

INSECT AND RODENT CONTROL IN FOOD ESTABLISHMENTS

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I INTRODUCTION

A Food Sanitation and Filth

The Food, Drug and Cosmetic Act is often referred to as the "Pure Food and Drug Act" which emphasizes one of its basic purposes - the protection of the consuming public from food that may be deleterious, that is unclean, or decomposed, or has been exposed to insanitary conditions that may contaminate the food with filth or may render it injurious to health. Filth includes contaminating elements such as rat and mouse hairs and excreta, whole insects, insect parts and excreta, maggots, larvae and parasitic worms. The presence of such filth renders foods adulterate whether or not danger to health can be shown.

B Relationship of Insects and Rodents to the Spread of Disease

We are interested in the control of all insects and rodents that destroy or contaminate our food supply. The relatively few insects and rodents which spread disease through food are the ones we are primarily concerned with along with stored food insects which cause damaged and wasted food. These include the rat, the house fly, the cockroach and the small moths and beetles. Insects and rats carry disease bacteria internally and on their hairy bodies. A fly is known to carry as many as 6 million microorganisms on its body and many more internally which may be deposited on food and food surfaces by excreta. We know that in order to prevent outbreaks of foodborne illness we must break the chain of infection or contamination. The good practices of washing and sanitizing hands by employees, the proper cleaning and sanitizing of utensils and food contact surfaces, the proper storage of dishes and utensils and good refrigeration practices as well as time and temperature controls in food handling, can all be wasted if insects and rats are allowed to contaminate foods and food contact surfaces. It is expected that any food establishment may have an occasional insect or rat problem but it is their continual presence that causes the major problem and indicates a lack of good sanitation and control measures.

C Basic Elements of Insect and Rodent Control

No single measure will effectively control insects and rats in food establishments, however, when we summarize all elements of control two remain in the forefront. These two are not separate and distinct but are an integral part of each other. Since each of the two elements may vary in different insects and rats, specific measures for each will be explained in more detail when the specific types of insects and rodents are discussed. The two elements are:

1 Basic environmental sanitation

This includes proper refuse and garbage storage and removal, to prevent harborage for the breeding of insects or rodents in or about the premises. It also includes installation of screens or door flashings to prevent entry of insects and rats into the establishment.

2 Effective chemical control

This is the use of chemicals or pesticides to control insect and rodent pests that may gain entrance to the premises, whether within the building or on the property outside the building.

D Responsibilities of Management

- 1 To operate a clean, safe food operation that provides good wholesome disease free food, (includes insect and rodent control).
- 2 To follow rules and regulations relating to good food operations and make any corrections in equipment, operation or building as required.
- 3 To assure that each food service employee is adequately trained in good food handling practices.
- 4 To see that all incoming food and supplies are inspected for filth, sanitation and damage, (includes insects and rodents).

This will afford the opportunity for quickly controlling and/or eliminating any insects and rodents brought into the establishment. Insects are ingenious in the ways they invade food establishments. Young roaches can come in on food, furniture, or appliances. Some insects literally arrive with the building materials and are built into the structure. Cockroach egg cases are often found on the bottoms of boxes, crates, and other items only to hatch after arrival in the food establishment. Remember it is not so much a disgrace to have these pests as it is to keep them. It is always best to keep any pest problem at a minimum. In a large part this means simply picking up and removing unwanted items so that there are no unnecessary hiding places, draining standing water where possible, properly storing garbage and rubbish, keeping screens in good repair, and rat proofing buildings, in short, good housekeeping inside and out.

E. Responsibilities of Food Sanitarian

He should know enough about those insects and rodents common to food establishments so that he or she can:

- 1 Recognize an insect or rat problem if one exists.
- 2 Know what the problem is - i. e.: type of insect or rat and where problem is and extent.
- 3 Recognize and be aware of hazardous insecticides used and poor application practices.

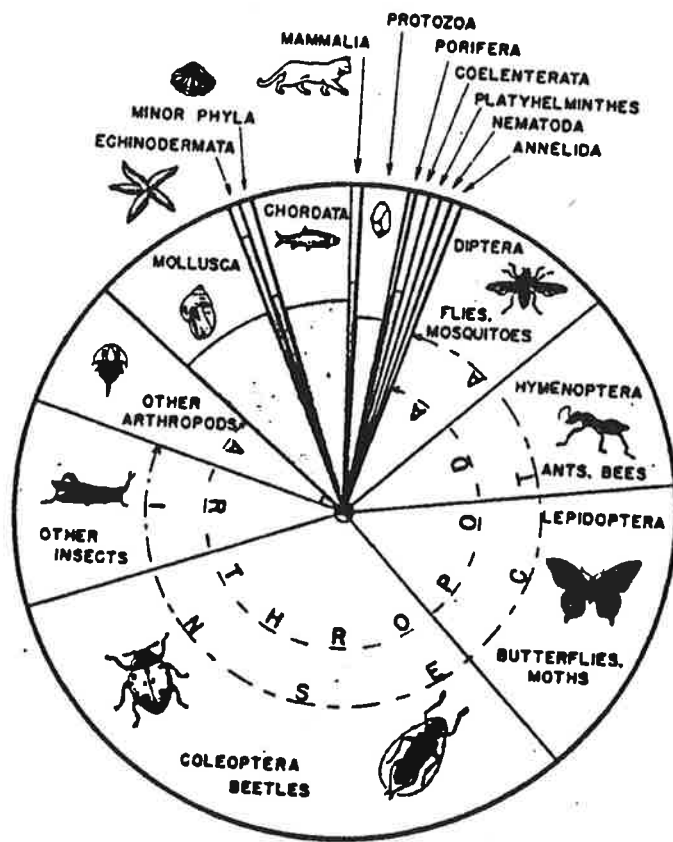
II INSECT CONTROL

A Problem With Insects in Food Establishments

This is the age of insects; what insects lack in size they more than make up for in numbers. Insects are probably the most successful of all land animals. Man has fought insects for centuries, chiefly to protect his food supply. This will likely continue for some time as man has never succeeded in eradicating a single species of insect. However, when the need is great enough man does have the ability and technical know-h

to control insects. Insects may transmit diseases, contaminate food, destroy property or merely be nuisances. Insects need water, food and breeding places in order to survive. The best method of control centers on good sanitation or housekeeping with judicious use of insecticides.

RELATIVE NUMBER OF INSECTS IN THE WORLD FAUNA



B Flies

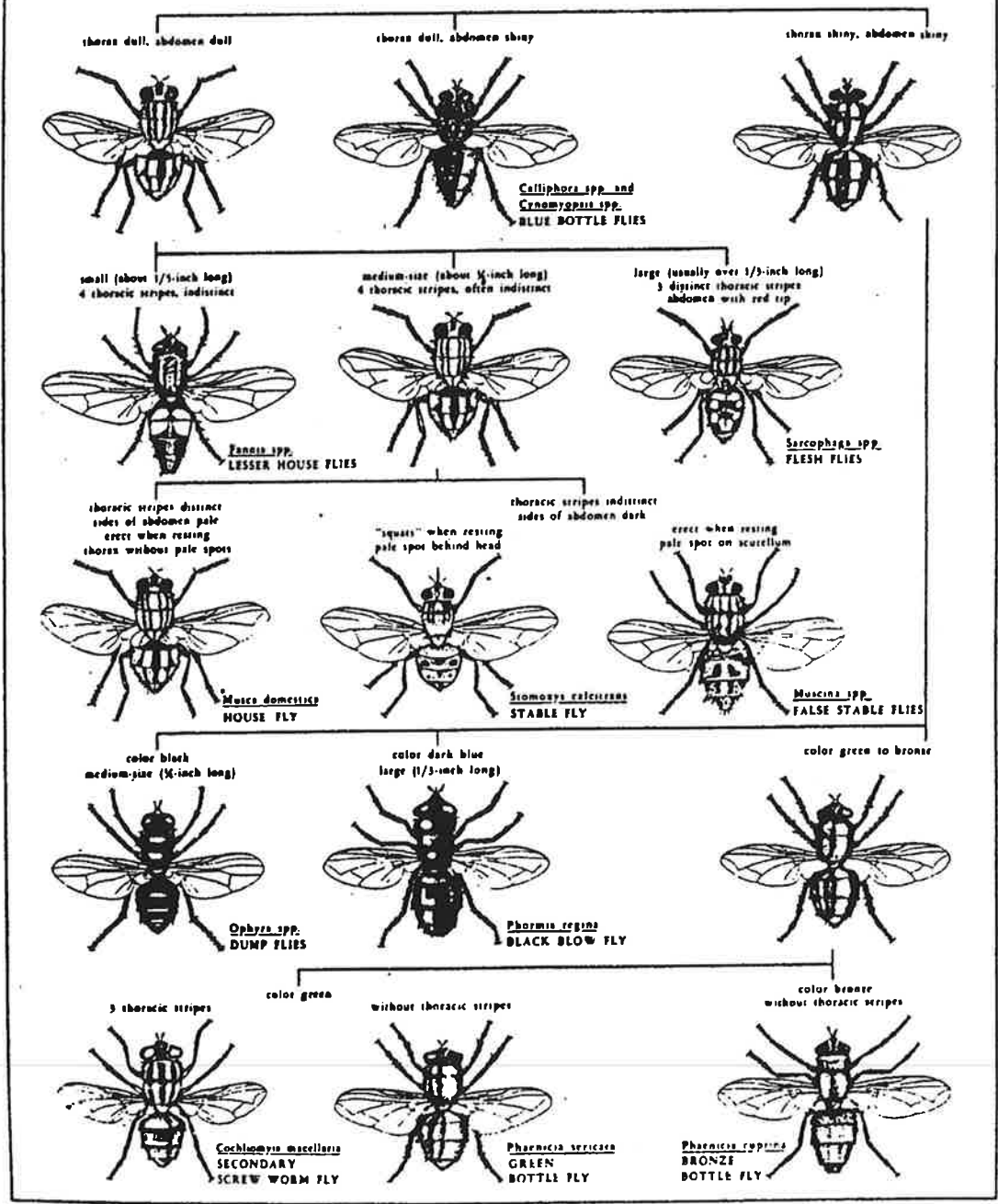
1 Types

There are many kinds of flies, and it is possible to spend a lifetime learning about them. Fortunately there are only a few, commonly found around food establishments, these are the ones we are really interested in; certain blow-flies and most of all the house fly (*Musca Domestica*).

