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CONTROLLING RATS AND MICE

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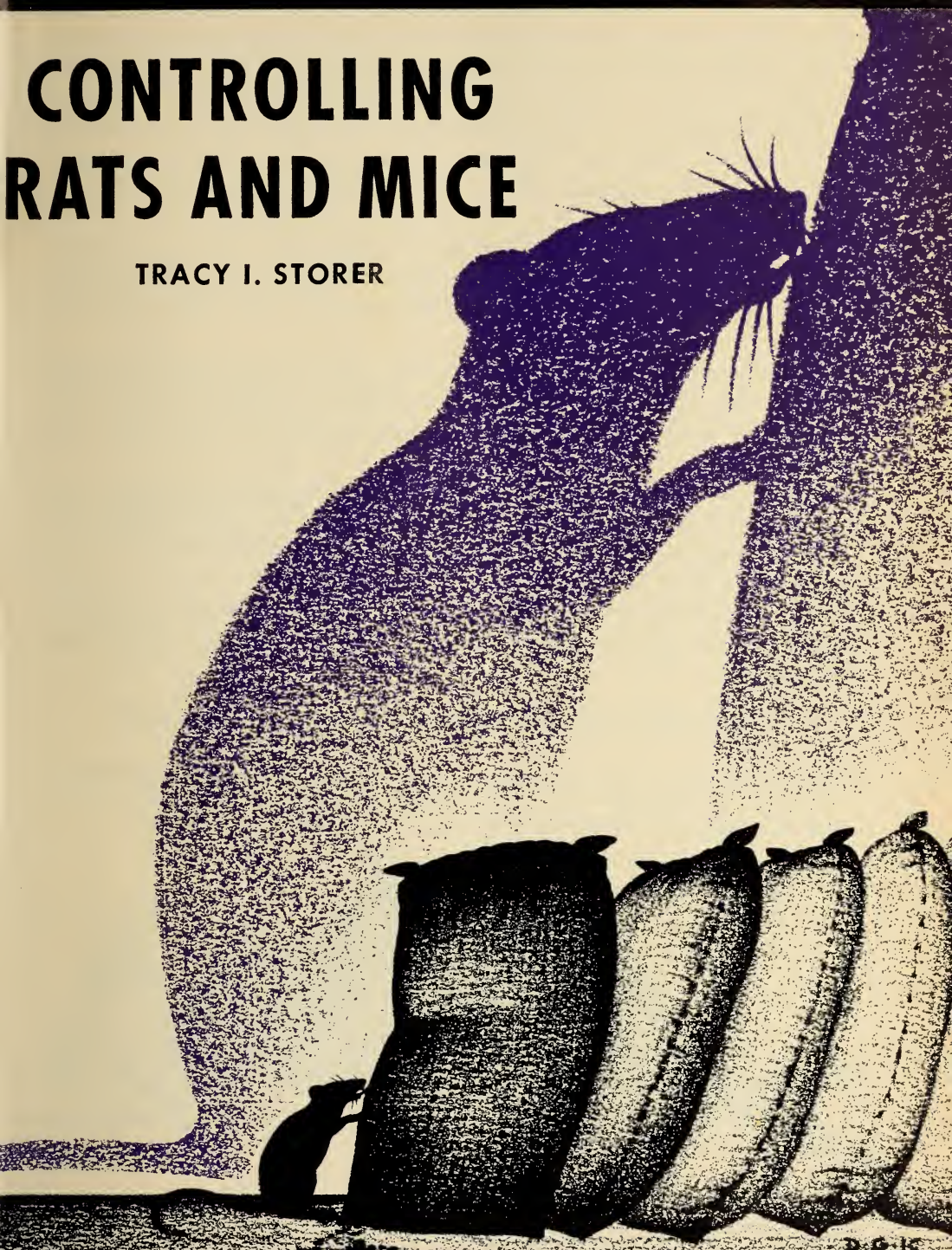

CALIFORNIA AGRICULTURAL
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CIRCULAR 410

THE RATS AND MICE of our homes and cities are real pests. These rodents, their habits, and means for their control are discussed in this circular. Brief attention also is given to native white-footed mice and woodrats that often invade cabins in the hills and mountains.

Food and property worth millions of dollars are destroyed or damaged each year by house rats and mice. These pests may also bring serious diseases to man—plague, endemic typhus, and others—either directly or through fleas or mites.

The best control is continuous and community-wide. Quiet day-by-day application of control measures by private citizens and local government officials is far better than a much-publicized "rat week" after which the rodents are left undisturbed.

Exclusion and proper sanitation are the surest and most lasting defenses against rats. This circular tells how to ratproof buildings, and describes control by use of other methods, such as traps, poisoned baits, gases, and dusts.

Rat poisons are dangerous to people and to livestock. Some gases used in rat control are explosive. Stocks of these materials must be locked up, and certain precautions are necessary in their use. A doctor should be called immediately if an accident occurs.

Aid in control may be obtained from any county agricultural commissioner or farm advisor, and in some cities and counties from the health department.

This circular replaces the former Extension Circular 142.

Fig. 1. The Norway rat—the most destructive of all. Distinctive features (as compared with the roof rat) are the blunt nose, moderate-sized, slightly haired ears, and the tail which does not exceed the combined length of the head and body. The total length is up to 16 inches.

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CONTROLLING RATS and MICE

Tracy I. Storer

THE RAT PROBLEM

The "house" rats and mice have long been unwelcome associates of man. They followed his occupation and development of new countries and now are present in many parts of the world. In contrast to native rats and mice they are "aliens," but well established. In California, as elsewhere, these animals are all too common in cities and on farms, in stores and warehouses, in slaughterhouses and on garbage dumps, and sometimes along streams or in fields well apart from man's dwellings.

Rats and mice are objectionable in many ways:

1) They eat and foul all sorts of foods.
2) They gnaw into packages, boxes, cabinets, and buildings.
3) They damage furniture, clothing, and other goods in homes and places of business.
4) They carry diseases that menace human society.
5) They give fright and annoyance to many persons, and injure some by rat bites.

Mankind unfortunately provides rats and mice with their two essentials of life—food and shelter. In consequence, they live and multiply in almost every suitable place to which they have access. Rats and mice have been fought for centuries, but the "rat problem" is still unsolved.

This circular describes the kinds of rats and mice, their habits, the kinds of damage they may do, the evidence of their presence, and the equipment, materials, and methods used for control. To get rid of these rodents, it is necessary to know their habits, reactions, and food preferences, and then use this knowledge in control operations. Often one must experiment to find the most suitable bait, the best places for traps, or other satisfactory methods of control. No single formula or method will give good results in all cases.

Advice in control of rats and other rodents may be had from various government officials and agencies, including county agricultural commissioners and farm advisors; city, county, and state health departments; state departments of agriculture, and the U. S. Fish and Wildlife Service and U. S. Public Health Service. Specialists in these agencies will give technical advice. Some will do control in places where there is serious damage to property or a health hazard. Moreover, these agencies can use materials and methods not available to the general public.

KINDS OF RATS AND MICE

General Features. Rats and mice are rodents or gnawing animals (mammals of the zoölogical order Rodentia). Like all rodents, they have, at the front of the mouth, two pairs of chisel-like teeth that grow continuously and are self-sharpening. These incisors are used to cut food, to remove shells or coverings of nuts and seeds, to make nests by shredding cloth, paper, or grasses, and to gnaw wood, plaster, or softer materials so that the animals may enter places giving food or shelter. Rats and mice have no canine

teeth (tusks). Their check or grinding teeth have small projections used to chew food finely before swallowing it.

The toes end in sharp claws that help in climbing and digging. When cornered, a rat uses its incisor teeth and claws, and may inflict severe injuries. The long tail serves as a counter-balance to the body in running, jumping, and climbing.

Most rodents have scent glands which leave odors on their droppings, trails, and nests. In rats and mice these glands are just inside the vent or anal opening, below the base of the tail. The odor from house rats is mild to the human nose, but that from the house mouse is strong and unpleasant—the "mousy odor."

Rats and mice have rather poor vision, but the senses of smell, taste, hearing, and touch are keenly developed. Their frequent sniffing movements tell them much about their surroundings through odors received. Their choice in foods is undoubtedly based upon taste preferences. They are frightened by unusual sounds, which may cause them either to stop abruptly or to hurry to safety. They become used to ordinary noises, however, and are often active where people, domestic animals, or machines are close by.

The long "whiskers," or vibrissae, on the nose, and other long hairs above the eyes, serve the sense of touch. There are sensory nerves about the base of each hair. It is the habit of a house rat or mouse to run close beside a wall, against which these sensory hairs touch to give the animal information about its surroundings. In the laboratory, rats with the vibrissae removed have been found less skillful in running and finding their way.

Three kinds of rats and one kind of mouse, all "aliens" from the Old World, are now abundant and of great economic importance in California and many other parts of the United States. They are the Norway rat, the roof rat, the black rat, and the house mouse. The alien rats may be distinguished from the native woodrat (p. 35) by their scaly tails and usually by their coarser hair.

Norway Rat. The largest of the alien rats, and the one which does most damage, is the Norway rat (*Rattus norvegicus*), also known as brown rat, house rat, wharf rat, and sewer rat (fig. 1).

Full-grown adults are about 16 inches

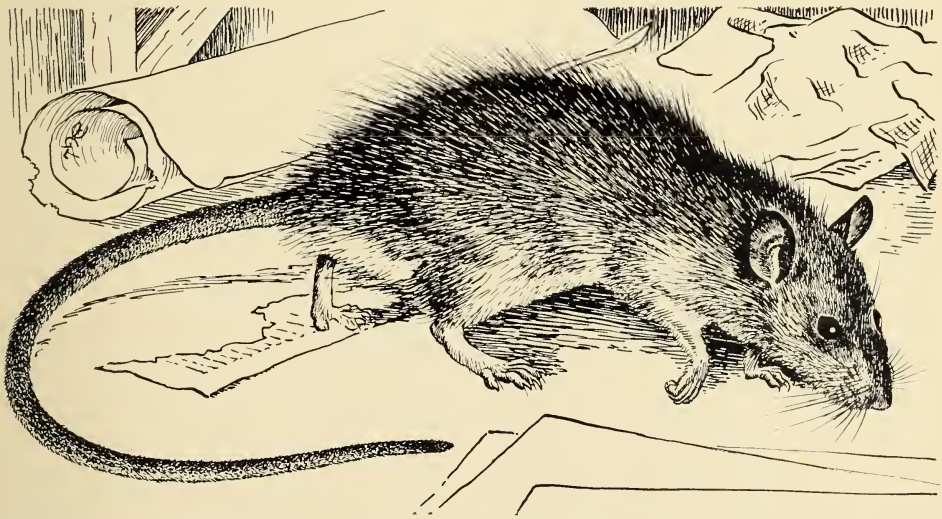

Fig. 2. The roof rat. Important characteristics are the slender snout, large naked ears, and long slender tail which usually exceeds the combined length of head and body. The total length is up to 15 inches. The black rat is identical in form except for its black coat of hair.

in total length, with the tail 7½ inches long, and weigh 11 or 12 ounces; exceptional individuals weigh as much as 24 ounces. The nose is rather blunt, and the ears are of moderate size and slightly haired. The tail is scaly, nearly naked, and blunt-ended; when laid forward it usually does not reach to the end of the nose, and is never longer than the head and body. The coarse body fur is generally brown, with scattered black hairs, and is darkest along the middle of the back. The under parts are pale gray to yellowish-white.*

The Norway rat is distributed generally throughout lowland California, along the seacoast and in the interior, both in cities and in the country, but has not invaded the mountains to any extent. It lives about residences, stores, warehouses, slaughterhouses, barns, pigpens, and chicken yards, on garbage dumps, in sewers and tunnels, and along the banks of streams and ditches.

This rat stays mainly at the ground level, seldom going above the first floor of a building. It climbs, but not as much as the other alien rats. It burrows and makes nests under buildings or platforms on the ground, beneath piles of lumber or stones, in garbage dumps, and in marshy places along both fresh and salt water. The nest, indoors or out, is of trash and not always neatly or well formed as with some other rodents.

The tunnels are 2 to 3 inches in diameter and of various lengths, often with more than one opening on the surface. In addition, each burrow commonly has secondary exits or "bolt holes" which may be hidden under grass or boards. Norway rats take to water when necessary, and can swim easily.

Female Norway rats average 8 to 9 embryos (extremes of 2 and 17 have been found) at a pregnancy, and may breed 4 or more times during a year. Pregnancy lasts 21 to 22 days, and it is thought that the young probably can shift for themselves when about 3 weeks old. A female may first breed at the age of 4 to 5 months, when her weight is about 5 ounces (140+ grams).

It is not known how long wild rats live, but much of the population probably is replaced by new individuals each year. The possible rate of increase is suggested by one laboratory experiment with captive Norway rats, which began with one pair; more than 1,500 were produced by the end of a year!

Because of its large size and bold nature, the Norway rat has in many places replaced the black rat. When rats are reduced in numbers by trapping, house mice often increase, suggesting some kind of competition between these various rodents. Yet Norway rats and house mice often inhabit the same buildings.

Roof and Black Rats. The roof rat (*Rattus rattus alexandrinus*), sometimes called Alexandrine, or gray rat (fig. 2), grows to a total length of 15 inches, with the tail measuring 8½ to 10 inches; its weight seldom exceeds 8 ounces. The nose is sharp and slender, the ears are rather large, with little or no hair, and the thin, tapering, scaly tail is almost always longer than the combined length of head and body. The back and sides are gray or gray-brown, and the belly white or nearly so.

