
HOUSE MOUSE

Integrated Pest Management In and Around the Home

The house mouse (*Mus musculus*) (Fig. 1) is one of the most troublesome and economically important rodents in the United States. House mice thrive under a variety of conditions; they are found in and around homes and commercial structures as well as in open fields and agricultural lands. House mice consume and contaminate food meant for humans, pets, livestock, or other animals. In addition, they cause considerable damage to structures and property, and they can transmit pathogens that cause diseases such as salmonellosis, a form of food poisoning. House mice have not been found to be carriers of the deadly hantavirus.

IDENTIFICATION

House mice are small rodents with relatively large ears and small black eyes. They weigh about 1/2 ounce and usually are light brownish to gray in color. An adult is about 5 1/2 to 7 1/2 inches long, including the 3- to 4-inch tail.

Droppings, fresh gnaw marks, and tracks indicate areas where mice are active. Mouse nests are made from fine shredded paper or other fibrous material, usually in sheltered locations. House mice have a characteristic musky odor that identifies their presence. Mice are active mostly at night, but they can be seen occasionally during daylight hours.

While the house mouse has not been found to be a carrier of hantavirus, other mice have. Most notable are the deer mouse (Fig. 2) and the white-footed mouse, which sometimes invade cabins and outbuildings in California. The house mouse is distinguished from the deer mouse and the white-footed mouse by its overall gray-colored coat. The other two species have a white underside with a distinct line of demarcation between the dark coloration on top and the white underside. In addition,

the tail on the house mouse has almost no fur on it whereas the tails of the deer mouse and the white-footed mouse are moderately to well furred and are light underneath and dark on top.

BIOLOGY

Native to Central Asia, the house mouse arrived in North America on ships with settlers from Europe and other points of origin. A very adaptable animal, the house mouse often lives in close association with humans along with Norway rats and roof rats; however, mice are more common and more difficult to control than rats. Although house mice usually prefer to eat cereal grains, they are "nibblers" and will sample many different foods.

Mice have keen senses of taste, hearing, smell, and touch. They are excellent climbers and can run up any rough vertical surface. They will run horizontally along wire cables or ropes and can jump up to 12 inches from the floor onto a flat surface. Mice can squeeze through openings slightly larger than 1/4 inch across.

In a single year, a female may have 5 to 10 litters of about 5 or 6 young. Young are born 19 to 21 days after mating, and they reach reproductive maturity in 6 to 10 weeks. The life span of a mouse is probably 9 to 12 months.

MANAGEMENT

Effective control involves sanitation, exclusion, and population reduction. Sanitation and exclusion are preventive measures. When a mouse infestation already exists, some form of population reduction such as trapping or baiting is almost always necessary.

To devise the best control program for a particular situation, always begin by removing or limiting the mouse's food source and shelter whenever possible. Trapping works well when mice are not

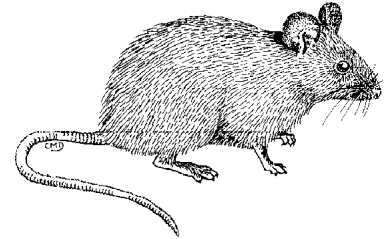


Figure 1. House mouse.

numerous, or it can be used as a follow-up measure following a baiting program. When considering a baiting program, decide if the presence of dead mice will cause an odor or sanitation problem. If so, trapping may be the best approach. Removal of mice should be followed by taking steps to exclude them so that the problem does not reoccur.

Several types of rodenticides are used in baits: anticoagulant rodenticides, single-dose toxicants, and chronic rodenticides. Because all of these materials are toxic to humans, pets, and wildlife, special precautions must be taken to prevent the poisoning of non-target animals. Of the rodenticides, the anticoagulant rodenticides are most commonly used around homes because they either require multiple feedings or take several days before they kill the mice, and there is an antidote in case of accidental poisonings.



Figure 2. Deer mouse.

