caused by the bites of house mouse mites.

_____ 12. A skin irritation caused by the bites of house mouse mites.

_____ 13. A virus infection of house mice; transmitted to people through contaminated food or dust.

_____ 14. A fungus that humans contract directly or indirectly (through cats) from mice.
- A mature female rat gives birth to about:
 - 10 young/year.
 - 20 young/year.
 - 30 young/year.
 - 40 young/year.
- A rat can compress its body and squeeze through an opening as small as:
 - 1/4 inch high.
 - 1/2 inch high.
 - 1 inch high.
 - 2 inches high.
- A reason for "bait shyness" in rats is:
 - Young learn to be wary of baits from their mothers.
 - Rats can taste chemicals at a parts-per-million concentration.
 - Rats are wary of anything new in their territory.
 - Other food sources are available.
 - All of the above

18. Rats commonly travel a distance of ____ from their nest looking for food and water and patrolling their territory.
- 10 to 25 feet
 - 100 to 150 feet
 - 1 to 2 miles
 - None of the above
19. Which is NOT true of rat nests?
- Burrows have openings 2 to 4 inches in diameter.
 - Burrows have “bolt holes” for emergency escapes.
 - Indoors, Norway rats may nest inside walls, between floors and ceilings, under pallets and in crawl spaces.
 - Indoors, Norway rats prefer to nest in attics.
 - Norway rats will nest in sewers and storm drains.
20. When “hotel” nest sites are included in calculations, a rat’s foraging range may be up to 20 acres.
- True
 - False
21. Why is the hoarding behavior of rats a pest management concern?
22. Which of the following is NOT true about adult rat droppings?
- They average 5/16 inch long.
 - Fresh droppings are black or nearly black.
 - The highest number of droppings will be found where rats rest or feed.
 - A single rat can produce 50 droppings in a day.
23. In the long term, the most successful form of rat control is rat-proofing (“building them out”).
- True
 - False
24. Match the inspection tool with the rat sign it is used to detect.
- | | |
|------------|-----------------------------|
| A. Urine | _____ Ultraviolet light |
| B. Burrows | _____ Light dusting of talc |
| C. Tracks | _____ Wadded-up newspaper |
| D. Sounds | _____ Stethoscope |
25. With a medium-level rat infestation, you would NOT expect to see:
- Rats during the daytime.
 - One or two rats at night.
 - Gnawings.
 - Droppings.
26. List some non-lethal methods used to control rats and give an example of each.
27. Rodenticides should be placed:
- In locations not accessible to children, pets, wildlife, and domestic animals.
 - In tamper-resistant bait boxes.
 - Only outdoors.
 - All of the above
 - A or B
28. Some rat food baits may kill rats after a single feeding; others will kill after multiple feedings.
- True
 - False
29. Clients should be made aware that rodent baits are only slightly toxic to humans.
- True
 - False
30. When using a trigger trap to catch a Norway rat, you should:
- Spray insecticide near the trap to keep insects away from bait.
 - Set traps a distance away from droppings and gnawings.
 - Bait with peanut butter.
 - Place the trigger side away from the wall.
 - C & D
31. Which type of baits are best placed inside rat burrows?
- Bait packs
 - Bait boxes
 - Water baits
 - Tracking powders
 - A & D

32. Once rats have fed from a bait box, remove it immediately.
- True
 - False
33. When water is limiting, water baits can be used in open areas.
- True
 - False
34. Tracking powder kills rats because:
- Rats swallow tracking powder when they groom their fur.
 - Tracking powder is a powdery rodenticide bait.
 - Tracking powder is absorbed dermally through the rats' skin.
 - B and C
 - None of the above
35. The advantage of using tracking powders is that they can be used anywhere.
- True
 - False
36. The key to rat control is to control rat **populations**, not individual rats.
- True
 - False
37. List some features of bait boxes that help make them "tamper-resistant."
38. In 6 months, one pair of house mice can eat about 4 pounds of food and deposit about _____ droppings.
- 400
 - 1,800
 - 4,000
 - 18,000
39. When mice infest food, the greatest loss is not what mice eat but what is thrown out because of contamination.
- True
 - False
40. Government regulations currently exclude any contamination of food commodities by rodent hairs.
- True
 - False
41. Which is NOT true of mice's physical abilities?
- Can jump 12 inches from the floor onto an elevated flat surface.
 - Are better swimmers than rats, diving below the surface.
 - Can travel upside-down hanging off a 1/4-inch hardware mesh.
 - Can jump from a height of 8 feet to the floor.
 - Can run up almost any vertical surface.
42. Voles (meadow mice) have shorter tails and smaller ears than house mice.
- True
 - False
43. Mice, unlike rats, are shy of changes in their territory.
- True
 - False
44. Which of the following is NOT true about mice?
- Outdoors, mice tend to breed all year long.
 - Mice are mostly active at night.
 - Females can produce up to 50 young per year.
 - Mice seldom travel 30 feet from their nest.
 - Mice are nibblers.
45. Mouse control is difficult because:
- They can squeeze through openings slightly larger than 1/4 inch.
 - There can be many nests in an infested building.
 - They have a very high reproductive potential.
 - All of the above.
46. Which is NOT true of the food and water habits of mice?
- Feed at dusk and just before dawn.
 - May feed 20 or more times during an evening.
 - Prefer cereals over meats.
 - Must drink water every day.

47. The signs of mice infestations can be differentiated from rat infestations by the:
- Size of gnawings.
 - Odor.
 - Urination pillars.
 - A & C
 - All of the above
48. The **best** way to estimate the number of mice infesting is by:
- The amount of food consumed.
 - Non-toxic tracking patches.
 - The number of mice observed.
 - A & B
 - All of the above
49. Mouse-proofing is all that is needed to control an existing mouse population.
- True
 - False
50. Glue boards trap mice better than rats.
- True
 - False
51. Which is NOT true about multiple-catch traps?
- Can catch up to 15 mice without requiring resetting.
 - Mice often enter entrance holes without hesitation.
 - Mice are killed instantly.
 - Mousy-smelling traps often catch more mice.
 - B & D
52. Tying a cotton ball to a trigger trap will attract mice.
- True
 - False
53. The key difference between baiting mice and baiting rats is:
- You need to apply many small bait placements.
 - You must use water baits.
 - You need to wait weeks for mice to stop avoiding the "new" bait.
 - Baits are not effective against mice.
54. Tracking powders should be applied in a layer less than 1/16 inch deep for control of mice.
- True
 - False
55. Tracking powders are more effective against rats than mice.
- True
 - False
56. Mousetraps should be placed:
- About 6 inches away from a wall.
 - Every 30 feet.
 - Along walls, behind objects, and in dark corners.
 - In the center.
57. Which would be an effective placement of glue boards for trapping mice?
- Every 5 to 10 feet in infested areas
 - Lengthwise flush against the wall; along narrow runways
 - Every 5 feet in food preparation areas
 - In areas free of mouse droppings
 - A & B
58. Why should you use food baits in three dimensions when controlling mice?
59. List some sanitation methods for controlling mouse populations.
60. List some ways to mouse-proof a building.