Roof rats live in much of lowland California, coastwise and inland, in cities and rural areas, and have been found scatteredly in the mountains to altitudes of 5,000 feet. They inhabit homes, warehouses, packing sheds, and feed stores, often living in attics or upper stories, but may also be found at ground level, especially when Norway rats are absent. In

* Additional more technical characters are: (a) *norvegicus*, length of ear from notch, 16–20 mm; ear when laid forward normally not extending more than halfway to eye; tail more or less bicolor; hind foot 38–46 mm long; mammae (teats), 12; first molar (cheek tooth) without distinct small cusp or style on first row of cusps. (b) *rattus* and *alexandrinus*, length of ear from notch, 24–26 mm; ear when laid forward reaching halfway to eye; tail not bicolor; hind foot, 36–40 mm long; mammae, 10.

Fig. 3. The house mouse. The eyes are small, the body is brown, and the tail scantily haired. The head-and-body length is 3 to 4 inches, and the tail 3 to 3½ inches.

some inland localities they live along stream banks. Roof rats climb readily and travel on the exteriors of rough-surfaced buildings, on electric wires and cables, and in trees. In California they often nest in trees, especially palms, and in dense hedges or vines growing on fences. These rats can also swim easily.

The roof rat averages about 6 embryos per brood and may breed several times per year. The rate of development and ages at which young become independent are thought to be about the same as for the Norway rat. Female roof rats become sexually mature at a weight of about 3 ounces (90 grams).

Except for its almost solidly black color, the black rat (*Rattus rattus rattus*) resembles the roof rat in size and structure. In California this rat is found only near salt water, in seaports and adjacent towns along the entire coast, but inland only about as far as Martinez, Contra Costa County.

Roof and black rats are far more common on ships than the Norway rat, but all these alien rats travel in vessels, especially cargo ships.

House Mouse. The common house mouse (*Mus musculus*) is 3 to 4 inches in head-and-body length, and the tail is 3 to 3½ inches long (fig. 3). The ears and eyes are small (as compared to those of the native white-footed mice, fig. 16), and the tail is scantily haired. The upper surface of the body is almost uniformly brown, and the under parts pale brown to whitish.

House mice have followed settlers into almost all parts of California. The mice live in any structure they can enter, and also entirely apart from man in the fields of some interior lowland districts. Those living outside during the summer tend to move into buildings with the first cold weather.

Since house mice in nests are easily transported in bales of hay, household goods, crates, and boxes, they are constantly being moved about and into new localities. These mice live at all levels in buildings, from basements to attics. They climb readily, and can pass through holes ½ inch square, but seldom burrow in the ground. They often make compact nests of cloth, sacking, or other materials

that are shredded finely and worked into a round hollow ball used especially to shelter the young.

House mice average 5 to 6 young per litter; the young can run about when 21 days old and can breed at 42 days. Individual captive female mice have produced 100 young per year. This species is short-lived; most individuals probably do not live much more than one year, hence the population "turnover" is rapid. At times house mice increase to very large numbers (Hall, 1927; Piper, 1928; Storer, 1931).

DISEASES CARRIED BY RATS AND MICE

The alien rodents and their insect parasites carry several important human diseases (Hull, 1941). This is a most important reason for control of rats and mice.

Plague is a bacterial disease of wild field rodents and rats, and is usually transmitted by fleas. With the spread of rats by ship-borne commerce, plague infections have occurred in several United States seaports. Two epidemics of flea-transmitted bubonic plague in San Francisco (1900, 1909) resulted in 281 cases with 191 deaths. In Los Angeles during October, 1924, plague from rats took the pneumonic form in human beings. This form is spread by coughing (droplet infection) from one person to another. Of 32 human cases, 30 died.

Plague is now well distributed among field rodents (as sylvatic plague) in many parts of the western United States, and some human cases have resulted. Rats in cities or towns may be reinfected from the surrounding field rodents, and thus be a health hazard. A few plague-infected rats have been found in California cities during recent years. Often when neither rats nor field rodents show visible signs of plague, the fleas from these animals prove to contain plague bacteria, thus maintaining the "reservoir" of this disease among rodents.

Endemic or murine typhus is a New World disease of rats and man carried by rat fleas. It is related to the louse-borne typhus of Europe, and to the spotted fever carried by ticks, but is not as deadly. Human cases of murine typhus have increased greatly during recent years in states of the Atlantic seaboard and Gulf Region.

It was first reported in California in 1916, and to the end of 1945 there were 362 human cases and 17 deaths in the state. Here it occurs mainly in Los Angeles, San Diego, Orange, San Bernardino, and Santa Barbara counties. Cases have been reported in all months, but are more numerous in late summer and autumn. The largest percentage of human cases is among food industry workers in large cities, but some cases have been found in other kinds of business establishments, motion picture theaters, and private homes (Beck and Van Allen, 1947). Control of rat fleas by DDT, and control of rats, have been effective in reducing the number of human cases.

Leptospirosis. This disease, also called Weil's disease, infectious jaundice, and Stuttgart disease of dogs, affects the kidneys in rats, and is spread by rat urine contaminating food or water. Workers in mines, rice fields, sewers, etc., in the Orient suffer a heavy mortality, and there are some human cases in the United States. About 40 per cent of the rats in San Francisco show evidence of this disease. Dogs also are susceptible, and one or more epidemics have occurred among city dogs in California.

Food Poisoning. Certain bacteria common in rats and their droppings cause food poisoning in man, and epidemics have resulted from human food contaminated by rats. Food dirtied by rats is always a health hazard.

Rat-bite Fever. Another bacterial disease of rats transmissible to man is rat-bite fever, of which several cases have been reported in the United States during recent years.

Trichinosis. This disease of rats, swine, and man is also present in cats, bears, and some other animals. It is caused by a microscopic trichina worm that lives as a larva in the muscles of infected animals. When flesh of one infected animal is eaten by another of the susceptible animals, the larvae taken in with the flesh become mature, breed, and produce many new larvae. If the latter are abundant, the poisonous substances they secrete lead to illness or death of the new host. Rats aid in spreading this disease among pigs, and man becomes infected by eating pork or bear meat which has been imperfectly cooked or cured and therefore contains many living trichina larvae.

Rickettsialpox. A disease of house mice, transmitted by a tiny blood-sucking mite, was first recognized in 1946, when about 80 human cases occurred in two housing centers in New York City. Some cases have occurred in other places.

> Because of the danger of these rodent-borne diseases, no one except a trained public health official should handle alien rats or mice or keep them in cages.

RAT BITES AND MITES

In the poorer housing areas of large cities some persons are bitten by wild rats. In Baltimore, Maryland, 87 people were treated for rat bites at one hospital during 1939–43. Most of the victims were infants under one year of age, and nearly all were bitten at night while asleep.

House rats carry mites and several kinds of fleas, some of which also attack human beings, and may carry disease. The tropical rat mite (*Liponyssus bacoti*) is so small that it can just be seen by the unaided eye. It is common on rats in California, and at times bites people, causing serious discomfort to both adults and infants. The spots of attack are reddish, with slight swelling and persistent itching that may be mistaken for flea bites.

DAMAGE BY RATS AND MICE

The total amount spent for rat and mouse control is small when compared with the amount of damage done by these animals.

No one knows how many rats exist. One guess, widely reprinted, placed the rat population as equal to the human population; but recent careful surveys in several cities fail to support this idea. The numbers of rats vary from place to place.

If rats did equal the number of persons in the United States and if each rat ate one ounce of food per day, the daily needs would be about 4,690 tons. If they ate only wheat—at $1.00 per bushel—the total annual levy would cost over 57 million dollars.

Assumptions aside, it is well known that rats consume much food intended for man and domestic animals, that they often take high-priced foods, and that they foul or damage far more than they eat. Hence rats (and mice) are expensive nuisances.

The alien rats and mice may eat practically anything used as food by human beings and by livestock (except hay). State and federal food inspectors are giving increased attention to foods contaminated by rats and mice, and can recognize hair, droppings, or urine stains in packing houses. Contaminated food is condemned for human use, and must be disposed of at a loss.

Even more important economically than the food actually consumed is the damage to sacks, boxes, and other containers, causing the loss of packaged materials. Many thousands of such food containers are thus rendered unsalable in packing houses, warehouses, and retail stores. In homes, cardboard cartons and other packages of food are torn open, spilled, and dirtied so that many must be discarded. Slabs of bacon and other meats may be eaten and gnawed extensively. House mice sometimes live con-

tinuously in cold-storage warehouses where they eat nothing but high-priced meat.

To get nesting materials, rats and mice often gnaw and pull apart clothing, drygoods, blankets, mattresses, upholstered furniture, and carpets, so that the damage is too great to repair. Cloth or paper bags of grain or cereals in feed warehouses often are so chewed that much labor is needed to resack the contents and to repair the sacks. Piles of empty bags sometimes are riddled with holes and made useless by the work of rats and mice.

On poultry and pigeon farms, in addition to destroying feedstuffs and sacks, rats often eat eggs, and at times kill numbers of young birds.

Rats, and less often mice, gnaw into buildings, usually at the doors or windows, and when inside they cut holes in cabinets and other interior fittings as they search for food or for places to nest. Both indoors and out, rats may put electric circuits out of operation by gnawing away insulation (either lead or fabric), exposing, and sometimes cutting the wires. Mice may enter wiring conduits and travel within them; they also may gnaw off the insulation of wires and produce short circuits.

Rats and mice have been accused of causing fires by short-circuiting power wires (also by gnawing matches), but conclusive evidence of such damage is difficult to obtain. At times they build nests inside the frames of electric motors. Short circuits caused by nest materials may burn out motors.

EVIDENCE OF RATS AND MICE

Rats and mice may be seen or heard, or their presence may be discovered through other common signs, such as droppings, runways or foot marks, smears, holes, piles of earth from burrows, nests, damage to food or property, gnawings, and disappearance of bait.

Sight. Rats and mice try to avoid being seen. One may have quite an infestation without seeing a single live rodent. Gunderson (1943), in Iowa, believes that the number of rats present, particularly on farms, may be roughly guessed on the following basis: none seen, 0 to 20 present; occasionally seen, 20 to 200; often seen, more than 200.

When rats are numerous on a garbage dump, some can usually be seen in daylight. A dump after dark, seen by a flashlight, often is a spectacular sight.

Sound. In any place where fair numbers are present, rats and mice may usually be heard running and squealing after dark. In a home, even one or two mice or rats scampering and dragging food over the rough plaster "keys" in an attic often make enough noise to disturb the people below—and often lead to prompt efforts toward control.

Droppings. These signs commonly are blackish, soft, and somewhat shiny when fresh, but become hard and dull later (fig. 4). Undisturbed droppings last for a long time; hence only those in places often swept are useful to indicate recent activity, and whether few or many rodents are present. A Norway rat (captive) may produce 25 to 180 droppings per day, more being voided with fruit or vegetable diets. Droppings are found scattered wherever rats run, but may be concentrated in places where the animals stop to feed. Those of the Norway rat often are in groups, are spindle-shaped, and $\frac{3}{8}$ to $\frac{3}{4}$ inch long; those of roof or black rats are scattered, more sausage-shaped, and slightly smaller; droppings of the house mouse are scattered, spindle-shaped, and about $\frac{1}{16}$ by $\frac{1}{4}$ inch.

Runways. Paths regularly used by numbers of rats may become beaten runways on the ground or over piles of refuse, and smoothed routes over board surfaces indoors. On soft earth, dust, or flour, the foot prints and tailmarks often show clearly; the fresher the print, the sharper the pattern. Flour, whiting, or other light-colored powder may be dusted from a sifter can on places where rats are