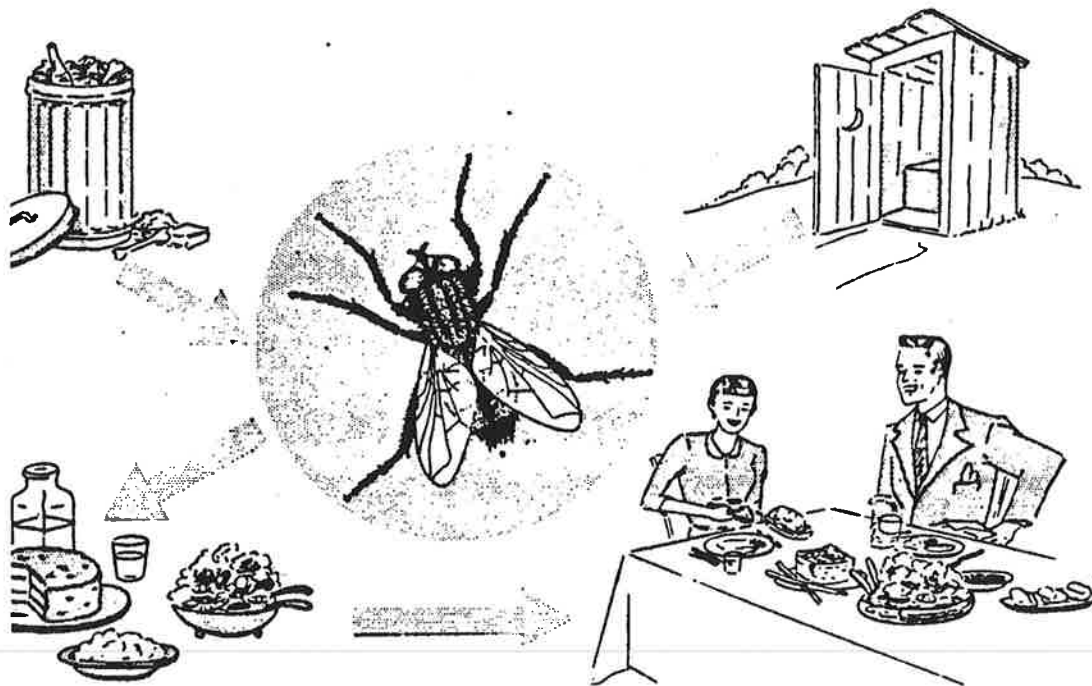
PICTORIAL KEY TO COMMON DOMESTIC FLIES

(for use with CDC fly grill record)

Harold George Scott, Ph.D



The house fly is the one most likely to spread human disease as it breeds in human or animal waste as well as garbage and then enters food establishments where it may contaminate food. When a fly walks over filth, some of the filth material sticks to his hairy body. If disease bacteria are in the material they too stick to his body and leg hairs. When he feeds on the waste material he takes some of the bacteria into his intestines. The rest of the story you are familiar with. The fly goes into the dining area or kitchen where he walks on the food, utensils and food surface areas. More sickening is the fact that the house fly has to vomit on solid food to soften it before he can eat it. This is because the house fly cannot chew, but has sponging, sucking mouthparts. In vomiting, some bacteria are spread on food and can cause intestinal infections (worms, amoebic organisms, etc.) Bacteria are also present in the fly excreta, called fly specks.

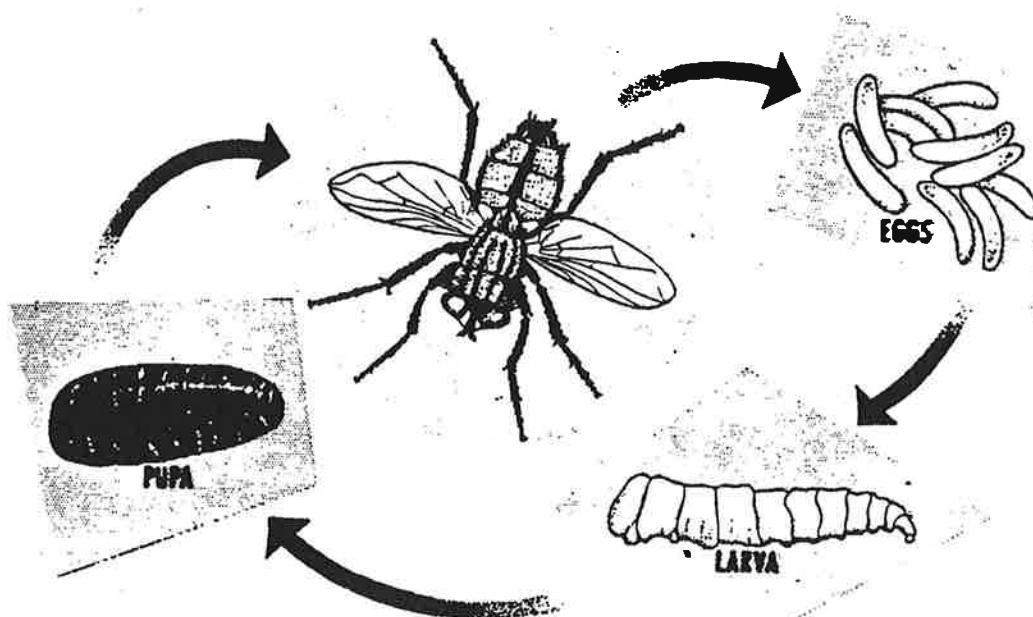


Mechanical Transmission of Disease by Flies

Blow-flies are usually larger than the house fly and are often a shiny blue, green, or bronze color. Because of their keen sense of smell they are particularly attracted to garbage dumps, stockyards and meat processing plants but also are attracted to restaurants and food processing plants. Of the other flies, the one that is the most nuisance is the stable fly (biting house fly). It looks like a house fly but has a sharp beak (Proboscis) and bites or stings, usually around the ankles. A single fly may carry up to approximately 6 million bacteria on its outside body and 25 million in its intestine.

2 Life cycle

The house fly is typical of flies as a whole, and will be discussed as an example. The female fly lays up to 150 eggs at a time on garbage, human or animal waste, or other moist food. The small white, oval eggs (about 1/25 inch long) are deposited in batches of 75 to 150, with the average female laying 5 or 6 batches during her lifetime. Hatching of larvae (maggot) occurs 12-24 hours after laying, during the summer months. The active young larva burrows into the breeding material using its two mouth hooks for tearing and loosening food material. When the larva (maggot) is fully grown (4-7 days in warm weather) it crawls into the soft ground nearby where it forms a brown shell (puparium) which encloses the true pupa. The pupa is immobile and takes no food. The pupal stage normally takes about 4-5 days. At warm temperatures pupation may take as short a time as 3 days or several weeks at low temperatures. When the pupal period is complete the fly breaks open the end of the puparium and surfaces to the ground where it crawls about rapidly while its wings unfold and its body expands, dries and hardens. This takes about one hour in warm temperatures. Complete activity is reached in about 15 hours at which time mating can take place. The female begins egg laying within 4-20 days after hatching. The adult is a very active, two winged, six legged insect. During daylight hours it moves from one attractant to another, it is strongly attracted to excrement, decaying organic matter as well as milk and food products. When

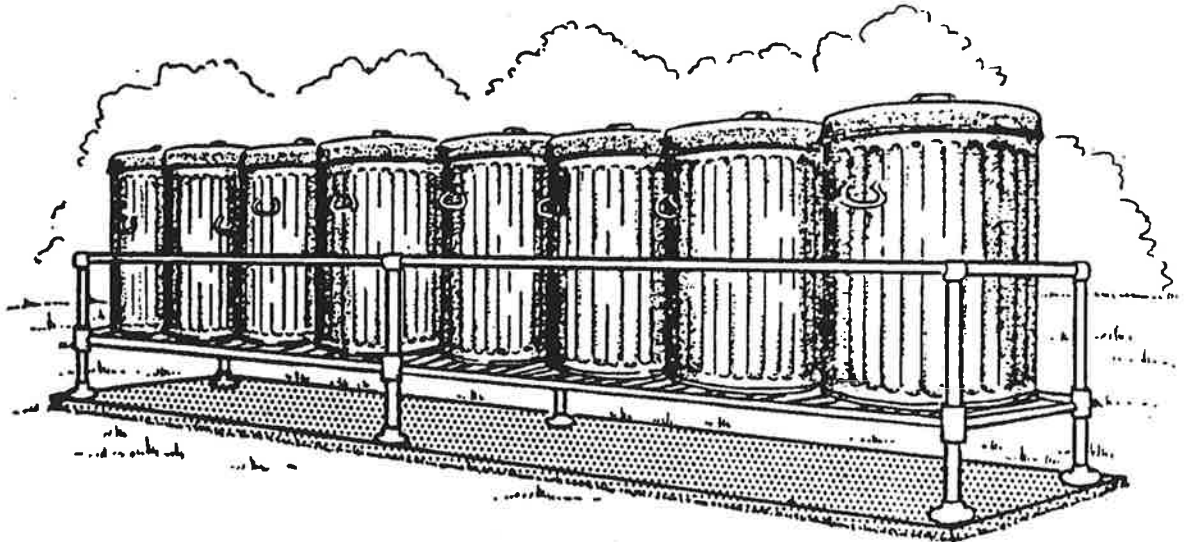


Life History of the House Fly

3 Control

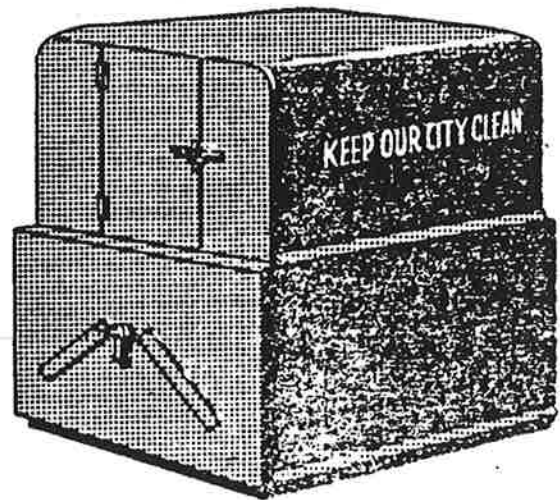
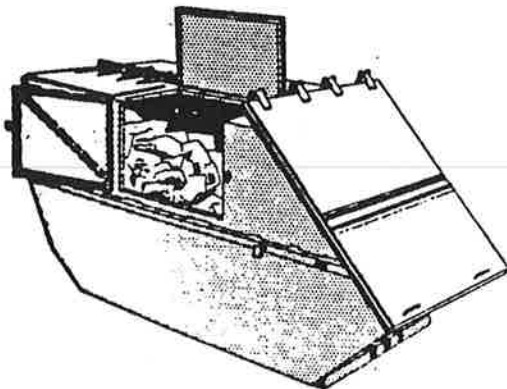
Controlling house flies is most easily carried out by removing moist food in which larva develop. In many cases the principle source of flies is improperly stored garbage.