Sanitation

Because mice can survive in very small areas with limited amounts of food and shelter, their control can be very challenging, especially in and around older structures. Most buildings in which food is stored, handled, or used will support house mice if the mice are not excluded, no matter how good the sanitation. While good sanitation will seldom completely control mice, poor sanitation is sure to attract them and will permit them to thrive in greater numbers. Pay particular attention to eliminating places where mice can find shelter. If they have few places to hide, rest, or build nests and rear their young, they cannot survive in large numbers.

Exclusion

Exclusion is the most successful and permanent form of house mouse control. "Build them out" by eliminating all gaps and openings larger than $\frac{1}{4}$ inch, through which mice will enter a structure. Steel wool makes a good temporary plug. Seal cracks in building foundations and around openings for water pipes, vents, and utility cables with metal or concrete. Doors, windows, and screens should fit tightly. It may be necessary to cover the edges of doors and windows with metal to prevent gnawing. Plastic screening, rubber or vinyl, wood, and other gnawable materials are unsuitable for plugging holes used by mice.

Traps

Trapping is an effective method for controlling small numbers of house mice. Although time-consuming, it is the preferred method in homes, garages, and other structures where only a few mice are present. Trapping has several advantages: (1) it does not rely on potentially hazardous rodenticides; (2) it permits the user to view his or her success; and (3) it allows for disposal of trapped mice, thereby eliminating dead mouse odors that may occur when poisoning is done within buildings.

Simple, inexpensive, wood-based snap traps are effective and can be purchased in most hardware and grocery stores. Traps can be baited with a variety of foods; peanut butter is the most popular because it is easy to use and very attractive to mice. Set the triggers lightly so the traps will spring easily.

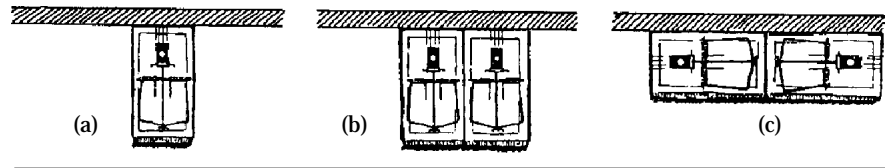


Figure 3. Placement of snap traps: (a) single trap with trigger next to wall; (b) the double set increases your success; (c) double set placed parallel to the wall with triggers to the outside.

Multiple-capture live traps for mice, such as the Victor Tin Cat and the Ketch-All, also are available from hardware stores and pest control suppliers. They can catch several mice at a time without being reset so labor requirements are reduced.

Set traps behind objects, in dark corners, and in places where there is evidence of mouse activity. Place them close to walls so mice will pass directly over the trigger (Fig. 3). Traps can be set on ledges, on top of pallets of stored materials, or in any other locations where mice are active. Use enough traps to make the trapping period short and decisive. Mice seldom venture far from their shelter and food supply, so space traps no more than about 10 feet apart in areas where mice are active.

An alternative to traps are glue boards, which catch and hold mice that are attempting to cross them, in much the same way flypaper catches flies. They are available at many places where other rodent control products are sold. Place glue boards along walls where mice travel. Do not use them where children, pets, or desirable wildlife can contact them. Nontarget animals that become caught on the glue board can be removed in most cases by using vegetable oil as a solvent to loosen the glue. Glue boards lose their effectiveness in dusty areas unless covered. Extreme temperatures also may affect the tackiness of glue boards.

The problem with the traps or glue boards is that you will need to dispose of live mice. The American Veterinary Medical Association states that the only acceptable methods of euthanasia for mice or small rats are decapitation and cervical dislocation. For mice caught on glue boards this means taking a sturdy rod or stick to make a sharp blow to the base of the skull.

Baits

Baits to control rodents are formulated with an attractant (generally food) and a rodenticide (toxin). Most rodenticides used to control mice around the home are already mixed with an attractant in commercially ready-to-use baits. The rodenticides in these baits are either anticoagulants or other rodenticides such as single-dose toxicants and chronic rodenticides.

Anticoagulant Rodenticides. Anticoagulants cause death as a result of internal bleeding, which occurs as the animal's blood loses the ability to clot and capillaries are damaged. The active ingredients are used at very low levels, so the rodent does not avoid the bait because of its taste or the onset of illness. When prepared with good-quality cereals and other bait ingredients, all anticoagulant baits provide good to excellent house mouse control if placed in suitable locations for the mice. The various anticoagulant active ingredients currently registered for use against house mice in California are listed in Table 1.