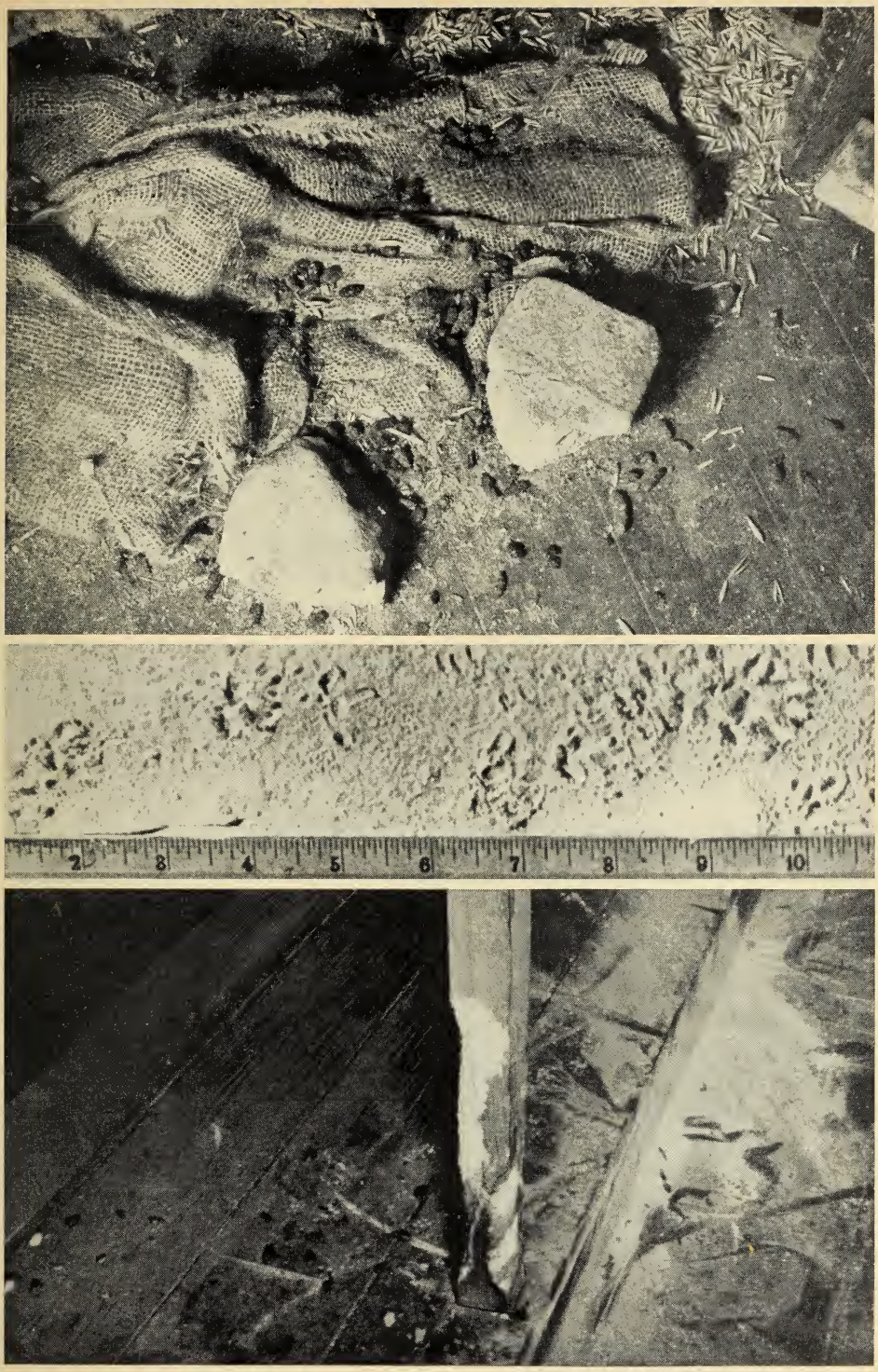

Fig. 4. Evidences of rats: Droppings and damage to grain sacks; tracks in dust; a freshly gnawed post, and footprints and tail marks in flour. Courtesy of U. S. Public Health Service.

believed to be running; then any tracks made during the night can be seen the next day, and one may estimate the number of animals using the runway. A small mirror set at an angle on the end of a stick can be used to search for tracks on overhead pipes or other structures. A flashlight is useful in dark corners.

Smears. Grease, soot, and dirt from the belly hairs will leave smears on well-travelled runways. These can best be seen where the animals press their bodies down in changing direction over the sides of beams and on ladders or along pipes or beams. A run along a beam below floor or ceiling joists is often marked by a series of ∪ ∪ ∪ shaped marks between the joists (fig. 5). Smears are most evident as dark marks on whitewash or non-glossy light-colored paint, or as whitish markings where flour is stored. Shiny smears indicate recent use.

Holes. Entrances to burrows in open ground or under pavements, foundations, or piles of rubbish are common signs, and, if they show foot prints, are in active use. Not all holes show mounds of earth excavated from burrows. Old holes may last long after disuse. Stopping all holes in an area with plugs of crumpled newspapers or soft earth, and later noting which are reopened, is an easy way to recognize those being used.

The nests of Norway rats (fig. 6) are not easily found, since they are hidden in burrows, under floors or foundations, in piles of goods or rubbish, or in disused packing boxes. Nests of roof or black rats may be in similar places (rarely in burrows), but some are built out-of-doors in dense trees or in bushes and vines. The small nests of house mice are placed in any sort of shelter: under piles of sacks or paper, in loose or baled hay, in boxes, in disused clothing, inside upholstered furniture, and in office desks. When living in fields, house mice nest in burrows.

Urine Stains. These are not usually easy to find, although they are present in many places inhabited by rats or mice, even on sacks of food materials. Such stains fluoresce under ultra-violet light. Unfortunately, certain other materials are also fluorescent, but identification of rodent stains is possible by trained inspectors.

Fig. 5. Smears made by rats traveling along a supporting floor beam. The rats must crawl along the side of the beam under each joist, and thus leave the ∪ ∪ ∪ ∪-shaped markings. Courtesy of U. S. Public Health Service.

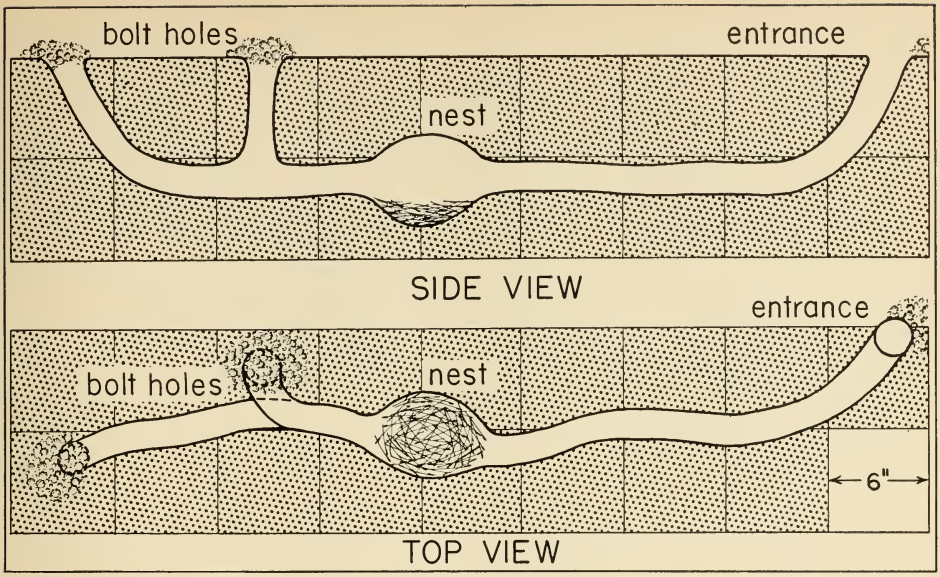

Fig. 6. Burrow of Norway rat in a poultry pen. In addition to the open entrance, there are emergency exits or bolt holes, lightly covered by soil, and not easily seen from the surface. (Pisano and Storer, 1948.)

METHODS OF CONTROL

The principal means of controlling rats and mice are (1) exclusion, (2) traps, (3) poisoned baits, and (4) poisonous gases or dusts. Various other control measures have been tried, but many are of little use. Exclusion is the real solution, and all other methods give only temporary relief.

EXCLUSION

Exclusion of rats and mice means essentially only two things: leaving no opening more than $\frac{3}{8}$ inch in width into a building, or other enclosure, and protecting all food supplies from these animals (see figs. 7–10).

House mice can pass easily through a crevice $\frac{1}{2}$ inch wide, and young rats need little more space. If buildings are *constructed and maintained* with these two principles constantly in mind, no rats or mice can find shelter or food inside. Unfortunately this is not always done, and in some places it is difficult to do.

In practice, exclusion of rodents requires the following:

1) Concrete floors and exterior curtain walls around foundations.
2) Solid exterior walls with no holes or large cracks.
3) Elevation of small buildings 12 to 18 inches above ground.
4) Screens over all openings, both at the ground level and above, of hardware cloth of ⅓- or ¼-inch mesh, or metal grille with equally small apertures.
5) Cement or metal sheathing around all holes where pipes or conduits pass through walls.
6) Tight-fitting doors and window screens throughout the premises.

Rat proofing alone is not enough; such construction must be frequently inspected and kept in good repair. Leaving unscreened doors or windows open over night, or failing to replace sheathing after a small plumbing job, can give rodents a

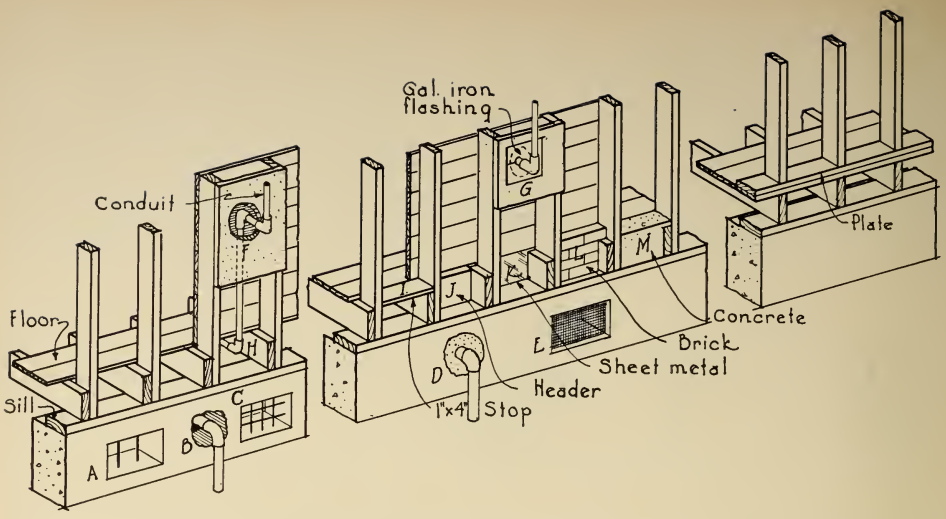

Fig. 7. Structural details of buildings in relation to exclusion of rats and mice. Undesirable features: A, ventilator to basement with widely spaced bars; B, space about entrance of pipe; C, ventilator with wide-mesh grille; F, hole in wall around entrance of conduit; H, free passage for rats from below the floor into the walls.

Corrective measures: D, filling space around entrance of pipe with concrete; E, covering ventilator with hardware cloth of ⅓- or ¼-inch mesh; G, covering entrance of conduit with close-fitting sheet-metal flashing; I, stop of wood at floor level; J, header block between joists, completely closing the space between sill and floor; K, sheet-metal "header"; filling space between studs with brick L, or concrete M.

At the right is shown the usual "western" type of framing which, when walls are in place, prevents rodents in a basement from gaining access to spaces between studs and walls.

chance to reinfest the building. Crates, baled goods, and other packaged materials brought into a building should be immediately examined for rodents or young in nests.

Foundations. Rats burrow readily under concrete slab floors laid on the ground. Interior openings in such floors, as around pipes or sumps, may be used as entrances. Rats also tunnel under the foundations of exterior walls, even when the foundations extend 24 inches below the ground surface. To prevent such burrowing, a thin curtain wall, L-shaped in section, may be poured around the foundation or slab. It need be only 2 or 3 inches thick. The foot of the L should project outward to discourage rats from tunneling down beside the wall.

To make a curtain wall, dig a trench 12 inches wide and 24 inches deep around the edge of the foundation or slab. Brace an upright retaining form (thin boards or even corrugated box cardboard will do) with stakes, so that it stands 2 or 3 inches from the inner side of the trench, and fill the space with concrete. Then pour the foot of the L. Later, remove the form and refill the trench with earth.

Exterior Walls. Concrete, masonry, or sheet metal walls will exclude rats. When corrugated metal sheets are used, mice may enter at the bottom unless stops are added to close the small semicircular spaces where the corrugations join the foundation or sill. Wooden walls can be kept rodent proof if knotholes are covered, cracks battened tightly, and the bottom boards are nailed down securely. The lower edge should be sheathed with strips of light weight (28 gauge) galvanized iron sheeting. It is of prime im-

portance to leave no "gnawing edge" where the animals can start an entry hole.

For outbuildings and farm structures of frame construction on wooden studs, single walls are preferable. Double walls, especially if sheathed on both sides with wood or wall board, provide ideal shelters for rats and mice, and often serve as passageways by which the animals reach upper floors or attics. Old buildings with double wooden walls often may be made rodent proof by tacking strips of sheet iron along the outside base and removing the lowermost inside boards to place stops of one kind or another, as shown in figure 7.

Openings. Black and roof rats easily climb vines, trees, and rose trellises against outside walls, and can run along electric cables or wires, or even the antenna for a home radio. Rats of all kinds and mice can go up rough stucco or board walls. They seldom climb smooth walls of sheet metal or finished concrete, but may find a foothold on outside pipes, drains, or rain ducts. Rats may cut fly screen, particularly near the ground or roof, although window screens at intermediate levels are rarely damaged. A top-hinged screen frame left unhooked at the bottom may give rodents a chance to get in.