- a The use of standard garbage cans with handles and tight fitting lids will accomplish a tremendous amount of fly control with relatively little effort. If bulk containers are used they should be properly designed to be fly tight and easily cleaned. In either case, the containers should be checked several times a day to make sure lids are on tight (doors shut tight in case of bulk containers). Sufficient containers should be provided to hold all refuse. The containers will need to be scrubbed and preferably disinfected periodically.



The bulk containers can best be cleaned using steam. The storage area for garbage and refuse should be kept clean, and free from spillage. Refuse and garbage should be properly stored and picked up at least twice a week in order to break up the life cycle.

Containers may be emptied directly into a large compactor-type truck capable of receiving the contents of a number of bulk storage units.



- b Animal droppings, spilled feed and other such sources of breeding material should be picked up promptly.



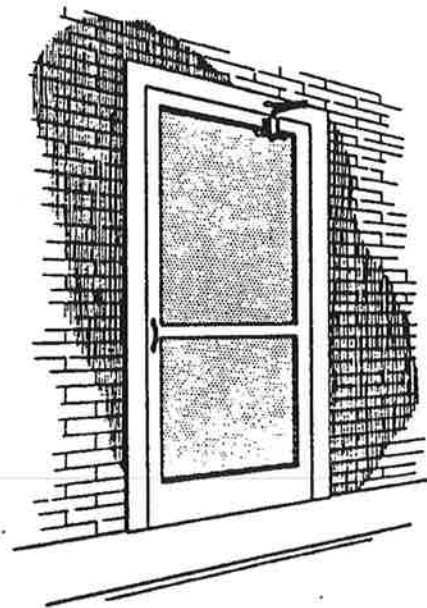
- c Screening of doors and windows (in good repair) is necessary to keep flies out of the food establishment. It is easier to keep flies from developing than it is to deal with them after they are grown and traveling.
- d All doors should be self closing and in cases where fly fans are used, screen doors should also be provided as the fans may not be running at all times.



INSTALL 16-MESH FLY SCREEN OVER ENTIRE DOOR AND 2X2 MESH GALVANIZED HARDWARE CLOTH OVER LOWER HALF.

INSTALL $\frac{1}{2}'' \times 1''$ FLAT MOLDING STRIPS OVER WIRE WITH 3-PENNY FINISHING NAILS. MOLDING STRIPS SHOULD BE CUT TO LENGTH AND PAINTED IN ADVANCE.

NOTE:
INSTALL WITH EITHER COIL SPRING OR AUTOMATIC DOOR CLOSER AT TOP OF DOOR.

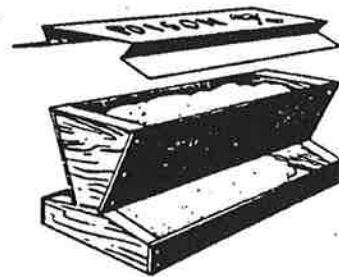


A FLY-PROOF SCREEN DOOR
which is also rat-proof

- e Chemicals such as commercially prepared fly sprays, cords, and baits should be used in strict accordance with instructions. Vapona strips (gardona) are not to be used in food establishments where there is any possibility of overhead dripping onto food. They may be used in the garbage area. Continuous insecticide vaporizers cannot be used where food is stored, prepared or served. In cases where a fly problem is of such magnitude that it cannot be controlled with sanitation → then it is usually advisable to employ a licensed pest control operator. The most effective insecticides for fly control are the organo phosphorous group which includes diazinon, dipterex, malathion and dichlorovoro. These can be used with care, as wet or dry baits out of doors. Remember, insecticides are a supplement to, never a substitute, for clean food establishments.



SPRAYING



POISONING

- f Scrupulous cleaning of floors, tables etc. should be a routine practice. Toilet facilities should be kept clean with self closers on the doors. All food should be protected from flies.
- g Other methods of fly control that are not recommended routinely are electrocution screens, and fly traps.

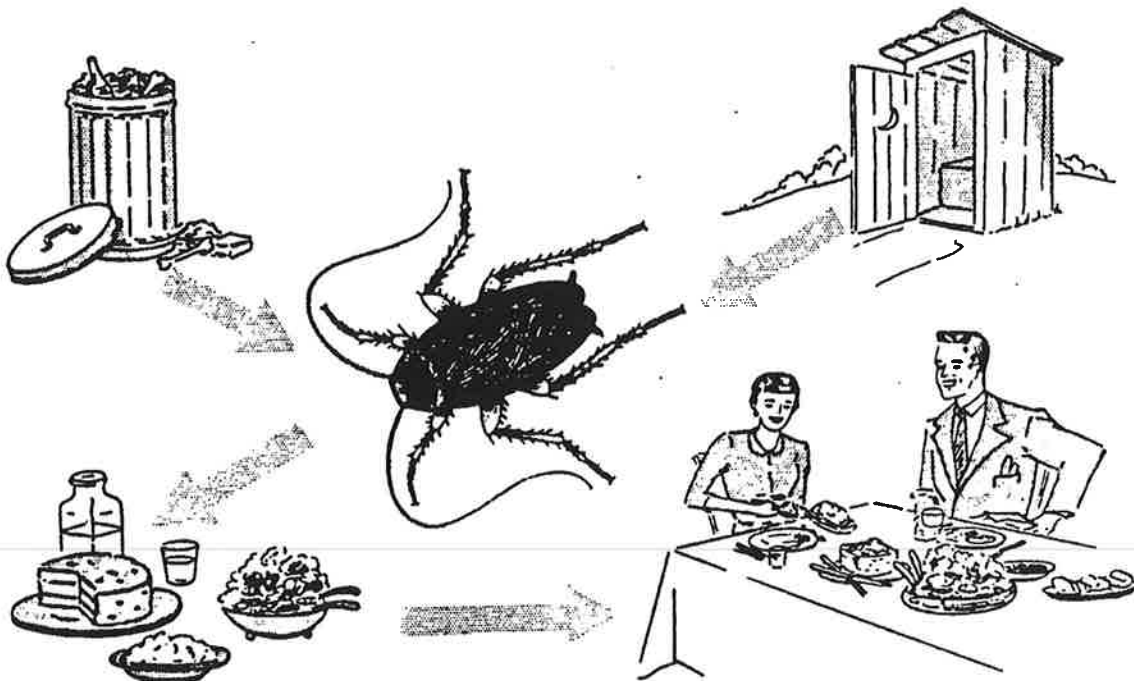
C Cockroaches

The elusive cockroach is sometimes called croton bug or water bug, depending on who has them. If you have cockroaches in your home or restaurant they are water bugs. If

your neighbor or the food establishment down the street has them, they are cockroaches.

1 Types

There are four common types of roaches. The American, Oriental, German and Brown Banded. There are others common to certain areas such as the Australian Roach found in Southern Florida and California and The Brown Roach found in Southern U.S. Cockroaches have been in existence for 300 million years. Similar to flies, the cockroaches are capable of carrying disease organisms on their body. They crawl from toilets and sewers into kitchens, running over utensils, food preparation areas and unprotected food. They carry bacteria on their hairy legs and body as well as in their intestinal tract. Roaches harbor in cracks and crevices and are nocturnal (avoid light). It is possible to have a number of roaches around without realizing they are there until they are caught by surprise some night when a light is turned on suddenly.