Because most anticoagulants require that multiple doses be ingested before death occurs, fresh bait must be made available to mice continuously over a period of time. In practice, baits should be offered to mice for at least 2 weeks or as long as feeding occurs. While the newer anticoagulants (such as brodifacoum, bromadiolone, and difethialone) may be capable of causing death after a single feeding, the mice do not die for several days after feeding on the bait. Therefore, the method of setting the bait out is essentially the same as for the older anticoagulant products such as warfarin, pindone, diphacinone, and chlorophacinone. All baits must be used according to the label directions.

Anticoagulants have the same effect on nearly all warm-blooded animals, but the

Table 1. Anticoagulant Rodenticides¹ and the Percent Active Ingredient Usually Found in Food Baits for House Mouse Control.

Common name (example trade names)	Chemical name	% active ingredient used in food bait
brodifacoum (d-Con, Havoc)	3-{3-[4'-bromo(1,1'-biphenyl)-4-yl]-1,2,3,4-tetrahydro-1-naphthalenyl}-4-hydroxy-2H-1-benzopyran-2-one	0.005
bromadiolone (d-Con, Maki)	3-{3-[4'-bromo(1,1'-biphenyl)-4-yl]-3-hydroxy-1-phenylpropyl}-4-hydroxy-2H-1-benzopyran-2-one	0.005
chlorophacinone (RoZol, Eaton AC Formula 90)	2-[(p-chlorophenyl)phenylacetyl]-1,3-indandione	0.005
difethialone (D-Cease, Hombre)	3-(3-(4'-bromo(1,1'-biphenyl)-4-yl)-1,2,3,4-tetrahydro-1-naphthylenyl)-4-hydroxy-2H-1-benzothiopyran-2-one	0.0025
diphacinone (Ditrac, Ramik)	2-diphenylacetyl-1,3-indandione	0.005
warfarin (d-Con, Rodex)	3-(4-acetylbenzyl)-4-hydroxycoumarin	0.025

¹These materials are generally available in retail stores that sell rodent control products.

Table 2. Other Rodenticides¹ and the Percent of Active Ingredient Commonly Used for House Mouse Control.

Common name (example trade names)	Chemical name	% active ingredient used in food bait
bromethalin (Assault, Vengeance)	N-methyl-2,4-dinitro-N-(2,4,6-tribromophenyl)-6-trifluoromethyl benzenamine	0.01
cholecalciferol (Rampage)	9,10-Secholesta-5,7,10(19)-trein-3-betaol	0.075
zinc phosphide (Eraze Rodent Pellets)	zinc phosphide	1.0 - 2.0

¹These materials, with the exception of zinc phosphide, are generally available in retail stores that sell rodent control products.

sensitivity to these toxicants varies among species. If misused, anticoagulant poisoning can cause the death of pets, livestock, or desirable wildlife that may feed on the bait. Additionally, residues of anticoagulants that may be present in the bodies of dead or dying rodents can cause toxic effects to scavengers and predators. In general, however, this "secondary hazard" from anticoagulants is relatively low. Symptoms of anticoagulant poisoning in mammals include lethargy, loss of color in soft tissues such as the lips and gums, and bleeding from the mouth, nose, or intestinal tract. Because anticoagulants are toxic to humans, particular care should be taken to keep rodent baits out of the reach of children. Vitamin K is the antidote for anticoagulant rodenticides, although in cases of severe poisoning, whole blood transfusion is also utilized.

Bait Selection and Placement. Several formulations of anticoagulant baits are available. Grain baits or pelleted forms often are packaged in small plastic, cellophane, or paper packets or are sold in bulk. The "place packs" are designed to keep baits fresh and to make it easy to

place baits into burrows, walls, or other locations. Mice will readily gnaw into place packs and feed on baits.