All outside openings above ground

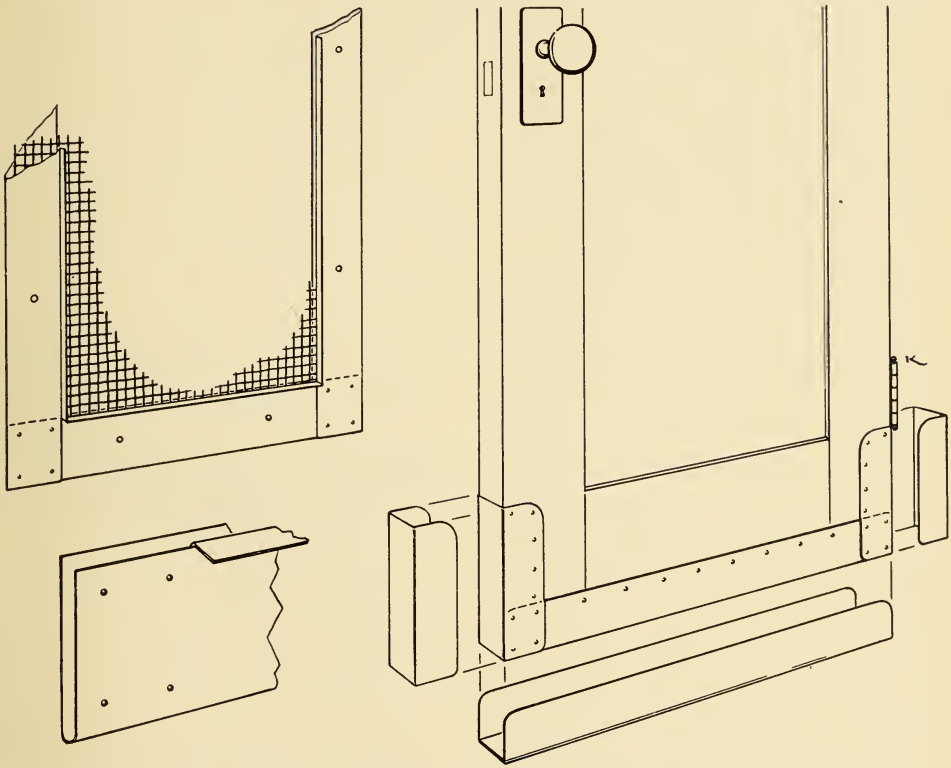

Fig. 8. Permanent rat-proofing for windows and doors. Left, four folded channels of galvanized sheet iron bent to cover edges of hardware cloth (3 meshes per inch); a narrow lip (3/16 to 1/4 inch) is bent out along one margin of each channel to stiffen the frame; the 4 channels are riveted together at the corners and the framed screen is fastened to the window casing with screws. Detail of the channel is shown below. Right, three rectangular channels bent from galvanized sheet iron to fit closely around the bottom and lower edges of a door and nailed or screwed into place. Channels add strength to the door, prevent damage to the lower edge, and will stay in position better than flat strips of sheet metal tacked to one side of the door.

must be screened completely with hardware cloth of 1/8- or 1/4-inch mesh. This includes all attic ventilators and louvers, tops of air shafts, elevators wells, rooftop stairway entrances, windows, and vent pipes.

Gaps left by plumbers and electricians around pipes or conduits entering walls (fig. 7, B) are often the commonest paths of entry for rats and mice, and may be closed in three ways.

1) In brick, tile, or concrete walls the space is filled with concrete, using reinforcing of old wire screen if necessary (fig. 7,D).

2) On wooden walls a sheet-metal collar is fitted closely around each pipe, extending several inches beyond the edges of the opening, and nailed to the wall (see fig. 7,G).

3) At entrances to steam tunnels, air ducts, or other places where ventilation is necessary and where workmen must enter from time to time, close-fitting but removable hardware cloth screens, framed with sheet metal, are bolted or screwed into place.

Doorways. Every outside door should fit closely in its frame when closed, and the clearance over the floor or sill should never be greater than 3/8 inch. A strip may be nailed to the bottom edge if there is a wider gap. Doors to restaurants, grocery and feed stores, and granaries or feed rooms should be sheathed along the bottom and up 6 to 12 inches on each side, with a 3-inch width of galvanized sheet iron, securely nailed. An even better practice (fig. 8) is to form U-shaped channels of sheet metal, of a width to fit closely over the thickness of the edge and bottom of the door, and fasten them with wood screws. A rat or mouse needs a free edge on a door to start gnawing and cannot begin if the edge is covered with metal or fits closely in the casing.

Sliding doors to warehouses seldom fit tightly, and rats often enter in the space between the door and wall. Often strips of wood covered with metal can be fitted to the doors or casings to keep the animals out.

At receiving and shipping departments in the rear of stores, the main doors must be open throughout the day and often after dark. An extra pair of half-height "Dutch" doors 3 to 4 feet high may be installed to stop rodents. They should be light in weight, sheathed completely on sides and edges with smooth sheet metal, and hung on double-swing spring hinges. They should fit closely over the floor and come together with no more than 3/8 inch between the free edges. Loaded warehouse hand trucks or dollies can easily be pushed against and past the doors, and the doors will close at once behind the person pushing the truck. No rat can run in at floor level or climb the smooth surface of the doors.

Corn Cribs. The ordinary wooden corn crib, set on the ground, provides a good home for rats and mice. Space below the floor gives shelter for nesting, and

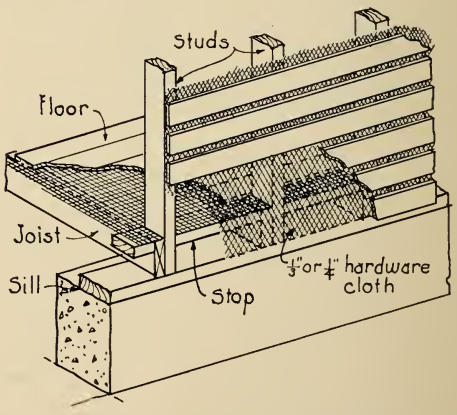

Fig. 9. Construction for a corn crib to exclude rats. The ends of studs and joists are nailed together to resist lateral pressure when the crib is filled. Spaces between studs are closed by wooden stops at the floor level. Hardware cloth is placed between joists and flooring and between studs and outside slats. The whole crib is elevated on concrete, field stone, or wooden sills so that the floor is at least 12 inches above ground.

the open construction above makes food easy to obtain. Old wooden cribs should be raised 18 inches above the ground, using concrete, field stone, or wood for supports. The top, walls, and door should be covered with hardware cloth in addition to the wooden slats (fig. 9). New wooden cribs should be built off the ground and lined with hardware cloth. Prefabricated cylindrical cribs made entirely of sheet metal are available and are used by many farmers, who thereby practically end their rodent troubles in this kind of storage.

Feed Storage. Large supplies of livestock feed in piled sacks offer both food and shelter for rats and mice. When feed is stored in warehouses or barns with open eaves, poorly fitted doors, cracked or warped outside walls, or floors of earth or of wood close to the ground, there is often serious loss of grain and damage to sacks.

Whenever possible, sacked materials should be placed on low platforms (pallets) to leave a clear space beneath. The tiers of sacks should be in narrow piles with lanes between, and with alleyways between the outermost tiers and exterior walls. Damage then will be lessened and any rats and mice present can be controlled more readily.

Rodent-proof wooden bins may be built to contain bulk materials. The interiors should be sheathed with tongue-and-groove boards, or sheet metal. The studs and other framing should be on the outside. The supporting legs can be sheathed with sheet metal to prevent rodents from climbing, and the tops should be provided with tight coverings or screening.

Smaller stocks of feed for poultry can be kept in large clean garbage cans covered with close fitting lids; the daily supply can be easily removed with little spilling. Cans holding 2 or 3 sacks of feed are usually available. If the amount of grain given to poultry at each feeding is closely measured so that the birds will clean it up rapidly, little will remain in the troughs to attract rats and mice.

Temporary stacks of newly threshed grain left in the field sometimes are attacked by rodents, and sacks may be damaged. Such outdoor stacks in Australia are protected from rodents by a tight "fence" of solid sheet iron about 36 inches wide, of which 6 inches is set into the soil. The corners and the lapping between sheets must be kept tight.

Hay in bulk or bales is difficult to protect against mice, and often is heavily infested, sometimes also with rats. Nests in baled hay are a common means of carrying infestations of mice into buildings. No solution for excluding rodents from hay has been found except the sheet iron fence just described. Use of baiting stations (see section on Poisoned Baits), and baits other than the food present, such as barley in a barn containing oat hay, will often reduce the number of rodents, especially if control is continued as the stock of hay is used or gradually moved out.

Human Food Supplies. Grocery stores may reduce losses by keeping small supplies of grain products, sugar, and similar materials in metal containers. In homes and in store rooms adjacent to farm kitchens the same means may be used. Covered tin cans, glass bottles, 2- to 10-gallon crocks, and even small garbage cans are useful for flour, cereals, dried fruits, nuts, etc. Such containers give protection from rodents and make it easy to remove the contents without spilling.

Cabinets and Enclosed Platforms. The "dead" spaces between walls and floors and built-in cabinets, platforms for refrigerators, and similar conveniences in homes and stores make good hiding places for rats and mice. Often there are entryways into these spaces where workmen have cut holes in fitting pipes and conduits. When such shelters are used by rodents, it may be necessary to remove the false floors or back partitions and stop

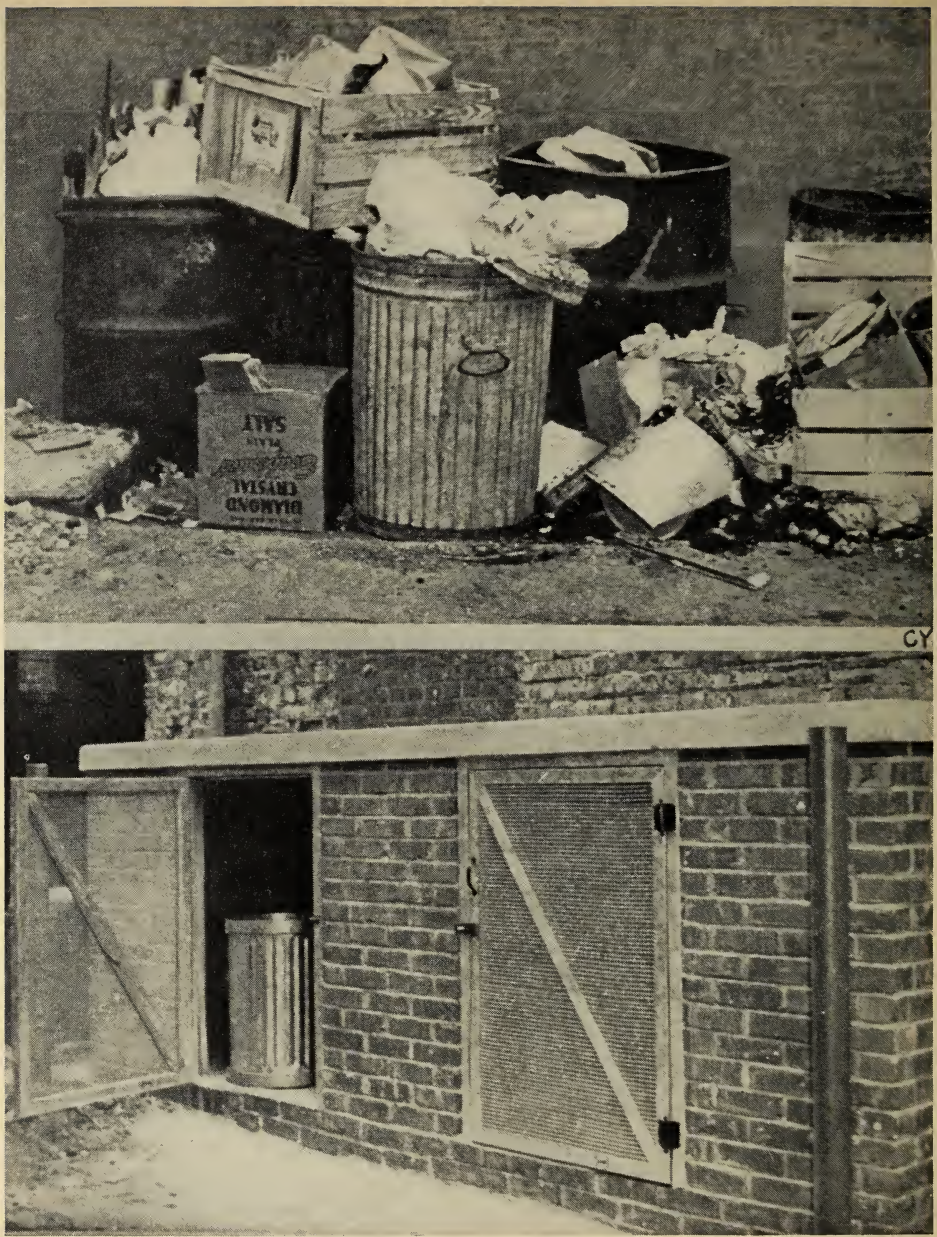

Fig. 10. Storage of garbage and rubbish. Above, poor; easy of access to mice, rats, and flies. Below, good construction; doors are covered with both hardware cloth and fly screen and provided with spring hinges, thus excluding all pests. Courtesy of U. S. Public Health Service.

all entry by tacking tin sheets or hardware cloth over the openings. If the space is on the first floor, some of this work may be done in the basement—searching with a flashlight in dark places and closing all entry ways.

Garbage, Boxes, and Trash. Incorporated cities and towns usually require each residence or business place to provide metal garbage cans for disposing of waste food and trash. But many housewives, restaurant employees, and storekeepers are careless (fig. 10). They fail to cover the cans tightly or they overload them. Home and farm yards, and the alleys behind both homes and stores often have irregular heaps of boxes, lumber, or trash. The open garbage cans provide food and the piles of debris offer shelter. The practice on many farms of throwing all table scraps into pens for chickens or hogs helps to support both rodents and flies, particularly if the pens are seldom or never cleaned up. To keep down rodents, dispose of refuse promptly and properly.

Empty boxes and stocks of lumber should be piled compactly and neatly on trestles or other supports that keep the bottom 12 to 18 inches above ground. Trash piles, brush heaps, old prunings from fruit trees, bundles of corn stalks, and all such litter should be burned. Large piles of firewood, if not in separate tiers, may serve as shelter for rats—and in the country, are often used by ground squirrels.

The most effective way to control rats is to build them out and starve them out. The houseowner, storekeeper, or farmer should inspect his property, keeping in mind the methods of exclusion just discussed, and then repair his premises. In many cases, a little work, using materials already at hand, will result in keeping all rodent pests out of buildings.