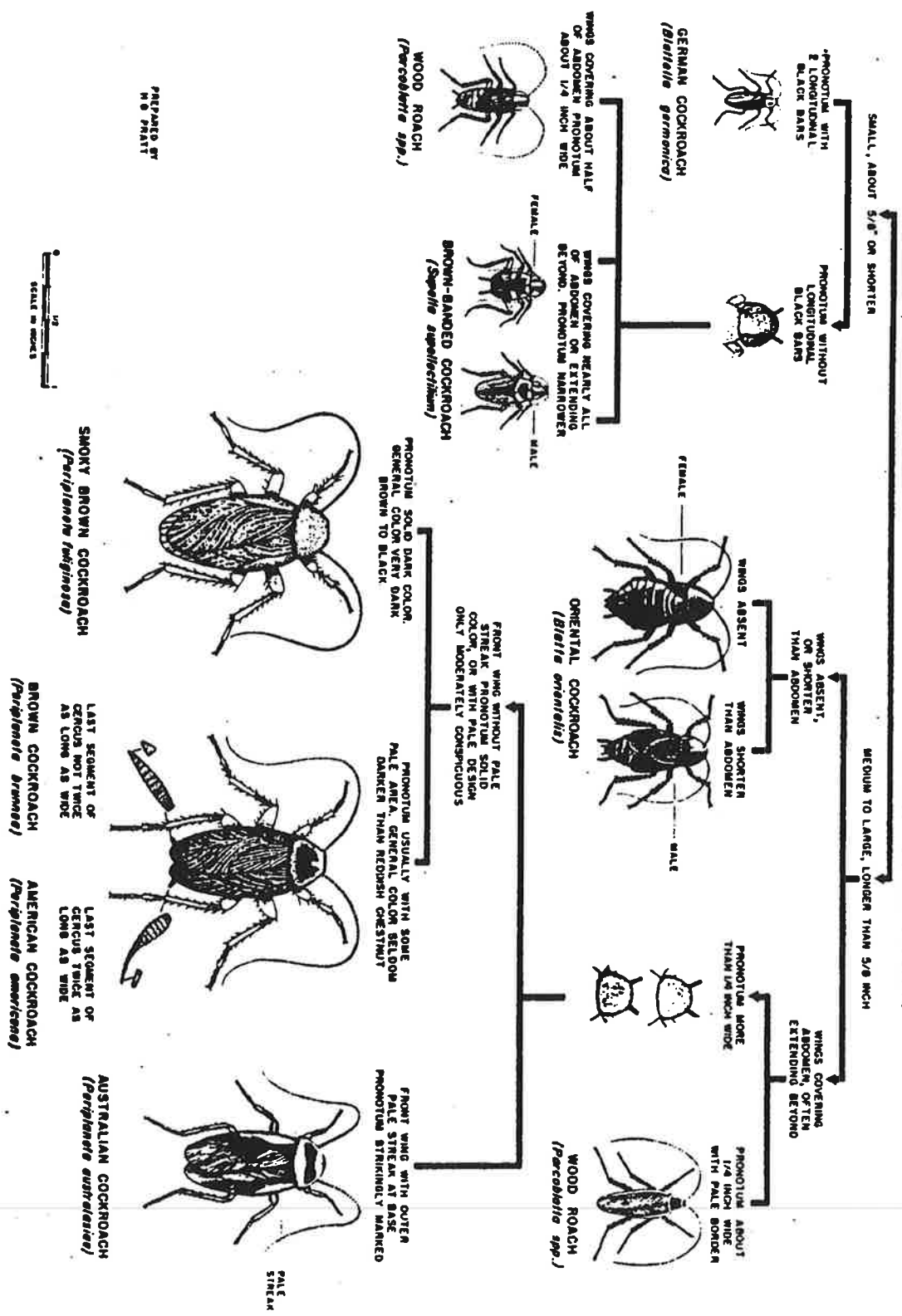


- a American Roach (*Periplaneta Americana*) is the largest roach, found in boiler rooms, basements and sewerage systems. It is capable of flights of a gliding nature. Adult is 1 1/2 - 2 inches in length.
- b Oriental Roach (*Blatta Orientalis*) is found in garbage and refuse, sewer lines, under refrigerators, etc. It does not fly and is less domestic than most others. It grows to about one inch in length.
- c German Roach (*Blatella Germanica*) is found in kitchen food storage areas, and toilets and is the most common roach found in restaurants. It does not fly. It grows to about 3/4 of an inch in length. Is the only domestic roach where egg cases are carried by female until ready to hatch.
- d Brown Banded (*Supella Supellectum*) is found throughout the restaurant and not in any one particular place. The adults will fly readily. Favorite place for depositing egg cases is in furniture. Grows to about 3/4 inch in length.

2 Life Cycle

Cockroaches do not develop as flies do. The fly, as you recall, has four stages - egg, larva, pupae and adult. The roach has only three stages - egg, nymph, and adult. The eggs are laid in a case or capsule called ootheca. When the eggs hatch, tiny nymphs (resemble adult but have no wings and are much smaller) emerge and go through a succession of molts before becoming a mature adult. The egg cases are deposited almost anywhere, and are very often glued to some object like a shelf or curtain. The newly molted (nymph) roaches are white or cream colored before tissues harden, which accounts for reports of albino roaches. Life cycle takes from 3 months to a year. Roaches love to live where there is plenty of food to eat. They are capable of getting into food establishments by crawling in through cracks and along pipes as well as coming in on food and supplies.

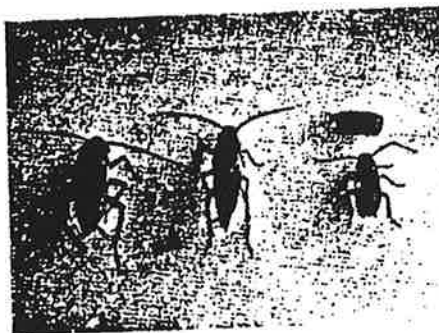
PICTORIAL KEY TO SOME COMMON ADULT COCKROACHES



PREPARED BY
M. B. FRANK



LIFE CYCLE



German cockroach

3 Control

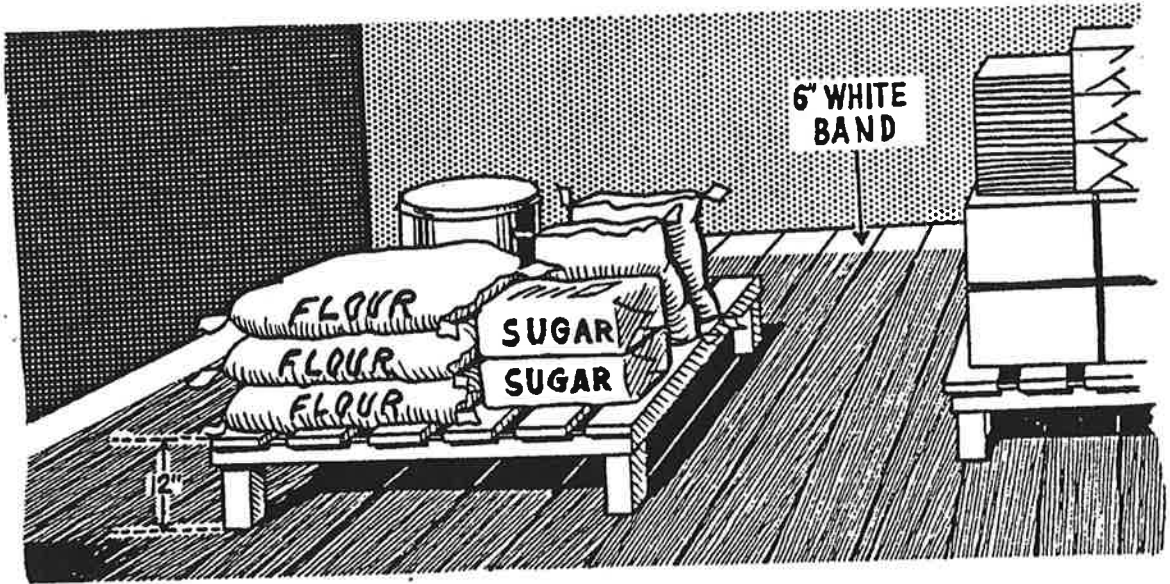
- a Cockroach control is best accomplished by maintaining good housekeeping indoors and out. Pick up boards, rags, old cartons, and any unwanted material that might provide a hiding place. Caulk up cracks and crevices, and repair leaks, as moisture attracts roaches.
- b Keep foodstuffs in tightly lidded containers on clean shelves. Shelf paper is just another hiding place, and should not be used. By keeping floors, tables, walls and equipment (storage shelves, hoods, filters, grinders, etc.) clean, there will be little food available for roaches.



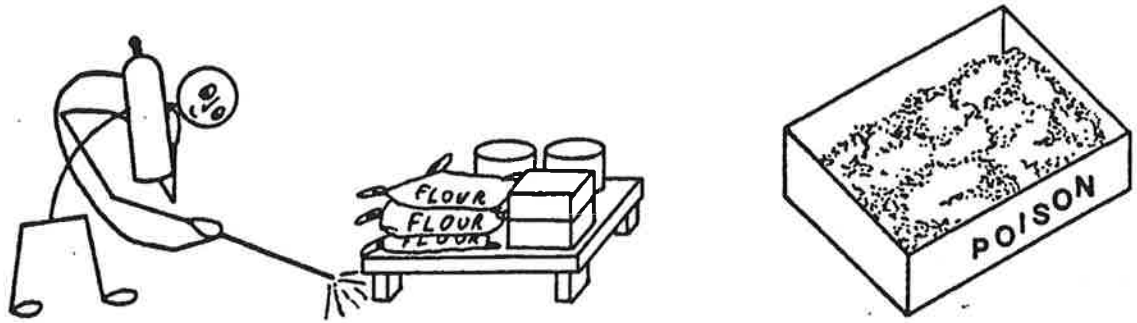
PACKAGING

- c Check incoming material for egg cases and adults.

- e Keep supplies stored off the floor and in an orderly fashion to make cleaning easier. Frequent cleaning will help remove egg cases and hence reduce the roach population.



- f Chemical control is only recommended in conjunction with the other control procedures and not as the primary method. In very heavy infestations, it may be cheaper to employ a licensed pest control operator. The method of application of insecticide for roach control is very important. A residual of insecticide should be placed in cracks and crevices by a needle nose spray rather than cone spray. Remember to treat baseboards, windows, door trim, and under and around appliances. Insecticidal dusts should be used around electrical outlets and circuit breakers. Commercially available baits can be used in "blind" areas (false ceilings, etc.) Re-treatment in a week or two is necessary to be sure to get any young roaches that may have emerged. Insecticides should always be used carefully around food storage and preparation areas. Dishes, utensils and food should be removed and covered.



D Stored Food Insects

There are many other insects that bother us by invading foods. Most of these are small moths or beetles which create problem of wasted food and nuisance rather than disease.

1 Types of Beetles and Moths

A Beetles and Moths Infesting Whole Grain

- 1) **THE RICE WEEVIL** (*Sitophilus oryza*) world-wide in distribution, is probably the most important grain pest. This small, reddish-brown to black snout beetle, 1/8 to 1/6 inch long, has small, round pits on the thorax and two reddish or yellowish spots on each wing cover. The larva is short, fat, and whitish. The adult is a strong flier. The larva and pupa develop within a single grain of rice or kernel of corn, from which the adult weevil emerges about 30 days after the egg is laid. The adult female lives 4 to 5 months, depositing 300 to 400 eggs in small opening bored into grain. The rice weevil feeds upon corn, rice, wheat, barley, and other grains.
- 2) **THE GRANARY WEEVIL** (*Sitophilus granarius*) is similar to the rice weevil in appearance, but with oval pits on the thorax, and with the wing covers uniformly

dark brown. This insect has become thoroughly domesticated, losing its power of flight and forsaking wild and cultivated grain fields for the grain storehouses of man. This snout beetle is slightly larger than the rice weevil and lives from 7 to 8 months. Whereas the rice weevil is a major pest in the South, the granary weevil more often frequents the Northern States.

- 3) **THE CADELLE** (*Tenebroides mauritanicus*) is a black beetle $\frac{1}{3}$ to $\frac{1}{2}$ inch long, with the head and pronotum distinctly separated from the forewings by a loose joint. The large, whitish, fleshy larvae are about $\frac{3}{4}$ inch long when fully grown and may be recognized by their prominent black heads, the paired black spots on the three segments of the thorax, and two short dark hooks, at the posterior end of the abdomen. Larvae burrow into the woodwork of grain bins, and a seemingly clean bin may harbor thousands of larvae, pupae, and adults. The life cycle requires from 2 to 14 months, many adults living more than a year. The females lay about 1,000 eggs in protected situations, such as in cracks near food. The cadelle feeds upon grain and grain products and does much damage to bolting silk in flour mills. It is especially injurious in poorly sanitized mills.
- 4) **THE LESSER GRAIN BORER** (*Rhyzopertha dominica*) a brown or black, slender, cylindrical beetle with numerous coarse elevations on the pronotum, is about $\frac{1}{8}$ inch long and is most common in the Gulf States but may occur anywhere in the country. Both larvae and adults attack and destroy wheat kernels. The females lay up to 500 eggs each, dropping them in the loose grain. In warm weather the life cycle is completed in about 1 month.
- 5) **THE ANGOUMOIS GRAIN MOTH** (*Sitotroga cerealella*) is a light grayish-brown or straw-colored moth with a satiny luster and wing expanse of $\frac{1}{2}$ inch to $\frac{2}{3}$ inch. The hind wings are fringed with long, dark setae, and

have a point at the tip like a finger, which distinguishes the insect from the clothes moth. The larva is white with a brown head. It is only 1/5 inch long and lives within the individual grain of wheat, corn, or other grain. The winter is passed in the larval stage in stored grain. The adult emerges and infests cereal crops either in the field or in storage, depositing about 40 eggs. The entire life cycle may be complete in 5 weeks. The Angoumois grain moth is second in importance to the rice and granary weevils as a pest of stored grain. It is of greatest importance in the South and in the soft red-winter-wheat region of the Eastern and Central States.