Anticoagulant baits formed into paraffin or wax blocks are useful in damp locations where loose grain baits spoil quickly. Unfortunately, mice may not accept these blocks as readily as they do other baits. Mouse baits containing certain grass seeds are often particularly well accepted by mice, even in the presence of other competing food items.

Proper placement of baits is important for house mouse control. Place baits no more than 10 feet apart in areas where mouse activity is evident. If mice are living in wall spaces, place baits inside the walls.

Other Rodenticides. In addition to the anticoagulant baits, there are currently three other rodenticides available in California for use against the house mouse (see Table 2). Although not anticoagulants, bromethalin and cholecalciferol are used in a manner somewhat similar to the anticoagulant products. These two materials are formulated to serve as chronic rodenticides, so that

house mice will have the opportunity to feed on exposed baits one or more times over the period of one to several days. Bait acceptance is generally good when fresh, well-formulated products are used.

The third material, zinc phosphide, differs from bromethalin and cholecalciferol in that it is an acute toxicant that causes death of the mouse within several hours after a lethal dose is ingested. When using zinc phosphide baits, prebaiting (offering mice similar but nontoxic bait before applying the zinc phosphide bait) is recommended in order to increase bait acceptance. If acceptance of prebait is poor, do not apply toxic bait, but change the bait material or its placement. Zinc phosphide bait is not designed to be left available to mice for more than a few days, as continuous exposure is likely to result in the mice learning to avoid the bait, a behavior known as "bait shyness." The advantage of using zinc phosphide bait is its ability to achieve a comparatively quick reduction of a mouse population. Because bait shyness can occur with zinc phosphide baits, these products should not be used more frequently than once or twice per year at any given location.

When using any rodenticide, carefully follow label instructions and understand all precautions. Remove and properly dispose of all uneaten bait at the end of a control program. Also, it is wise to collect and properly dispose of any dead rodents found during the course of rodenticide application. You can pick them up, using a sturdy plastic bag inverted on your hand, and seal them in the bag for disposal with household garbage, or bury them in a location where they will not be easily dug up by pets or scavengers.

Bait Stations. Bait stations are very useful when applying the chronic and single-dose toxicant rodenticide baits. They protect rodenticides from weather and provide a safeguard to people, pets, and other animals. Bait stations should have at least two openings about 1 inch in diameter and should be large enough to accommodate several mice at one time. Place bait boxes next to walls (with the openings close to the wall) or in other places where mice are active. It is best to place bait stations between the source of shelter and the food supplies that the mice are using. Clearly label all bait boxes "Caution — Mouse Bait" as a safety precaution. Some rodenticide labels or situations may require use of ap-

proved tamper-resistant bait stations. If so, be sure to secure these stations to buildings by nailing or gluing them to walls or floors in a way that will not permit a person or animal to knock them over or shake the bait out.

Where it is impossible to exclude rodents from structures, establish permanent bait stations in and around the perimeters of buildings. Place fresh bait in these stations to control invading mice before mouse populations become established. Check bait stations regularly and replace bait if it gets old and moldy, because mice will not eat moldy bait.

Electronic Devices

Although mice are easily frightened by strange or unfamiliar noises, they quickly become accustomed to regularly repeated sounds. Ultrasonic sounds, those above the range of human hearing, have very limited use in rodent control because they are directional and do not penetrate behind objects. They also lose their intensity quickly with distance. There is little evidence that electronic, sound, magnetic, or vibration devices of any kind will drive established mice or rats from buildings or provide adequate control. Despite their lack of effectiveness, such devices continue to be sold through magazine advertisements and at some retail outlets.

Predators

Some dogs and cats will catch and kill mice and rats. There are few situations, however, in which they will sufficiently control rodent populations. Around most structures, mice can find many places to hide and rear their young out of the reach of such predators. Cats probably

cannot eliminate existing mouse populations, but in some situations they may be able to prevent reinfestation once mice have been controlled. In urban and suburban areas, it is not uncommon to find rodents living in close association with cats and dogs, relying on cat and dog food for nourishment. Mice frequently live beneath doghouses and soon learn they can feed on dog food when the dog is absent or asleep.

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WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash nor pour pesticides down sink or toilet. Either use the pesticide according to the label or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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