TRAPS

Trapping is the preferred method of control in homes and office buildings, because animals killed in this way may be easily removed, whereas poisoned rodents may die within walls or in other inaccessible places and create bad odors. Almost any trap (fig. 11) will catch some rats, but long experience proves that the ordinary spring snap trap is best and cheapest.

The many kinds of traps designed and manufactured comprise four main types: wooden or steel "breakback" or guillotine traps, steel jaw traps, cage traps, and automatic traps (fig. 12). Results depend more on the number of traps used and on the way in which they are placed than on the type of trap used. Contrary to popular opinion, human odor from handling traps will not keep rats or mice away; it is not necessary to wear gloves or to boil, wash, or smoke the traps. It is important, however, to keep traps in good working order and to set each trap with a "hair trigger," so that the least touch will release the spring.

Trapping House Mice. The small breakback and choker-loop traps are used where there are signs of mice: tracks, droppings, holes, or damage. In buildings, place traps along the wall, with trigger end toward the baseboard, or against boxes or other objects, at intervals of 2 to 3 feet. Many traps should be used if mice are abundant. If a mouse hole is found, put a trap about 9 inches on either side.

Rolled oats is almost always effective as bait (cheese is not!). Bread crumbs, oatmeal, or other cereals may be tried. Meat or fish baits are seldom necessary. A little loose bait should be placed under the trigger, to catch mice skillful at robbing traps. The "set" of the trigger should be delicate. A string or light wire from the trap to some nearby object will prevent a prowling cat from carrying the trapped mouse away, and will also keep a mouse caught by the tail or foot from crawling into hiding.

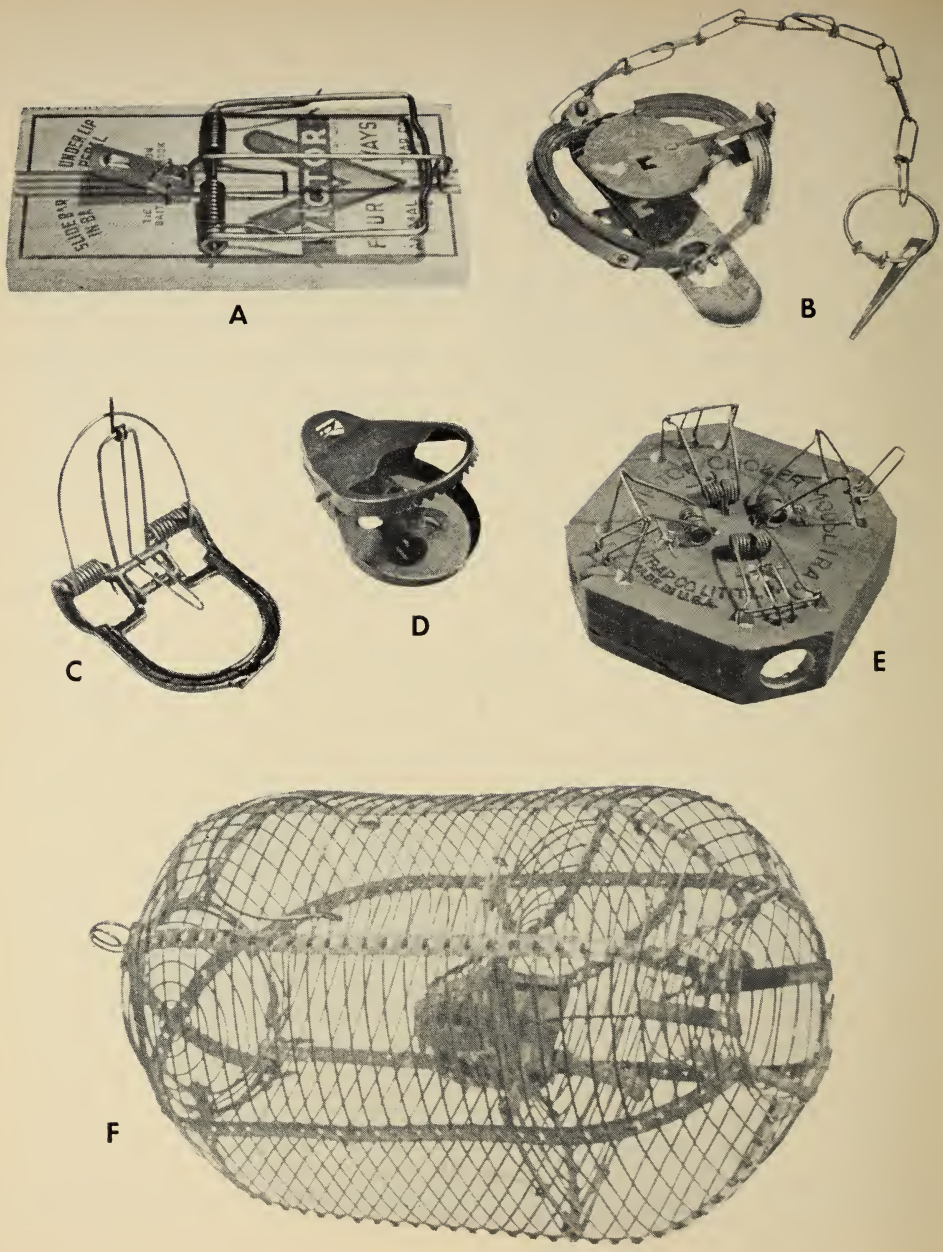

Fig. 11. Traps for rats and mice. A, wooden snap or breakback rat trap; the same type in smaller size is used for mice; B, steel jump trap size 0 (the leather padded jaws are not necessary); C, Schuyler trap (made in both large and small sizes); D, all steel quickset mouse trap; E, 4-hole choker-loop mouse trap; F, wire cage trap, 2 sizes available.

Trapping Rats. Rats are considered somewhat "wiser" than mice, yet many are taken with wooden snap traps or steel traps. Trapping is most useful in homes, offices, and generally in places where there are few rats. If there is a heavy infestation, other control methods should be used first, and traps placed to kill those remaining.

The wooden-based spring trap is generally used, but some trappers employ the No. 0 steel trap. If traps are set and baited at once, some rats will be caught. However, better results will be had if the traps are placed and baited, but left unset for 3 to 5 nights, then baited and set. This practice overcomes the rats' fear of a new object.

Traps should be placed along runs or where there is other evidence of rats, spaced at intervals of 6 feet or more, with the trigger ends close to the wall. Each trap should be fastened to some nearby object by a cord or light wire about 2 feet long.

In places where regular rat runs are found, baited traps are usually set 2 or 3 feet off the trails. If no rats are taken, then traps, baited or unbaited, are set with the trigger directly across the runway.

When rats are using overhead pipes or beams, traps can be placed or fastened on the runs with the trigger across the line of travel. The best method to support such traps is to drill a hole in the trap bottom near the trigger, then drive a finish nail into the beam or twist a wire around the pipe, leaving a short upstand-

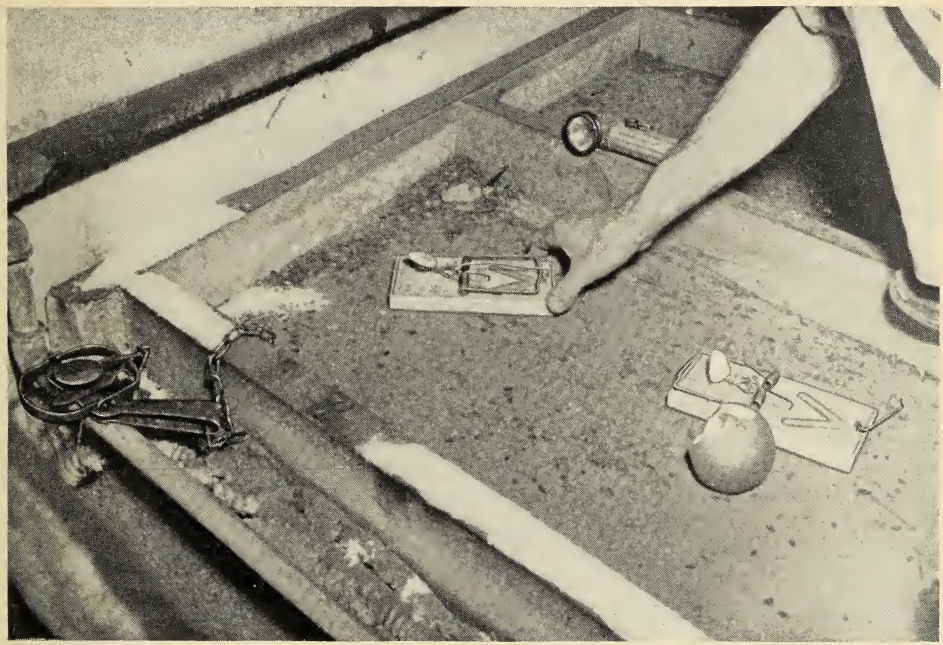

Fig. 12. Placing traps and antu dust for rat control. The steel trap (unbaited) is set with its trigger pan on the same level as the jaws, the spring is turned at a slight angle with the trap axis, the trap chain is nailed to some solid object, and the trap is placed where rats have been running, as indicated by black smears on the pipes. One wooden trap, baited with cut apple, is set near the run on a flat surface used by rats, as shown by the droppings. Other kinds of bait may be used. A thick layer of white dust containing antu has been sprinkled on the edges of timbers traveled by rats; any Norway rat that evades the traps but walks through the dust is likely to be poisoned. It is usual practice either to set traps or put down dust patches but not to combine these two methods at one site. Courtesy of U. S. Public Health Service.

ing end of wire. The hole in the trap is put over the nail or wire end. A soft wire from the other end of the trap is fastened to some object below the level of the runway. When sprung, the trap and rat will bounce off the support and hang from the wire, leaving the runway free for other rats to find other traps similarly placed.

When a trap is placed on the ground, the base may be countersunk in the soil so that only the trigger projects above the surface. Indoors or out, for especially wary rats, it is often helpful to cover a trap with sawdust, fine soil, or other camouflage that does not interfere with the trigger or action.

To increase the chance of catching any rat that crosses a trap, some workers add a trigger card, a piece of corrugated cardboard, about $2 \times 2\frac{1}{2}$ inches, forced over the trigger to increase its effective surface.

Rats that ignore an exposed trap will often be caught if a board or box is placed to shield the trap, leaving a space for entry and for the trap spring to operate.

Rat baits may be of almost any human food. In many places these rodents develop special preferences for the kinds of food most readily available. In general the Norway rat seems to prefer protein and fatty foods, whereas the roof and black rats seem to have greater liking for cereals and fruits.

Sometimes a trial with several kinds of baits will indicate what the local rats prefer. Rolled oats and other cereals, bread crumbs and corn meal are common baits; ground meat, bacon, fish, nut meats, apples, and raisins also are used. When bait is finely divided, some should be scattered under the trigger as well as on top. Solid materials should be pressed onto or tied to the trigger. If the material spoils or dries, baits not taken should be replaced the next day, but dry cereals can remain longer.

Traps should be examined at least once each day, preferably in the morning. Dead rats should be removed promptly and buried at least 2 feet deep, burned in an incinerator, or placed in a tight garbage can for early removal. Since fleas and mites will leave dead rats and may get onto people, the trapper should handle dead rats as little as possible, and should wear gloves.

Cage and box traps that capture one rat at a setting are provided with 1 or 2 drop doors. Some have an overhead trigger on which the bait is fastened and the door is released when a rat works at the bait. Others have a treadle in the floor on which the rat steps to drop the door. The "automatic" traps are intended to catch more than one rat. When one enters, a balanced door closes behind the animal, preventing its escape. As the rat moves into another compartment the outer door reopens. Several types of electric or "electronic" traps have been offered for sale or lease. None of these special traps have proved more efficient than a good supply of snap traps, and all are much more expensive.

POISONED BAITS

Poisons. The chief method of routine control by all government agencies, commercial pest control operators, and many others is use of poisoned food or baits. The principal poisons are red squill, zinc phosphide, antu, and warfarin, although arsenic, barium carbonate, phosphorus, and strychnine have been used. Many other substances have been tried with little or no success. Thallium sulfate and Compound 1080 are both effective poisons, but they are too dangerous to be used by the general public.

All but one of the materials named are "stomach poisons"; when sufficient doses are eaten they are absorbed and kill by toxic action. The exception, warfarin, must be eaten in small amounts over several days, when it prevents blood clotting and death results from internal hemorrhages.

Many types of commercial rat and mouse poisons are on sale. In California

Except for red squill, all these poisons are dangerous to man, pets, and domestic animals. Stocks of poison and poisoned bait and all equipment used with them must be labeled POISON and must be securely locked up when not in use. Care also must be used in handling and placing poisoned baits and in the disposal of unused baits and of poisoned animals.

all poisons and poisonous baits (economic poisons) for pest control and for sale to the public must first be submitted to the State Department of Agriculture (Calif. Agric. Code, 1945, Secs. 1061–1079), and only those which are satisfactory are registered for sale within the state. The printed label on each package must include the name and percentage of the active ingredient(s), a statement about the poison, and information about antidotes. The Federal Insecticide, Fungicide, and Rodenticide Act of June 25, 1947, provides that all rodent poisons intended for interstate commerce must be similarly registered and labelled. Licensing does not guarantee that a material will always provide effective control, but it eliminates the poorer rodent poisons including some advertised in magazines for direct sale to users.