B Beetles and Moths Infesting Broken Grain

- 1) **THE CONFUSED FLOUR BEETLE** (*Tribolium confusum*) and the **RED FLOUR BEETLE** (*Tribolium castaneum*) are similar in appearance and habits. Adult confused flour beetles have the antennae gradually enlarged toward the tip, whereas the antennae of the red flour beetle have the last three segments abruptly enlarged. *T. confusum* cannot fly, whereas, *T. castaneum* may fly. The elongate, reddish-brown beetles are about 1/7 inch long, with a distinct joint between the thorax and abdomen. The adult female may live for as long as 2 years, depositing 300 to 400 eggs. The mature larva is brownish-white with six legs, and is up to 1/2 inch long. The life cycle requires 2 to 4 months when temperatures are favorable. These beetles are very important pests of flour, infesting many flour mills, warehouses, and grocery stores. They also feed upon grain, beans, dried fruits, nuts, chocolate, and other foods.
- 2) **THE FLAT GRAIN BEETLE** (*Cryptolestes pusillus*) is one of the smallest beetles found in stored grain. It is a tiny, reddish-brown beetle about 1/16 inch long with antennae nearly as long as the insect. It is usually found with other grain pests.

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- 3) THE INDIAN MEAL MOTH (*Plodia interpunctella*) has a wing expanse of 1/2 to 3/4 inch, with the basal one-third of each forewing dull white to cream and the outer two-thirds, brown to copper. The females lay about 200 eggs, and the tiny whitish, brown-headed larvae emerge in 2-14 days. The life cycle is 50-305 days. Full-grown larvae (1/3 to 1/2 inch long) produce silk which webs together flour, graham crackers, nuts, dried fruit, powdered milk and other foods.

C Beetles Infesting Dried Peas and Beans

- 1) THE BEAN WEEVIL (*Acanthoscelides obtectus*) is a short snout beetle that feeds upon stored beans and peas. The adult is 1/8 inch long with reddish legs and a light olive-brown color, mottled with darker brown and gray. The body narrows evenly toward the head. The tiny, legless larva and pupa live within the bean, whereas the adult emerges from the bean and feeds upon other materials. The female deposits eggs in beans, both in the field and in storage, and six or seven generations may be completed in a year. As many as 28 weevils have been known to develop in 1 bean. The use of tight sacks has been found to afford considerable protection. Bean vines and other refuse should be burned in the field or plowed under to prevent propagation of this insect. The adults hibernate in fields and warehouses.
- 2) THE PEA WEEVIL (*Bruchus pisorum*) appears similar to the bean weevil, but is larger (1/5 inch long), brownish flecked with white, and with black to gray patches of scales. There is one generation per year, the adults overwintering in peas in the field or in storage. Egg deposition occurs only in the field. House mice eat pea weevils by cracking open the infested pea, eating the weevil, and discarding the pea.

D Beetles and Flies Infesting Meats and Cheese

- 1) THE LARDER BEETLE (*Dermestes lardarius*) is

about 1/3 inch long, dark brown, with a wide yellow band across the front part of the wing cover. The larva is brown, very hairy, tapering towards the ends of the body. This insect is world-wide in distribution. The eggs are laid on or near animal products such as feathers, horns, skins, hair, ham, bacon, dried beef, and like products. The life cycle requires 40 to 50 days. This insect may be found in dog biscuits, cheese museum specimens, dried fish, and stored tobacco. It is also known to penetrate lead. Control consists chiefly of protection from attack, such as wrapping hams in paper and cloth immediately after smoking, and the use of cold storage lockers. Skins and hides are protected by dusting or spraying with 1 percent Lindane.

- 2) **THE RED-LEGGED HAM BEETLE** (*Necrobia rufipes*) a shiny blue to green beetle 1/7 to 1/4 inch long with reddish legs, is especially troublesome in the Middle Atlantic States. The adults usually disperse by rapid running, but are able to fly. The mature larva is about 2/5 inch long, purplish, with six short legs, and tapered toward the head. The life cycle usually occupies 36 to 150 days. The female lays 400 to 1,000 eggs on exposed meat, indicating the need for prompt wrapping of hams immediately after smoking. The larva is able to perforate grease-soaked paper wrappings. This pest lives primarily on dead and decaying animal matter, but is sometimes reported in groceries and warehouses on smoked ham, bacon, garlic, bone meal, and other materials.
- 3) **THE CHEESE MAGGOT or CHEESE SKIPPER** (*Piophilidae casei*) is a fly about the size of the house fly. The adult is black with bronze tints on the thorax, reddish-brown eyes, and iridescent wings which lie flat over the body. The larva is a slender maggot, pointed toward the head end. The larva is able to skip as much as 10 inches horizontally and 6 inches vertically, by curving its body into a ring, fastening its mouth hooks onto the end of the abdomen, suddenly releasing its hold, and throwing itself into the air.

The life cycle of the insect is completed in 12 days under favorable conditions. The adult deposits 140 to 500 eggs over a period of 3 to 4 days. This insect infests ham and cheeses. The adults can transmit enteric diseases to man by contamination, and the maggots cause intestinal irritation when ingested with cheese. Infestations of the cheese maggot should be prevented by screening (30-mesh) storage rooms and wrapping meat in paper and enclosing it in a tight cloth sack. Cheese may be protected with cheesecloth and paraffin. The recognized common name "cheese skipper" is very unfortunate for this pest, because "skippers" are moth-like Lepidoptera.

X X E Beetles that are Feeders on Stored Food

- 1) THE SAW-TOOTHED GRAIN BEETLE (*Oryzaephilus surinamensis*) is an important pest known throughout most of the world. A closely related species, *Oryzaephilus mercator*, is also important and is often mistaken for the saw-toothed grain beetle. The adult is a small active, brown beetle 1/10 inch long, with a flattened body and six saw-toothed projections on each side of the thorax. The larva is yellowish-white, less than 1/8 inch long, with a brown head, and abdomen tapering toward the tip. The female lives for 6 to 10 months, depositing 45 to 285 eggs in foodstuffs. Several generations may occur each year, as the life cycle requires only 3 to 4 weeks during the summer. The saw-toothed grain beetle is an important pest in grocery stores, food warehouses, and grain storage. It readily penetrates packaged cereals, dried fruits, and candies. It also attacks flour, meal, sugar, drugs, dried meat, and tobacco.
- 2) THE CIGARETTE BEETLE (*Lasioderma serricorne*) is primarily a pest of tobacco, but will feed upon many other products as was evidenced by its presence in the tomb of Tutankamen in Egypt. This small, oval, light brown beetle is 1/10 inch long with smooth wing covers. The head is retracted beneath the thorax. The adult beetle flies readily. The larva is yellowish-white,

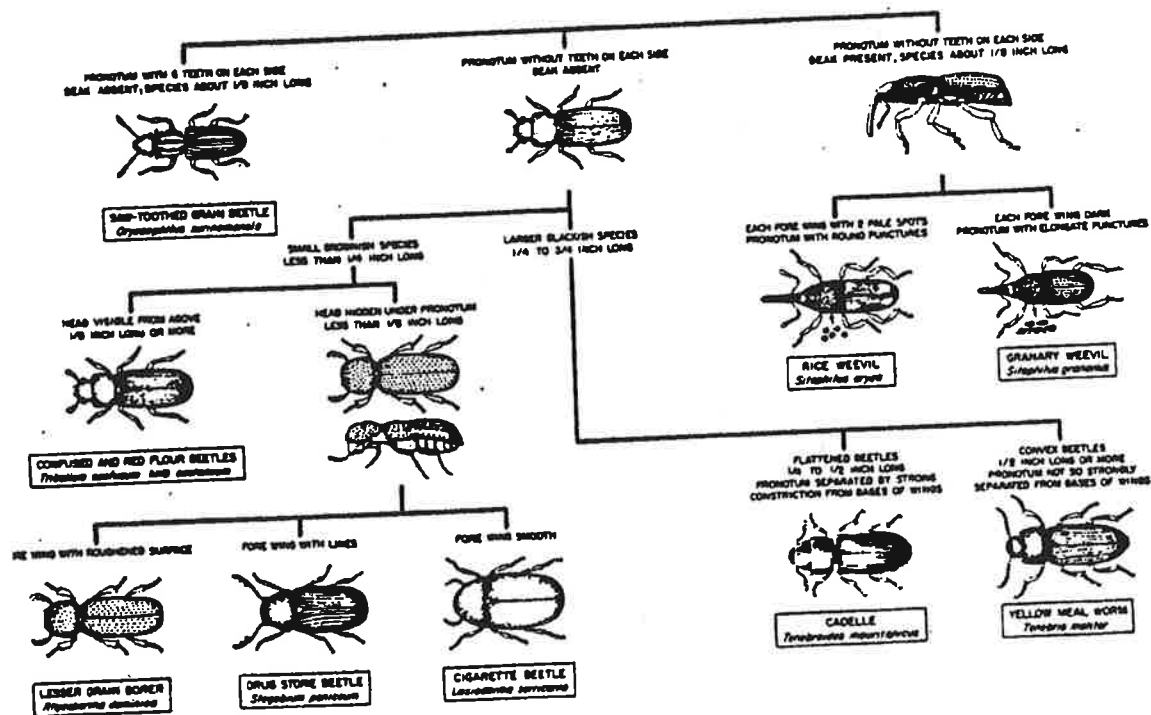
curved, very hairy, with a light brown head, and about 1/6 inch in length. The life cycle requires 6 to 12 weeks, and there may be five to six overlapping generations per year in warm localities, but only one generation in cooler areas. The female deposits as many as 100 eggs in tobacco, grain, mil cereals, and other products. This insect infests upholstered furniture, feeds, dried plants, drugs, black and red pepper, pyrethrum powder, raisins, rice, and many other commodities.

2 Control of Beetles and Moths in Stored Foods

- a Good sanitation which includes frequent cleaning of shelves and floors. These pests can thrive on flour, meal and cereal products that are spilled and left on the floor.
- b Clean cool dry food storage, (cool temperatures inhibits growth and reduces egg laying).
- c Examine all incoming stock for signs of infestation.
- d Isolate from rest of stock any infested products until ready to dispose of.
- e Rotate stock using a code or numbering system.
- f All open packages or sacks should be either used immediately or stored in covered containers.
- g Foods should be stored a minimum of 6 to 8 inches off the floor. This increases speed and ease in which products can be handled with mechanical fork-lift trucks as well as allowing an open space for good ventilation, and when kept clean, discourages insect infestation. It also affords an area for inspection to pick up early infestations. It is recommended that aisles a minimum of 2 feet wide be provided along walls, through the center and elsewhere depending on the size of storage area.

- h Use of insecticides may be necessary to prevent reinfestations. Remember, insecticides are poisonous and if they get on food products the product is adulterated and may be harmful. In food areas (where food is served, stored, or prepared) only crack and crevice treatment is approved. This means using a needle spray applied directly into the crack or crevice. All food should be covered, removed or refrigerated. Space treatment is not approved. Spot treatment (treating an area 2 square feet) is approved for treating walls, floors, and storage areas. EPA restricts the type of insecticides that can be used in these cases.

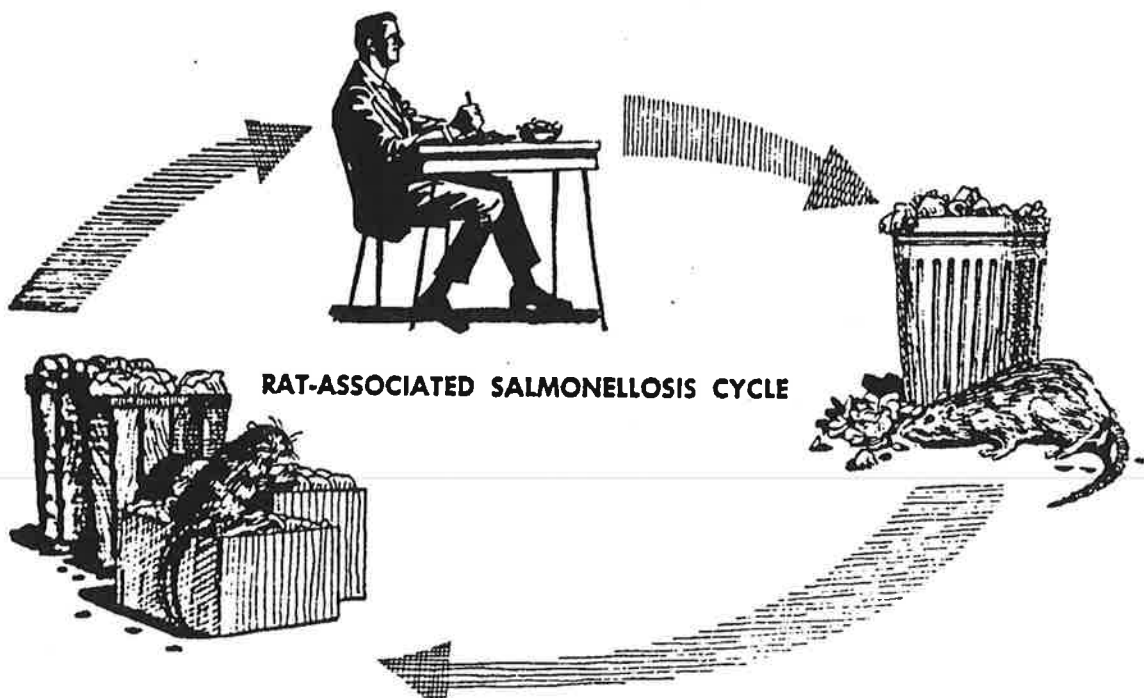
PICTORIAL KEY TO SOME COMMON BEETLES AND WEEVILS ASSOCIATED WITH STORED FOODS



III RODENT CONTROL

A Rodent Problem

Man's continual battle to eliminate or reduce rodent population has been going on for centuries, ever since the cave dwelling paleolithic man stored the products of his hunt. Historically rodents have been responsible for more human illness and deaths than any other group of mammals. It is estimated that each rat damages \$5.00 worth of food and other materials per year by gnawing and feeding, and contaminates 5 to 10 times more, (by discharged body wastes and body contact). Rats may carry a number of diseases such as salmonellosis, leptospirosis, plague and murine typhus. In addition rat bites create a serious health problem. The national average is about 10 bites per 100 thousand population. In large metropolitan areas, children and a few derelicts are the most common victims. Rodent populations are like a cork floating in water. Pressure keeps the cork down, release the pressure and the cork surfaces. Man must keep the pressure on in order to control rodent populations.



B Rodents

1 Types

The term domestic rodent includes Norway rats, Roof rats, and House mice. These rodents are best characterized by having a single pair of incisor teeth on each jaw and by the absence of canine teeth. These incisors grow about 6" in length a year, which accounts for the rat's tendency to gnaw and chew to wear the teeth down. They can chew through plastic, wood, lead pipe and aluminum.

- a **NORWAY RAT**-is the most important rat and predominant rat in the U.S., except for some coastal areas. The Norway rat being the larger and more aggressive will many times fight off and even kill the Roof rat. Common names for the Norway rat are Sewer rat, Wharf rat, Brown rat, House rat and Barn rat. The Norway rat is predominantly a burrowing rat, and therefore it harbors in burrows in ground, around dumps, sewers, and buildings close to food and water. It will eat almost any food, but prefers garbage, meat, fish and cereal. The range of travel is usually no more than 100-150 feet.
- b **ROOF RAT**-is the smaller rat but a very agile climber. In the U.S. it is found primarily in the south and pacific coast and in Hawaii. It generally harbors in the upper floors of buildings but occasionally is found in sewers. It prefers vegetables, fruits, cereal and grain for food supply. Its range of travel also is about 100-150 feet.
- c **HOUSE MOUSE**-is the smallest of the domestic rodents. It has the widest distribution of the three rodents throughout the U.S. It is found primarily in and around buildings, nesting in walls, cabinets, furniture, and stored goods. It prefers food similar to the Roof rat such as cereal, grain, etc. The House mouse is a nibbler taking a bite here and a bite there. Range of travel 10-30 feet.

DESCRIPTION OF RODENTS

	NORWAY RAT	ROOF RAT	HOUSE MOUSE
FUR	REDDISH BROWN	TAWNY BLACK	DUSKY GRAY
WEIGHT	16 OZS.	8-12 OZS.	1/2-3/4 OZS
BODY	HEAVY SET	SLENDER	SMALL SLENDER
TAIL	BI-COLORED SHORTER THAN HEAD & BODY	ONE-COLORED LONGER THAN HEAD & BODY	SEMI-NAKED EQUAL TO HEAD & BODY
MUZZEL	BLUNT	POINTED	SMALL POINTED
EARS	MODERATE CLOSE SET	LARGE PROMINENT	SMALL PROMINENT

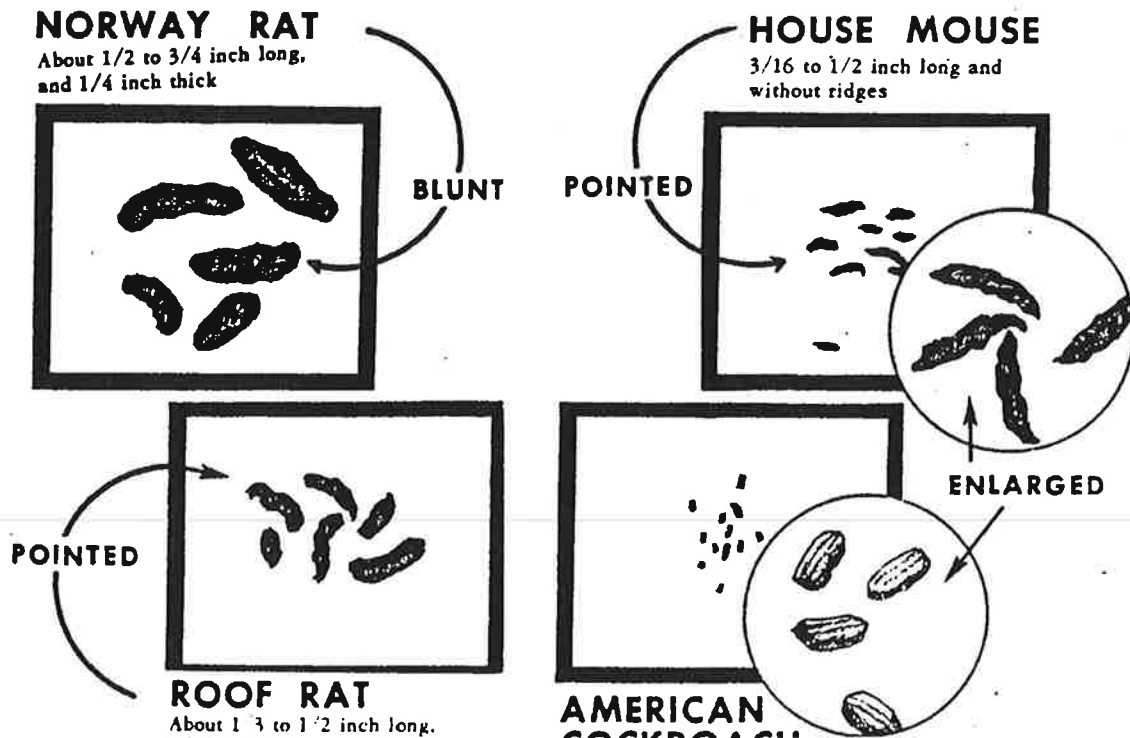
BIOLOGY OF RODENTS

	NORWAY	ROOF	HOUSE MOUSE
SEXUAL MATURITY	3-5 MOS.	3-5 MOS.	1 1/2 MOS.
GESTATION PERIOD	22 DAYS	22 DAYS	19 DAYS
NO. YOUNG/LITTER	8-12	6-8	5-6
NO. LITTERS/YEAR	4-7	4-6	UP TO 8
NO. WEANED/YEAR	20	20	30-35
LIFE LENGTH	1 YEAR	1 YEAR	1 YEAR