Baits. Rolled oats and other cereals, corn meal, bread crumbs, and diced bread are the commonest baits. In England dry stale bread soaked in water until mushy is used successfully. Wheat soaked overnight in water and then drained has served with some poisons. Addition of mineral oil, corn oil, molasses, peanut butter, or tomato pureé to bread or cereal has been advised by the U. S. Fish and Wildlife Service (Silver and Garlough, 1941).

Trials on the relative attractiveness of different baits for Norway rats in the northeastern states showed preferences in decreasing order to be: raw meat, raw fish, rolled oats, whole wheat, corn meal, bread crumbs, canned fish, canned meat, cooked cereals, cheese, meat scrap, powdered milk, fish meal, fresh vegetables, cooked vegetables, and fresh fruits (O'Connor, *et al.*, 1935). Rats in different localities and in places where one or another kind of food is most available often definitely prefer particular foods. Several kinds of bait should be tried to determine what the rats like best. Wet baits must be prepared and used fresh each day. Meat or fish in dry or hot places will soon gloss over and spoil.

Prebaiting. For many years it has been common practice simply to put down baits in places frequented by rats, leave them for one or more nights, and then remove the uneaten baits. Some rats were killed, but results were usually unsatisfactory. A recent major improvement is the use of prebaiting (Bartlett, *et al.*, 1946). Small piles of clean unpoisoned baits are placed at selected sites or in special bait containers for several nights, the supply being replenished whenever rats take the material. The prebait is then replaced by poisoned food of the same kind, which is left 1 to 3 nights, and then the remainder removed.

Prebaiting takes account of an important feature in rat behavior—a suspicious fear and avoidance of new objects, even a new food. If clean prebait is offered, they will, after one or more nights, overcome their fear and usually accept the new food. Also, when sites are prebaited for several nights in succession, increasing numbers of rats will come to feed at these places. Then when poisoned bait is substituted, a larger number will be killed.

A convenient program is to prebait on the first, third, and fifth days, replace with poisoned bait on the sixth day, and remove all remaining poison and dead rats on the eighth day. If acceptance of the prebait is poor, the prebaiting period should be extended for several more days.

The largest take of poisoned bait will be on the first night it is exposed; a little may be taken the second night, but practically none thereafter.

Prebaiting may provide a crude method of estimating the number of rats using bait stations. A given weight of prebait—say 2 ounces, which may be measured by bulk with a suitable spoon—is put out at each station. On succeeding days, if much is eaten, the station is refilled, doubling the amount each time (4, 8, 16 ounces, etc.), and this practice is continued until the amount taken "levels off," when a maximum number of rats will be eating at the station.

Assuming each animal eats about 1 ounce (25 to 30 grams), one may estimate the number of rats. Then after poisoned bait has been substituted, a guess as to the number killed can be made, on the basis of ⅓ ounce (10 grams) per rat, since the animals eat a smaller amount of poisoned food. A week or two after poisoning, an estimate of those remaining can be made by using a new bait (unpoisoned) and determining the amount removed.

Placing Baits. Both prebait and poisoned bait should be carried in a can or bag and placed with a long-handled spoon. Baits may be put directly into rat burrows, in rat-infested spaces under buildings, or in crevices about foundations or walls. In buildings, baits may be placed directly on floors, but should not be set out on boxes, packages, or sacks containing human food or animal feed. To avoid spilling and waste, baits sometimes are placed on small sheets of paper or in shallow paper or metal cups. The baits should be put down near walls, be-

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Fig. 13. Containers for safe exposure of baits used to poison rats.

A. Leaning board. Provides tunnel under which rats may eat; if space beneath is narrow, large cats cannot reach the bait; also may be placed over sodium fluosilicate dust (p. 31) to increase chance of rats running through the dust, and prevent them from scattering the material.

B. Box shelter. Narrow box, 2 sides removed and ends cut to make 3 x 3-inch opening; will shelter either bait or trap.

C. Sheet-metal hood. Useful outdoors to protect bait from rain. Board about 8 x 14 inches with half cylinder of sheet metal (14 x 18 inches, or sides of two No. 10 cans); small can 3 or 4 inches in diameter by 1 inch high holds the bait; used by Navy in Pacific Ocean areas (T. B. Murray, U. S. Naval Med. Bul., 46: 1318, 1946).

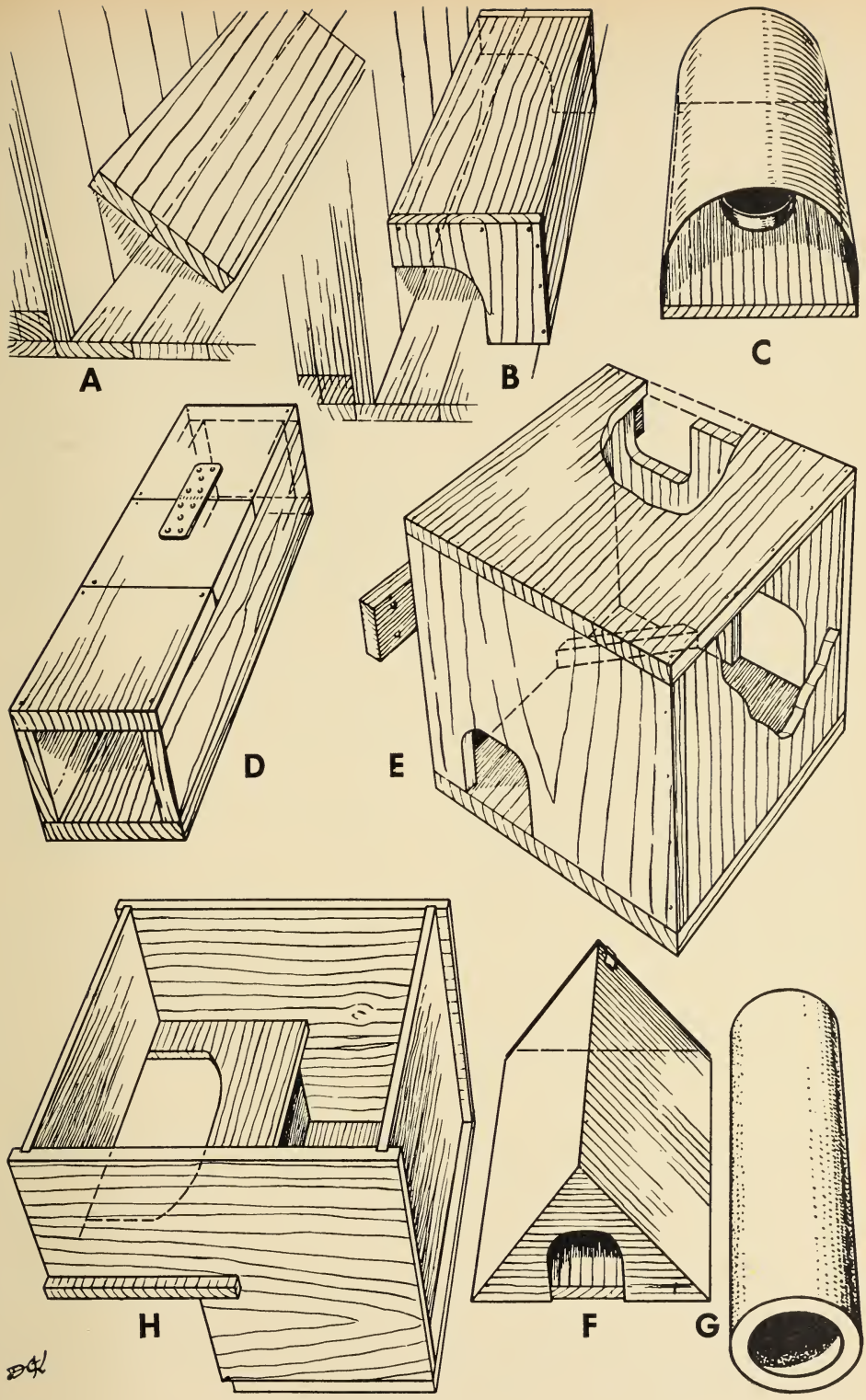
D. Bait box. Of ¾-inch wood, open at both ends with door in middle of top on leather hinge; used on garbage dump; too small for cats to enter (Coogan, Public Works, 75: 25, Sept., 1944).

E. Bait box. Of wood; about 12 inches on each side, but dimensions may be varied; entrances about 3 x 3 inches; diagonal cleat on inside floor forms bait enclosure; slat at back for nailing on wall; not easy to remove prebait (J. Silver and F. E. Garlough, 1941, p. 15).

F. Metal bait box. Made of 28-gauge galvanized iron; rear door hinged at bottom to insert bait and clean; about 12 inches long and 8 inches on side (W. S. Mangold and George King).

G. Drain tile or sewer pipe. Useful on garbage dumps; also may be used where poultry are present, if open end is faced within 3 inches of a wall; pipe is 3 inches in diameter and 24 inches or more in length; one end plugged with wood or concrete; closed end may be partly buried in garbage dump or embankment; bait should be placed well inside by use of long spoon (A. D. Middleton, Rat control on farms. Great Britain Ministry of Fisheries and Agriculture, 1945).

H. P_3 (protected poison point). Special box of wood, ⅜- to ½-inch thick (or of galvanized sheet iron); removable cover (not shown) fits over top; box when placed against a wall forms a tunnel without floor; rat must travel in 3 directions to reach bait inside on bottom, below small ledge; large enough for several rats to feed at one time; poultry or pets cannot reach into bait compartment; lid may be fastened by inside spring to prevent opening by children, and box may be bolted to floor or wall; bait not easily spilled if box is overturned, yet prebait can be removed easily (British Patent, No. 541,844; designed by Charles Elton and others, Bureau of Animal Population, Oxford, England; see also S. A. Barnett, et al., Rats and Mice, Great Britain Ministry of Food, pp. 13–17, 1946).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side piles of boxes or sacks, and in any other places where there is evidence of rats. It is important to distribute enough baits so that all rats will have access to one or more.

Several kinds of special containers have been designed (figs. 13, 14) for safer exposure of poisoned baits. Most of these are built so that only rats and mice may enter. If one of the more complex types is used, the containers must be placed, prebaited, and left for some days, even for 2 weeks, until rats enter freely. Then a regular schedule of prebaiting may be started.

> Be sure to keep poisoned material away from children, pets, and poultry.

If the first poisoning is successful, it need not be followed by another for about 3 months, depending on the amount of new "sign" of rats that appears. When the number remaining is small, trapping, with a new bait, may be tried.

Should one campaign fail to kill enough rats, a follow-up may be started about 2 weeks later. A new bait and new poison must be used, because any rats made ill but not killed in the first attempt are likely to be "prejudiced" against the bait and poison first used. After a good cleanup, rat proofing is in order.

Poisoned animals and uneaten bait must be burned, or buried at least 2 feet deep. They should not be put into garbage, since garbage often serves as feed for hogs, which might thereby be poisoned.

The real measure of success is not the number of rats found dead after a poison campaign, but the number that escape. For good results, 90 per cent or more must be killed; otherwise the young in nests and those developing in surviving females will soon repopulate the area.

Formulas. Some poisoned baits may be bought already prepared, but if these are used, prebaiting is not possible. Poisons are sold by dealers in chemicals and in garden and orchard supplies, and by some drug stores. Bait materials can be purchased from groceries and feed stores. To use the prebaiting method it is necessary to buy the bait and poison separately and prepare the poison mixture according to one of the following formulas.

Red Squill. This rat poison is obtained from an onion-like plant (*Urginea maritima*) native to lands about the Mediterranean Sea. At present there are some experimental plantings in this country. The large (5 to 6 pound) bulbs are sliced, dried, and ground to a fine reddish powder. This powder* keeps well when stored in a tightly-capped can or bottle.

Of all rat poisons, red squill has been the safest for use by the general public, but not always the most efficient. Experiments show that cats, dogs, chickens, pigeons, and hogs usually will not eat squill preparations, or will quickly vomit any they do eat. Poisoned baits, however, should not be put where children or pets can find them.

Formula 1

Bait (cereal, bread crumbs, fish, or ground meat, etc.)	9 parts by weight
Red squill, powdered	1 part by weight

To measure dry materials by weight, use 1 level tablespoon of red squill to 1 measuring cup of bait. Sift the dry powder over the bait, turning and mixing until the poison is well distributed.

Commercially prepared red squill baits are available as a dry mix of poison and bait, either loose or twisted in small squares of paper as "torpedos." Other squill preparations are baked as small biscuits or wafers. Such products often

* Different batches of squill bulbs yield powder varying widely in toxicity. For effective control, rats should be killed by 500 to 600 milligrams of red squill per kilogram of live rats as determined by laboratory test (bioassay). Most or all red squill powder now sold in the United States meets this specification, since squill of lower toxicity is fortified until of proper strength.

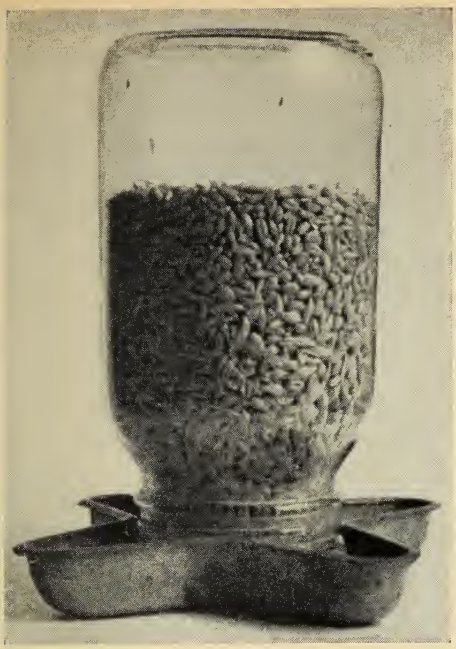

Fig. 14. Poison station for house mice (using drinking fountain for baby chicks). Poisoned material in the jar flows into open-topped metal base where mice can feed. The jar should be labeled POISON. This device should be used only in a place that can be securely locked to prevent entry by children, unauthorized persons, or pets, and where the odor of dead mice will not be objectionable.

are issued by city health departments to citizens for rat control about homes; but prebaiting then is impossible.