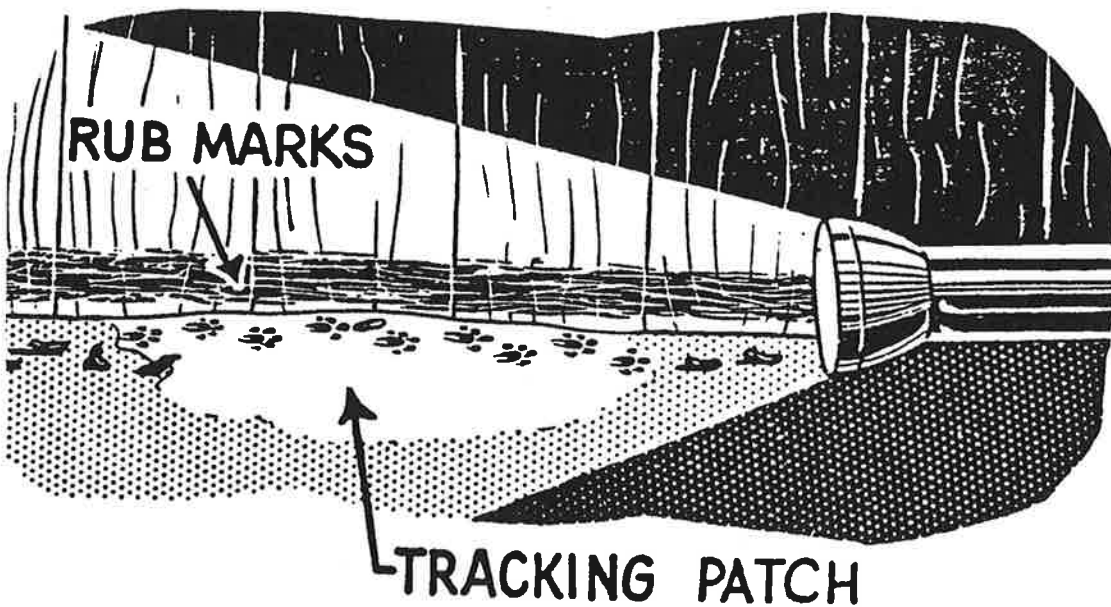
C Recognition of Rodent Signs

It is unusual to see rats or mice during the daytime as they are nocturnal by habit. It is therefore necessary to interpret signs of their activities. From rodent signs one can determine the species or type rodent, whether it is old or new and whether there is a light or heavy infestation.

- 1 Droppings - the presence of rat or mouse feces is one of the best indications of an infestation. Fresh droppings are usually moist, soft and shiny while old droppings become dry and hard and have a dull grayish appearance and crumble when pressed with a stick. Norway rat droppings are largest, $1/2$ to $3/4$ inch long, and have bluntly rounded ends which give it a spindle-shaped appearance. Roof rat droppings are smaller ($1/3$ to $1/2$ inch long) and more regular in form. The ends are usually quite blunt. House mouse droppings are very small ($3/16$ to $1/2$ inch), pointed at each end. American cockroach droppings are smaller than mice and have blunt, almost squared off ends.

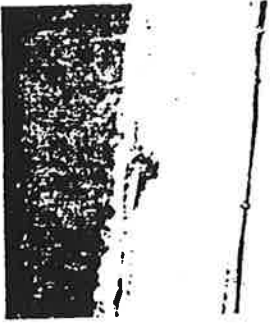


- 2 Runways - rats occupy only a limited area and use the same paths and odor trails that they are familiar with, as they are very cautious and suspicious. Outdoors in vegetation, such as grass, or weeds, you can see paths worn down which are between 2-3 inches wide. On earthen floors (outdoors) the runways appear as clean-swept, well packed earth paths.
- 3 Rubmarks - rats prefer to follow closely to walls where their highly sensitive whiskers (vibrissae) and guard (body) hairs can keep in contact with side surfaces. By using the same rat runs their oily bodies, rubbing against a wall or baseboard, creates a rubmark. Rubmarks of the Roof rat are commonly seen overhead as swing marks, and are found beneath beams or rafters at the point where they connect to the walls. Fresh marks are soft and will smear when rubbed. Mice do not leave rubmarks that are detectable except when the infestation is heavy.



- 4 Burrows - the Norway rat prefers to burrow for nesting and harborage while the Roof rat burrows only occasionally. Burrows are found in earth banks, hedgerows, along walls, under rubbish or concrete slabs, and near dog houses. Rat holes are about 3 inches in diameter while mice holes are only about 1 inch in diameter. If a burrow is active it will be free of cobwebs and dust. Fresh rubmarks on hard-packed soil at the opening indicate a well established and active burrow. The presence of fresh fragments of food or freshly dug earth at burrow entrance also indicates an active burrow.
- 5 Gnawings - since the incisor teeth of rats grow 4-6 inches a year they have to do some gnawing each day in order to keep their teeth short enough to use. Gnawings in wood are fresh if they are light colored and show distinct teeth marks. Small chips of wood or other materials indicate recent gnawing. Old wood gnawings become dark and smooth.
- 6 Tracks - may be observed anywhere along rat or mouse runs both indoors and outdoors. Tracks are more clearly seen by side illumination from a flashlight than by direct illumination from above. Dust in little-used rooms and in mud around outdoor puddles are especially good places to look for tracks. Rat tracks may be 1 1/2 inches long. The rear paws of rats have 5 toes while the front paws have 4. Tail marks are also often visible in dust or track patches.
- 7 Live or Dead Rats - positive proof of a rodent infestation is to see a live or dead rat or mouse. As a rule, only on very heavy infestations will you see a live rat. Dead animals may either indicate a current or past infestation.

LOOK FOR RAT SIGNS



Runways



Tracks



Droppings



Gnawed Places

Which of the rat holes below is being used?



- 8 Miscellaneous Signs - urine stains can be seen with an ultraviolet light. The rat leaves a distinct pattern from that of mice. Rat and mouse hairs may be found along walls etc. and when examined under a microscope can be distinguished from hair of other animals.

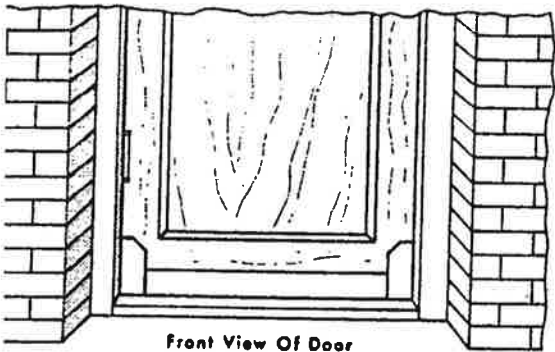
D Control of Rodents

1 Environmental Sanitation

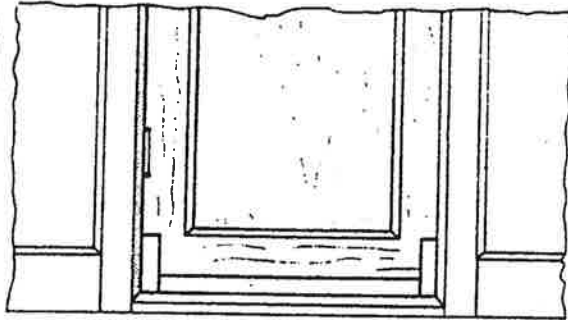
Get rid of all unwanted materials that might provide food or shelter. This means storing garbage and rubbish in approved type containers with tight fitting lids (plastic bags won't keep out rats). Lumber and other materials should be stacked 18 inches off the ground. Food set out for dogs, rabbits, pigeons or chickens is often a source of food for rats or mice and should be policed by picking up scraps of leftover food, and keeping dog dishes clean. Keep animal droppings cleaned up around dog pens.

2 Ratproofing

Consists of changing structural details to eliminate any openings 1/2 inch or larger that would admit rats, and 1/4 inch or larger for mice. Where only Norway rats are found, usually only first floor stoppage work is economically feasible and then at the likely points of entry and not every possible opening i.e.: around doors, windows where pipes and conduits enter building, floor drains, transoms, letter drops, fan openings, and foundations. Concrete, brick and mortar as well as galvanized hardware cloth, and galvanized metal are some materials needed for ratproofing. Where Roof rats are encountered, ratproofing must include wires, vertical pipes and openings to upper floors and roofs.



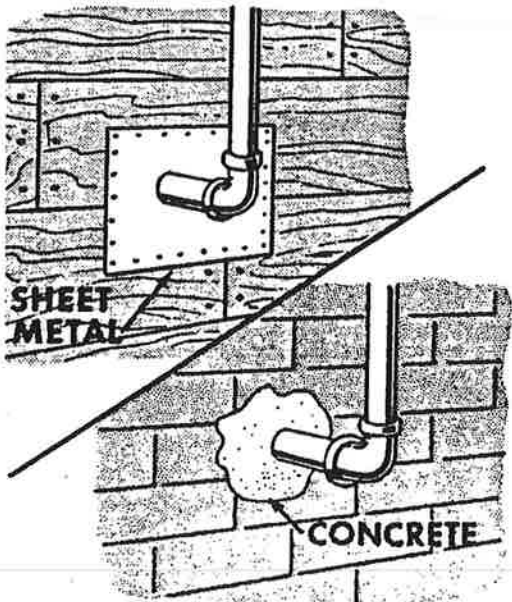
Front View Of Door



Back View Of Door

Note:— If door jambs have deteriorated or require treatment use pieces of sheet steel extending the same height as cuff pieces and install with 3—penny nails.