A liquid red squill extract is also available, but generally it seems less efficient than the powder. One pint of liquid serves to moisten ½ pound of bait (meal, or stale bread cut in ½-inch cubes).

Zinc Phosphide. This chemical (Zn_3P_2) is a heavy dark gray powder with a faint odor of phosphorus resulting from the slow release of phosphine (PH_3). Both the powder and gas are serious poisons. Zinc phosphide should be weighed, mixed, and handled only out-of-doors or in a well-ventilated room, and workers should wear gloves of leather or rubber when mixing or distributing poison baits.

Formula 2

Bait	96 to 100 parts by weight
Zinc phosphide, powdered	1 part by weight

Corn oil, mineral oil, or glycerin, at 12 to 24 fluid ounces per 100 pounds of bait, is often added to any dry cereal to make the poison adhere. The bait and poison are first mixed dry until the zinc phosphide becomes an evenly distributed coating. Then the oil, well warmed, is added slowly and the mixture is stirred again. Baits may be cereal or bread crumbs alone or may include some fresh fish, horse meat, or hamburger. Ground apple or carrot are sometimes used. Stale bread, without an oil, but mixed with an equal amount of water, has been used with 2½ to 5 per cent zinc phosphide in England.

Antu. The chemical known as antu (alphanapthyl-thiourea) is of use in control of Norway rats. It is a fine bluish-gray powder that keeps well when dry and is insoluble in water. It may be mixed with wet or dry foods (cereals, bread, etc.) and adheres well when dusted from a sifter on cut moist baits of apple, sweet potato, cantaloupe, or water melon and on ground meat, ground fish, or chicken heads.

Formula 3

Bait	100 parts by weight
Antu	2 or 3 parts by weight

This substance is quite poisonous to dogs, cats, and pigs; when used care is needed to keep these animals from the poisoned baits. Antu will not seriously poison poultry or man. For rodents other than the Norway rat it is far less toxic and other poisons should be used for control of those animals (Richter, 1945; Ward, 1946).

Warfarin. New in materials for rodent control is warfarin (Compound 42) which is licensed for manufacture and sale by the Wisconsin Alumni Research Foundation. Unlike the usual poisons, this substance produces fatal internal

bleeding (hemorrhage) when eaten in sufficient amount over several days. Additional differences are that rats take baits containing warfarin without hesitation and will continue to do so until death overcomes them after several days. No prebaiting is necessary. (Hayes and Gaines, 1950.)

This substance is marketed under various trade names (all packages show the active ingredient as warfarin). As offered for sale warfarin is available in two forms. One is a 1:200 (5%) mixture with flour or other powder that is to be combined with bait at 1:19 ratio by weight so the final mixture contains warfarin in a strength of 1:4000 (about 100 milligrams per pound). With dry baits (rolled oats, etc.) mineral oil at one quart per 15 or 20 pounds of bait may be added so that the powder will adhere and be spread uniformly. The other form is ready-to-use bait with warfarin in 1:4000 ratio (0.025 per cent).

The final mixture can be exposed like other baits in small piles or in bait boxes (Fig. 13). As taken by rats the supply must be replenished so that it will be available for the animals to eat as often as they desire. Bait spots should be so maintained for 10 days to 2 weeks or longer. In trials with warfarin it is common experience that after rats begin feeding there is a large initial take of bait for several days, then lesser amounts are removed as rats die off, and finally small quantities are eaten irregularly as rats from outside enter the area baited.

The only serious hazard in using warfarin is to domestic cats and dogs (two ounces of bait per day for 3 or 4 days would probably kill an 11 pound dog); like rats, these pets are killed by feeding on the baits for several days. A single meal, even of some size, is usually not fatal. Cats may die after feeding several days on poisoned rats.

There is litle danger to human beings from warfarin. If a child or person eats some of the prepared bait, he should be induced to vomit and a physician called at once. Treatment includes transfusion with whole blood and giving Vitamin K preparations by mouth or intravenously.

Arsenic. The heavy white powder commonly called arsenic (also known as arsenic trioxide, arsenious acid) has often been used for rat control. It is now less in favor in the United States than in England and elsewhere. The arsenic must be of very fine particle size (6 to 9 microns) for good results, since the larger particles are less toxic. It should be well refined because impurities make arsenic less acceptable to rats. The laws of some states and countries require that arsenic be colored blue or green to distinguish it from flour, soda, and other harmless or edible white powders, but this does not affect its toxicity.

Formula 4

Bait	90 parts by weight
Arsenic trioxide	10 parts by weight

Arsenic has been used with various dry and moist baits. In preparing and distributing baits, workers should be careful to keep arsenic off the skin, which is irritated by the chemical.

Barium Carbonate. Formerly this heavy, fine white powder was used commonly but it has been largely discarded in favor of more dependable poisons. While cheap, it is not always easy to buy.

Formula 5

Bait	4 parts by weight
Barium carbonate	1 part by weight

Corn meal, rolled oats, bread, and ground meat or fish have served as baits. Dry materials are first mixed with the barium carbonate, then moistened. Bread baits may be moistened with milk; "sloppy" baits may be more effective in hot weather. Fresh foods should have the dry barium carbonate sifted over them, and should be stirred until evenly coated or mixed with the poison.

Strychnine. Both alkaloid and sulfate strychnine have been tried for rat control, but results are often unsatisfactory,

since some rats will not take baits with this poison and others eat but little. House mice will often take strychnine-coated wheat, and this bait has been used especially for mice in outbuildings. In residences, trapping mice is better practice.

Yellow Phosphorus. The basis of many commercial rat and mouse poisons is yellow phosphorus which is often sold in a sirup to be spread on baits of bread and other foods. Some of these preparations are fairly effective.

Phosphorus has a distinctive, garlic-like odor, and is luminous in the dark, but these features do not prevent rats from eating phosphorus baits. There is a fire hazard from phosphorus probably only when the particles are larger than of microscopic (colloidal) size.

No directions for making phosphorus preparations are given here because the process is too complicated. Children and even adults sometimes eat phosphorus-poisoned sirup by mistake, with serious or fatal results. Hence this rodent poison is more of a hazard in homes than other types.

Special Poisons. Two other rodent poisons are not available to the general public because of the great hazards they involve. Baits poisoned with these chemicals have no distinctive appearance, taste, or smell. Both are toxic to rodents, other wild animals, domestic livestock, and man.

Thallium sulfate (thallous sulfate, Tl_2SO_4) is a "heavy metal" poison obtained from smelters. It has been used by government agencies for control of both rats and field rodents. Thallium poisoned grain has several times improperly come into the hands of persons who, not knowing it was poisoned, used it for food. A number of illnesses and several deaths resulted. Sale or possession of thallium for rodent control in California is restricted by law to federal, state, county, and municipal officers and employees (Calif. Agric. Code, 1945, Sec. 1066.5).

Since 1945, a new wartime discovery, "1080" (sodium fluoroacetate), has been used by military and government agencies for rodent control (Kalmbach, 1945; Ward, 1946). It is very effective, but extremely dangerous. Pet dogs and cats may be poisoned by eating rats or mice killed by "1080." Several human deaths, particularly among children, have occurred with "1080" in rat control. Like thallium, its sale is restricted by law.

These poisons can only be used by properly trained persons and in places where there is little chance of secondary poisoning.

There is no certain antidote for either of these poisons. Thallium is a slow-acting poison, but "1080" works so rapidly that it has been impossible to save experimentally poisoned animals even with prompt first aid under the best of laboratory conditions.

DEODORANTS FOR DEAD RATS

Manufacturers of some commercial rat poisons have claimed that their preparations will "embalm the dead rats," or cause them to have no odor, or that rats, when poisoned, will leave a building to find drinking water. None of these claims has been proved.

Rats dying within a wall often produce persistent offensive odors. Powdered activated charcoal blown into the place is reported to be the most effective deodorant. Other substances recommended are chloride of lime and solutions of lead nitrate, lead acetate, or formaldehyde.

POISONOUS GASES

Many rats in burrows or hidden in ships, buildings, and other enclosures can be killed by use of poisonous gases.

Calcium Cyanide. This compound, $Ca(CN)_2$, is the commonest material used for gassing. In the presence of moisture (water in the air or soil of rat burrows), this chemical forms hydrocyanic acid gas

Any careful person may use poisonous gas out-of-doors, but within buildings gas is more dangerous, and should be used only by a trained official or licensed pest control operator wearing a suitable gas mask. All of the gases used are poisonous to man and domestic animals. Take care to avoid accidents.

(HCN). Both calcium cyanide and the gas are deadly poisons for animals, insects, and man. In parts of the arid West and Southwest during the dry season there may not be enough moisture for successful use of cyanide, and cracks in the ground may permit quick escape of the gas, which is lighter than air.

Calcium cyanide is available both as a dust (Cyanodust A) and in granular form (G Fumigant). The dust is applied with a special pump (fig. 15). Air is forced through a glass jar which contains the powder, and the dust-laden air passes through a hose into the burrow. The tip of the hose is placed 10 to 12 inches inside the burrow, the entrance is closed with earth, and several strokes are made with the pump. If dust is seen coming out of hidden "bolt holes" (fig. 6) or through cracks in the ground, such openings should be covered with earth. The dust produces a high concentration of gas in the burrow, but only for a short time.

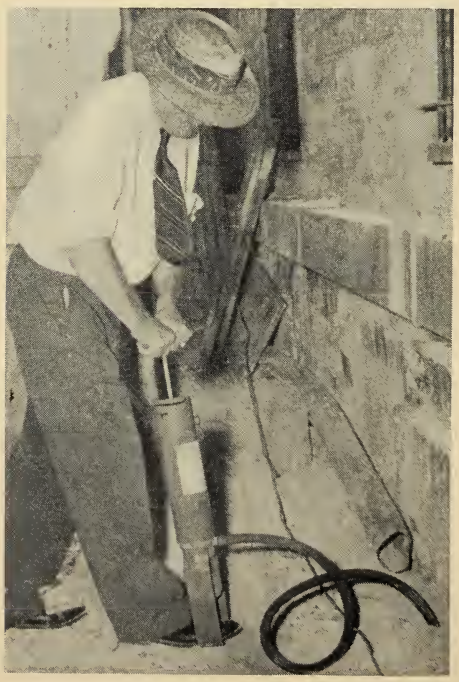

Fig. 15. Use of pump with calcium cyanide dust to gas rat burrows. Courtesy of U. S. Public Health Service.

Corn cribs may be temporarily rid of rats by use of a dust pump. There is no danger in using corn from fumigated cribs after several days of damp air, since the poisonous gas is generated rather quickly and the residue is only lime.

When using granular cyanide, place 1 tablespoon (one ounce) of the material 6 to 8 inches inside the burrow with a long-handled spoon, and block the entrance tightly, taking care that the cyanide is not covered. If there is moisture within the burrow, a strong concentration of cyanide gas will develop just inside the blocked entrance, where it will kill any rat trying to dig out. In damp weather the cyanide may be placed during the afternoon. When the temperature is low, the material should be put into burrows during the morning to give time for the gas to form. This method is not effective on garbage dumps, under piles of trash, or in places where the ground is cracked, as the gas will leak away too rapidly.

Cyanide readily dissolves in water; it can be used when the air is damp, but not during a rain or when the ground is wet. The supply can should be covered tightly except when cyanide is being removed. The chemical should always be kept off the operator's hands and clothing.

Other Gases. No other gas is so widely used as cyanide for rat control. Carbon disulfide (CS_2) applied with a pump or on waste balls, as for control of ground squirrels, can be used against rats. Fluid carbon disulfide burns readily,

and the vapor is highly explosive. It should not be used where there is any fire hazard from open flames, cigarettes, electric sparks, or other sources. Details on the use of carbon disulfide are given in Calif. Agr. Ext. Cir. 138, "Control of Field Rodents in California."

Sulfur dioxide (SO_2), produced by burning sulfur in air and forcing the fumes into burrows, is of some value, but now is seldom used.

Methyl bromide (CH_3Br) is a highly volatile fumigant occasionally used for burrows, especially where killing fleas for disease prevention is necessary, but it requires special equipment for use.

Carbon monoxide (CO) from an automobile exhaust may be forced through a hose into rat burrows. The pressure from the engine drives the gas into all parts of a burrow. Unlike some other gases, carbon monoxide will remain in a burrow for a considerable time, not being absorbed in the soil or soil water; hence it has a long period of effectiveness. This gas may be used for burrows under cement-floored farm buildings where cyanide would be dangerous to livestock.

POISONOUS DUSTS

If sodium fluosilicate (Na_2SiF_6) is spread on floors where rats and mice run, some of the dust gets on their hair and feet, proves irritating, and is licked off and swallowed (Mackie, *et al.*, 1934). The rodents die in 3 to 6 days. This chemical contains fluorine and must not be used where it might contaminate food. The dust should not be stirred up; and under no circumstances should kernels of cereals on floors dusted with fluosilicate be swept up and used as food for man or animals.

The law states that no food product may carry a residue of fluorine in excess of 0.019 grain per pound. Products found to contain more may be seized, and the owners prosecuted.