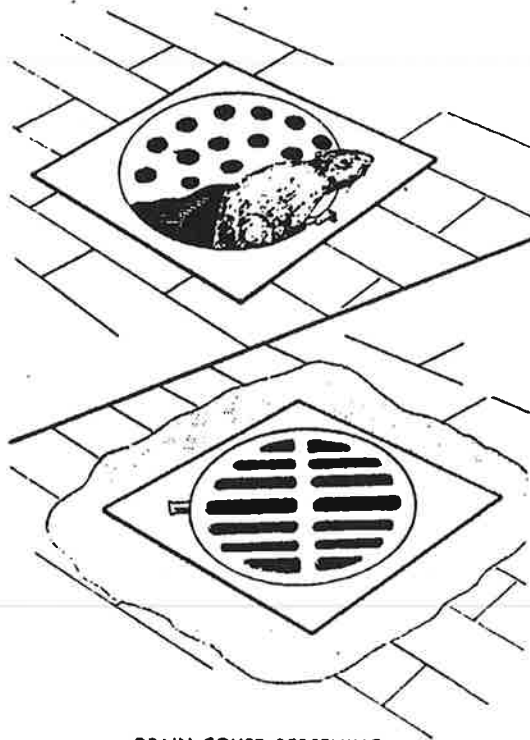
EXAMPLES OF PROPER INSTALLATION OF CHANNEL



SHEET METAL

CONCRETE

STOPPAGE OF OPENINGS AROUND PIPES

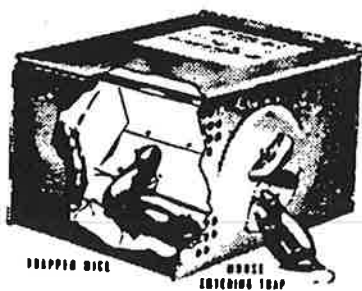
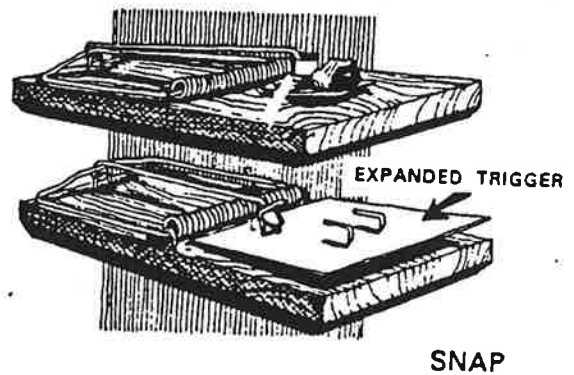
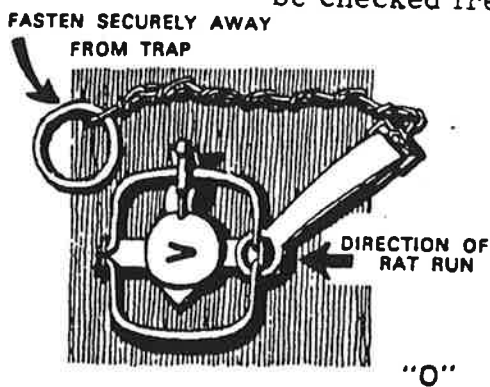


DRAIN COVER SCREENING

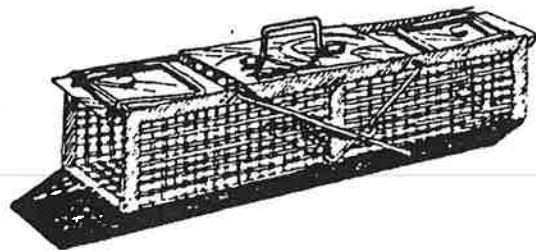
3 Traps - are useful around food establishments where rodenticides are not permitted or are hazardous, and where only slight infestations are predicted. Three main types of traps:

- a Live traps (O Traps) used for catching live rodents. Generally used for study purposes.
- b Killer traps (Snap Traps) good for both rats and mice.
- c Cage traps - used for collecting live rats or mice. These traps are designed to catch one animal at a time or several. An example of the multiple catch trap is shown at lower left. The mouse enters one of the openings and forcibly shoved into a closed compartment and then hurriedly the doors open for the next inquisitive customer.

In general all traps need to be maintained. They should be checked frequently, never less than every 24 hours.



CAGE



- 4 Poisoning - rodenticides are categorized highly toxic, moderately toxic and low toxicity, based on criteria established in the Federal Insecticide, Fungicide and Rodenticide Act. (Now called Federal Environmental Pesticide and Control Act).
- a Highly Toxic - (purchased and applied by Pest Control Operators only).
- (1) Sodium Monofluoroacetate (Sodium Fluoroacetate 1080) white, odorless and tasteless compound.
 - (2) Fluoroacetamide (1081) - safer to handle than 1080.
 - (3) Gophacide (Bay 33819) - Organophosphate - approved for use against pocket gophers only. It looks promising for Norway rat control and as soon as toxicological information is complete will probably be released for rat control.
 - (4) Strychnine - is an alkaloid that comes from seed of a tree Native to India. It is strongly bitter and "Bait Shyness" occurs.
 - (5) Zinc Phosphide - has a faint odor of phosphorous. Very effective against all species of rats.
 - (6) Elemental Phosphorous - comes in two forms, one is granular, non-absorbable, and non-toxic, the other is a white or yellow waxy form that is highly poisonous and will burn on contact with water or even moist air. Usually sold in a paste form.
 - (7) Arsenic (Arsenic Trioxide) - a white crystalline powder used in solid baits. Not effective against mice.

b Moderately Toxic

- (1) Antu (Alpha-Naphthyl Thiourea) - use in U.S. is non-existent because of "Bait Shyness" and tolerance to sub-lethal doses.

c Low Order of Toxicity

- (1) "RED SQUILL" comes from lily like plant that grows in mediterranean region. It is a natural emetic to most animals (induces vomiting) but since rats cannot vomit it causes convulsions and respiratory failure. It has a strong bitter taste which must be overcome with tasty baits. Bait shyness may develop and is therefore recommended as a one shot poison in an area.
- (2) Hydroxycoumarins (Anticoagulants) provided a completely new approach to rodent control. Must be used over extended periods in order to achieve maximum kill. Usually the best kill occurs between the fourth and ninth feeding. Anticoagulants cause internal bleeding. It is very safe to use and no known human deaths have been reported. Common type anticoagulants are Warfarin, Warficide, Coumachlor, Fumarin, Fumasol, Prolin, Indandiones, Pival, Diphacinone, PMP and Norbormide.

Pre-baiting - is exposure of unpoisoned bait for several nights prior to using poisoned bait. Pre-baiting is useful in controlling bait shy rats.

Test Baiting - used to determine what baits rats prefer. Several types of food are exposed one or more nights. Most readily accepted should be used with toxicant. Test baiting is practical only when rats won't accept usual bait. It also shows number of baits needed and where they should be placed.

IV SAFETY IN HANDLING PESTICIDES

They are made to kill. It is recommended that pesticides be applied by a reputable professional pest control operator. They know how to handle these toxic substances. As an Inspector you should know the safety guidelines and determine if any hazards to the public exist through improper handling and/or dispensing of insecticides.

CAUTIONS IN PESTICIDE HANDLING

- A Read and understand the label on containers for preparing and applying the pesticide.
- B Know the material being used.
- C Avoid prolonged exposure and wear protective clothing.
- D Do not use in any way which will result in contamination of food or drinking water.
- E Store pesticides in properly labeled containers away from food in a secure place.
- F Dispose of empty containers safely.
- G Know emergency measures for treating accidental poisoning.

SOME CHARACTERISTICS OF COMMON RODENTICIDES¹

POISONS	LETHAL DOSE (mg/kg)	PERCENT USED IN BAIT	DEGREE OF EFFECTIVENESS	ACCEPTANCE	REACCEPTANCE	CUMULATIVE TOLERANCE DEVELOPED	ODOR	TASTE	CHEMICAL DETERIORATION IN BAITS	SOLUBILITY			ACTION (Cause of Death)	RELATIVE TO HUMANS AND TO OTHER ANIMALS			ANTIDOTES IS
										WATER	OIL	DRY		TYPE OF BAIT MIXTURES	SECONDARY POISONING	ABSORBED THRU SKIN	
COAGULANTS BROMACETATE VAL VIT ²	1 ³	.025	GOOD	GOOD	GOOD	YES	NO	NONE	NONE	YES	YES	YES	NO	YES	NO	SLIGHT	Vitamins K ₁ and antagonists of blood blood
COAGULANT PHACLORE	0.5 ³	.005	GOOD	GOOD	GOOD	YES	NO	NONE	NONE	NO	YES	YES	NO	YES	NO	SLIGHT	dl-10
FU	8 ⁴	1.5	GOOD	GOOD	POOR	NO	YES	SLIGHT	MEDIUM	NO	NO	YES	YES	NO	NO	MEDIUM	None
IZENIC	100	3.0	FAIR	FAIR	FAIR	NO	YES	NONE	MEDIUM	YES	NO	NO	YES	NO	NO	MEDIUM	None
BROMINIDE	12	9.5	GOOD	FAIR	POOR	NO	YES	NO	SLIGHT	NO	NO	YES	YES	NO	NO	SLIGHT	None
IPRONIUS VASTE	1.7	2.9	GOOD	GOOD	FAIR	NO	NO	STRONG	STRONG	NO	YES	YES	NO	NO	NO	MEDIUM	Color tablets (white, green, yellow) and water (red or blue) (for bait)
QUILL	500 ⁷	10.0	FAIR	FAIR	POOR	NO	NO	MEDIUM	STRONG	YES	YES	YES	YES	NO	NO	SLIGHT	Bait is not suitable for control of rodents at present
HUM UDROACETATE 19801	2-8000 ⁸ 100/1000 ⁸		GOOD	GOOD	GOOD	NO	NO	NONE	SLIGHT	YES	NO	NO	YES	YES	NO	EXTREME	None. Bactericidal or strongly delayed and weak antiparasitic
YCHININE	6	0.6	FAIR	FAIR	POOR	NO	YES	NONE	STRONG	YES	NO	YES	NO	NO	NO	MEDIUM	None. Bait is not suitable for control of rodents at present
MOSPHIDE	40	1.0	GOOD	GOOD	GOOD	NO	NO	STRONG	STRONG	NO	YES	YES	YES	NO	NO	MEDIUM	None on predators

¹ Effective against Norway Rat only
² Effective against Norway Rat, House Mouse, and House Shrew
³ Effective against Norway Rat, House Mouse, and House Shrew
⁴ Adapted from USDA, Bureau of Sport Fisheries and Wildlife Lethal 317.
⁵ Also available as 2.12% tracking powder.
⁶ More or less. Successive doses required for 3-10 days or more.
⁷ Recovery rate only, on first exposure.
⁸ Also available as a 32% tracking powder.

Very fast acting
 Slow acting
 Fast acting
 Very fast acting

¹ Used only as a tracking powder, usually 5%.
² Maximum acceptable level; more than equalizes grain water toxicity.
³ Normally acceptable to rats.
⁴ Can be taken through ears or through the skin; also danger of poisoning house powder.
⁵ Recovery rate only, on first exposure.
⁶ Recovery rate only, on first exposure.
⁷ Recovery rate only, on first exposure.
⁸ Also available as a 32% tracking powder.

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