In some places sodium fluosilicate may be put down in a narrow strip on the floor close to the walls in a room or building. Then boards may be leaned along the floor and against the wall to prevent the dust from being scattered to nearby objects. Rats and mice usually run along the bases of walls, and tend to go beneath boards so placed.

> Cyanide in any form must be handled with extreme care. It should not be used indoors, or for burrows under or near a building where people, livestock, or poultry are present. Control should not be attempted during a strong wind. In opening cyanide cans, loading a pump, and using the pump or spoon, the operator should stand to windward and avoid exposure to dust or fumes.

Antu, up to 20 per cent, when mixed in flour, pyrophyllite, or talc, may be dusted heavily (1/8 inch or thicker) on rat runs and entrances to burrows for control of Norway rats. It has little value for roof or black rats. This is not a major means of control, but has been used to kill a few rats that escape poison, traps, or gas.

In areas where murine typhus is a hazard, DDT dust (5% to 10%) is placed on runways to catch on the feet and fur of passing rats and kill many of their fleas. When the number of fleas, which carry endemic typhus to man, is reduced, there is less danger of spreading the disease when the rats are killed off.

Heavy dusting with DDT is reported to reduce or eliminate house mice in places where this material can be used with safety. It is less effective for rats.

Any of these dusts can be applied with a sifter can. When much dusting is to be done, however, it is helpful to have a large (1 gallon) can with fly screen soldered on one end and a carrying handle on the side. For dusting rat runs on beams and pipes, a small sifter can fastened at right angles to the end of a 3- or 4-foot stick is convenient.

OTHER MEANS OF CONTROL

Destruction of Burrows. When rat burrows are numerous in fields or poultry pens, the first efforts at control should be by methods already described. Then the area should be plowed to a depth of 18 inches with a subsoiler or "chisel" to destroy most of the burrows. With fewer safety retreats, it will then be easier to keep down the number of rats.

Burrows in yards or about buildings can be collapsed by use of a pick, crowbar, or shovel.

Flooding. Rats may sometimes be killed by flooding their burrows, especially on poultry or pigeon farms. Rat burrows are shorter than those of field rodents, and the animals may escape the water; results therefore are not always satisfactory.

Blocking. In some places it is possible to close all rat entrances to a building and then kill most or all of the rats inside. This practice is called blocking. A careful preliminary search is made and all but the one or two entrances in most active use are blocked securely with sheets of tin, large rocks, or stout boxes filled with earth. On the night selected for operations, the remaining entrances are quietly blocked about an hour after dark. Then two or more persons, equipped with strong flashlights, enter and kill the rats with clubs. Boxes and other objects are moved when necessary to expose all the rats. Rats may even be prebaited to concentrate in a building, so that a larger number can be destroyed. Two or three dozen rats have been reported killed at one time in a poultry house or similar structure.

Dogs, Cats, and Ferrets. A rat terrier often is helpful in blocking, or when stored goods are being moved in a room or warehouse. The dog will catch rats that avoid human efforts.

Some domestic cats are good mousers, and cats are kept about barns or warehouses to help hold down the population of house mice. Cats seldom kill large rats, but when a property has been largely cleared of rats by other means, cats may capture incoming migrants. On the whole, however, they are of minor value.

Ferrets sometimes are trained to pursue rats in their burrows and force the rodents out so that they may be shot. Sometimes the ferret kills and eats the rat, then remains below ground, and the owner must dig to recover his pet. Ferreting is a sport, not a serious means of rat control. In California, possession of ferrets is illegal save for research and testing of certain biologics used in public health work (Calif. Admin. Code, Title 14, Sec. 700, 1945; Chap. 76, Calif. Statutes, 1933).

Rat Virus. Several kinds of "rat viruses," containing cultures of bacteria presumed to spread disease through a population of rats, have been exploited. Their use is commoner in continental Europe than elsewhere. Unbiased studies by rodent-control officials and bacteriologists in the United States have shown that such cultures spread on baits give far poorer results than the manufacturers claim. The bacteria used belong to the food-poisoning group (*Salmonella*) and may contaminate human food. In such institutions as hospitals, use of bacterial cultures for rat control has been followed by outbreaks of food poisoning, both in this country and in Europe. Their sale or exposure for sale has been prohibited in California since 1926 (Calif. Admin. Code, Title 17, Sec. 7925, 1945).

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

OTHER ASPECTS OF CONTROL

Legal Requirements. In many communities, rat control is dealt with in certain ordinances or in the public health laws, such as the California Health and Safety Code (Division 3, Secs. 1800–1813, 1945). The burden for control is placed on the owner or occupier of the premises, and failure to carry on proper control is declared a misdemeanor that may be made the subject of court action.

In increasing degree, many cities are also prescribing the detailed requirements for proper rat proofing of buildings, both new construction and alterations. In practice, many details of construction and maintenance are ignored, because owners, contractors, and workmen are seldom "rat conscious." If rodent-borne disease flares up in a community, a wave of public interest in rat proofing and a program of rat riddance may arise, but unfortunately it soon declines as the threat of immediate danger passes.

Pest Control Operators. When the owner of a residence or business establishment does not want to attempt rat control himself, he may engage a trained pest control operator for the work. The latter will do the premises as a single job for a specified charge, or will agree to do periodic inspection and control as needed under a contract for a stipulated monthly or annual fee. The degree of efficiency will vary with the individual operators or companies.

Several states now require that any person engaging for hire to do pest control must first pass an examination and be licensed. California provides for two types: structural pest control operators, who work in and about buildings; and agricultural pest control operators, who deal with pests of crops and farm lands. (See Calif. Structural Pest Control Act, Sept. 15, 1945, a part of the Business and Professions Code, Div. 3, Chapt. 14, Sec. 8500–8677; and Calif. Agric. Code, Sec. 150). State and national organizations of the operators hold schools and conferences for improving the technical and practical qualifications of their members.

NATIVE MICE AND RATS

White-footed Mice. The commonest rodents in California, outside cities and cultivated areas, are the small "deer mice" or white-footed mice (genus *Peromyscus*). There are several kinds in various parts of the state, but one or another is present in every sort of wild environment from the humid coast belt to the driest desert areas, and from sea level to the high mountains. These mice often invade buildings. Exclusion and trapping are the best methods for their control.

The head-and-body length of adults is 3 to 5 inches, and the tail is 2½ to 5⅔ inches long in different species. The eyes are large and black, the ears thin and prominent; the upper surface of the body is pale brown to gray, and the under parts and feet white (fig. 16).

White-footed mice are strictly nighttime foragers, but they are active throughout the year. They make no runways. They hide and nest in cavities of old stumps or downed logs, in rock piles, and probably in burrows. From 2 to 6 young are produced in a litter, and several broods may be borne during the year by one female. In nature these mice feed on a wide variety of plants and insects.

About homes, cabins, and barns where no house mice (*Mus musculus*) are present, white-footed mice will come indoors and become household pests. Mountain cabins that are closed after the summer vacation are often invaded by these mice, which may cut clothing or bedding to obtain nest material, and eat any human food not in mouse-proof containers. They are particularly undesirable because in some parts of California they are infected with plague.

The owner of a cabin must make special effort to build out these small rodents. The detailed directions for exclusion of house rats and mice (pp. 13–19) should be adapted as necessary to make cabins rodent proof.

Old and loosely built structures, and those of "rustic" design with bark slabs and other rough or irregular materials will need special attention. Buildings of natural stone combined with wood afford many irregular crannies where mice may hide, especially after parts of the structure have settled. Foundations of loose stones not solidly cemented, or of partly rotted logs, give shelter to the mice.

Besides openings on the first floor, the roof, upper windows, and chimney top are paths of entry to mice in winter when snow blankets most or all of a building. The chimney should be capped tightly with hardware cloth of ⅓- or ¼-inch mesh. Loose shingles or shakes must be fastened down, and all crevices between boards covered with battens, well nailed. Sheet tin or hardware cloth serves to cover cracks or holes wider than ⅓ inch. Irregular crevices may be wedged with folded strips of fly screen. Pipes entering walls or floors should be surrounded by metal collars (fig. 7).

Bedding, mattresses, and clothing not in use in summer, or stored during the winter, are safe only in a tight closet lined with sheet metal or hardware cloth. All foods should be in tightly covered containers of metal, glass, or crockery, or in cabinets fully lined with metal.

Killing of white-footed mice in buildings is best done with mouse traps, using a number of traps and persisting until all are caught. Rolled oats makes good bait, but other foods should be tried if necessary. Some owners leave a number of traps baited and set when closing their buildings for the winter. Dusting the floor with napthalene flakes or sulfur is reported to reduce mouse damage and DDT dust in heavy layers may also be used. Strychnine-coated grain sometimes will serve for control, but may be refused by the mice. If the owner cannot control

Fig. 16. The white-footed mouse, or deer mouse (Peromyscus). Its head-and-body length is 3 to 5 inches and the tail about the same. The large black eyes are conspicuous, the ears are large, the upper surface of the body is usually pale brown (bluish gray in young), and the feet and under parts are white.

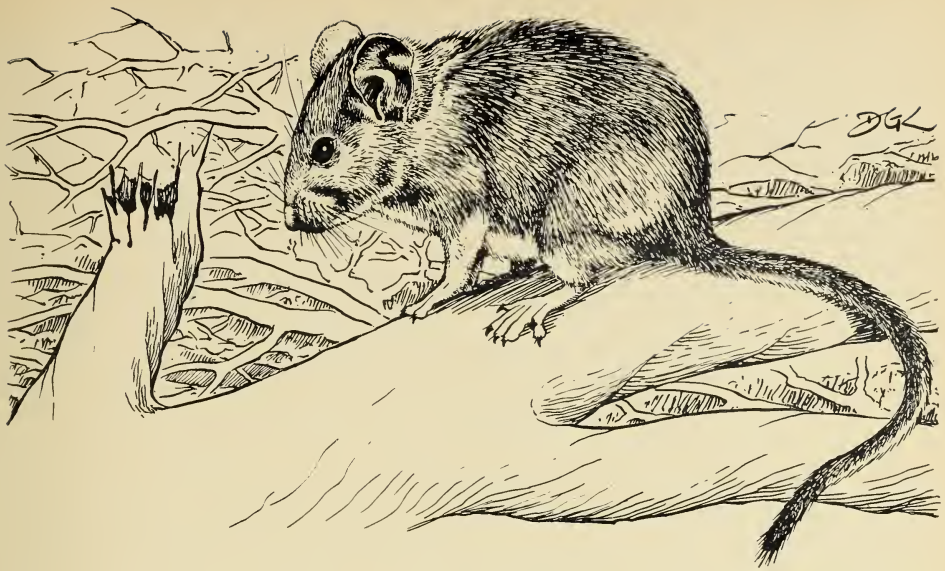

Fig. 17. The wood rat, or pack rat (Neotoma). Its head-and-body length is 7 to 8 inches and the tail 6½ to 7½ inches. The fur is soft, the upper surface is warm brown (bluish gray in young), the ears are large and scantily haired, the nose is blunt, and the tail is hairy.

these mice by the methods described, he should get help from some government agency (p. 4).

Dead mice in mountain cabins should be handled carefully to avoid the chance of live fleas or ticks getting on a person's clothes or skin. Gloves should be worn, and the clothing sprayed with a pyrethrum spray immediately after picking up any mice. The dead rodents should be completely burned, out-of-doors, or buried to a depth of 2 feet.

Wood Rats. The native wood rats, commonly known as "pack rats" or "trade rats," are sometimes a nuisance in homes, summer cabins, and other buildings outside cities and towns. Exclusion and trapping are the best means of control.

The brown-footed wood rat (*Neotoma fuscipes*, fig. 17) of the foothills and lower mountains, has a head-and-body length of 7 to 8 inches, and the tail is 6½ to 7½ inches long. The nose is blunt, the medium-sized ears are slightly haired, and the body coat is warm brown on the upper surface. The coat is softer than that of alien house rats, and the tail is moderately haired.

This wood rat builds large conical nests of sticks and forest litter, either on the ground or on horizontal branches in oaks and other trees and, if given a chance, will nest in buildings. These rodents are active throughout the year, mainly at night. They climb readily, and eat a wide variety of plant materials. They may also be attracted to human food supplies in buildings or in outdoor camps. Wood rats often remove small bright objects, such as spoons, forks, knives, or mirrors, sometimes leaving sticks or other items "in trade."

In the higher mountains there is a larger gray, bushy-tailed wood rat (*Neotoma cinerea*) that makes a nest of piles of rough sticks in rock slides. It also invades cabins for food or shelter. Since wood rats at times may carry diseases transmissible to man, they should be excluded from homes and buildings.

The directions for excluding alien rats and white-footed mice apply to making foothill cabins, mountain resorts, and

similar places proof against wood rats. No double walls or other spaces should be left to provide nesting places for these and other rodents. Means just described to protect food and bedding from white-footed mice will serve also against wood rats. Rock piles near cabins or crevices in foundations are other common shelters for these rodents.

Wood rats are less wary than alien rats, and may be caught in wooden-based spring rat traps baited with rolled oats, peanut butter, raisins, or prunes. They are not readily attracted by other grain baits, and are not easily poisoned with strychnine.

For safety in respect to disease, besides clearing buildings of these rodents, those in nearby nests, logs, or rock slides should be trapped. Dead wood rats should be handled with the precautions stated for white-footed mice. When a building is closed for the winter, several baited rat traps should be placed to capture any wood rats that gain entrance during the owner's absence.

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