VIRGINIA COOPERATIVE EXTENSION SERVICE

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PESTICIDE APPLICATOR CERTIFICATION TRAINING

Category 7a Manual

General Pest Control

EXTENSION DIVISION

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

INDUSTRIAL, INSTITUTIONAL, STRUCTURAL, AND HEALTH RELATED PEST CONTROL

CATEGORY 7a: GENERAL PEST CONTROL

A Training Program for the Certification
of Pesticide Applicators

prepared by
William H Robinson, Extension Specialist, Entomology

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INTRODUCTION

This training manual is intended to provide information that you may need to comply with EPA's Standards for Certification. It will help you prepare for the Certification examination prepared and administered by the Virginia Department of Agriculture and Consumer Services.

The emphasis of these standards and this training is on the principles of applying pesticides safely for man and the environment. It is not intended to provide you with all the knowledge needed. Additional information in the form of publications, short courses, field days, and professional meetings can be obtained from the local Cooperative Extension Service office in your area.

KEYS TO THE PROPER USE OF PESTICIDES

1. Read the label on each pesticide container before each use. Follow instructions to the letter; heed all cautions and warnings; note precautions about residues.
2. Keep pesticides in the containers in which you bought them. Put them where children and animals cannot get to them, preferably locked-up and away from food, feed, seed, and other materials that may become harmful if contaminated.
3. Dispose of empty pesticide containers in the manner specified on the label.

SEE YOUR DOCTOR IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER USE OF PESTICIDES

RECOGNITION OF PEST DAMAGE

Recognizing the damage caused by insects and other pests is a very important part of pest control. Pesticide applicators are often expected -- and should know how -- to identify a pest by its damage rather than by actually seeing the pest itself. Usually, the pest is in hiding or it has left the immediate vicinity to do damage elsewhere.

The following descriptions of damage are arranged according to the type of object attacked (i.e. fabric, wood, foods, etc.) The topics covered are:

I. Wool, Fur, and Leather

II. Synthetic Materials, Finished Cloth, Paper, and Books

III. Dried Foods, Grain Products and Containers, Medicine Products

IV. Wood and Wood Products

I. Wool, Fur, and Leather

1. Loose tunnel-like silk tubes attached to the fabric surface of material with flimsy and discontinuous webs. If wool, may be eaten in spots at surface or completely through fabric. If fur, hairs cut at the base causing loose fur and exposing the hide . . . . . .

WEBBING CLOTHES MOTH

2. Portable cigar-shaped (slightly enlarged in the middle) cases loose on the material; cases composed of silk and food (fabric) fibers; surface of fabric without webs. Fabric damaged on the surface . . . . . .

CASEMAKING CLOTHES MOTH

3. Large irregular holes chewed or torn in the fabric, holes may be 1 inch or more in diameter, edges frayed; damage may penetrate a number of layers; hairs often present . . .

RODENTS

4. Fabric surface damaged and with small penetrating holes; damage may be limited to scattered holes with surrounding surface damage. Skin or hide badly damaged, often loosening patches of fur; OR skin or hide only slightly damaged but large amounts of hair damaged . . . . . .

CABINET AND CARPET BEETLES

II. Synthetic Materials, Finished Cloth, Paper and Books

1. Surface of material slightly roughened or pitted in irregular patterns; small holes may be present. Minute, irridescent scales may be present. Preferred materials include paper, rayon, linen, sized cotton, and wallpaper . . . . . SILVERFISH AND FIREBRATS

2. Surface of material roughened from chewing and feeding, the roughness produced by the paper and cloth fibers being pulled or picked loose; surface of books may show irregular "trails"; surfaces with glue may be extremely eaten . . . . . COCKROACHES AND CRICKETS

III. Dried Foods, Grain Products and Containers, Medicine Products

1. Boxes of flour, meal, prepared mixes, dry pet food, etc., containing webbing on the inside and on the food; webbing may be so numerous that it can be peeled off like sheets of soft tissue paper. Small caterpillars often present. Escaping caterpillars may leave round holes 1/16" in size in the boxes or bags . . . . . .

   INDIAN MEAL MOTH

2. Flour, food products, or grain webbed together in masses. Sometimes thickly matted on bags, etc. Common in food-processing machinery where it may slow or stop operations . . . . . .

   MEDITERRANEAN FLOUR MOTH

3. Kernels of wheat or corn (on or off the cob) with one or two tiny, round holes or trap-door-like caps the same size . . . . . .

   ANGOUMOIS GRAIN MOTH

4. Kernels of wheat or corn with one or more rather irregular small holes . . . . . .

   RICE OR GRANARY WEEVIL

5. Kernels of corn or other grains with irregular, fine feeding scars showing distinct tooth marks. Damage may be extensive . . . . . .

   MICE, SOMETIMES RATS

6. Processed cereals, such as oatmeal, with irregular, fine feeding scars. Cast skins, minute larvae, and insect fragments often present . . . . . .

BRAN OR FLOUR BEETLES

7. Food containers with one-to-many "bird-shot" holes. Inside of container deeply etched and food (if present) with small beetles or their fragments. NO webbing present . . . .

DRUGSTORE OR CIGARETTE BEETLES

8. Pelleted food (dog biscuits, etc.) and crackers with small holes . . . . . .

DRUGSTORE OR CIGARETTE BEETLES

9. Dried beans with many round holes about 1/8" in size. Larvae or beetles sometimes still present . . . . . .

BEAN WEEVIL

10. Cheese or sometimes dried meat covered with brown patches of powder consisting of tiny molted skins, particles of uneaten food, excrement, and living mites. Sickish, sweet ordor . . . . . .

CHEESE MITE

11. Cheese or meat with burrows in it; advanced infestations show slightly sunken areas which are soft and waxy. Maggots, pupae, and small flies sometimes present . . . . . .

CHEESE SKIPPER

12. Gelatin capsules, containing vitamins or other medicinals, with small irregular holes chewed through them . . . . . .

CABINET BEETLE

13. Solid food and wax with distinct tooth marks made by gnawing . . . . . .

RODENTS

14. Dried milk, flour, and cereal products with extensive feeding. Usually with numerous cast larval skins of various sizes. Often living larvae . . . . . .

CABINET BEETLES
CARPET BEETLES
FLOUR BEETLES

IV. Wood and Wood Products

1. Numerous small holes (resembling "bird-shot") in surface of wood. If piece split open, many saw-dust filled tunnels can be seen, most running with the grain. In hard or soft woods . . . . . .

POWDER-POST BEETLES

2. Large round or oval holes in processed wood and rough timber, holes larger than "bird-shot." Irregular and rather extensive tunnels in the wood, usually with coarse saw-dust . . . . . .

LONGHORNED BEETLES
(OLD-HOUSE BORER)

3. Small holes about 1/8" in size found in rough, bark-covered wood; inner side of bark and surface of wood "engraved" with galleries. .

BARK BEETLES

4. Pinholes and slender galleries in sapwood, galleries round, uniform in diameter, not packed with saw-dust; wood surrounding pinholes usually with bluish or black stain . . . . . .

AMBROSIA BEETLES

5. Small round holes leading to extensive galleries within the wood; galleries contain considerable coarse, sand-like frass (eastern Virginia) . . . . . .

DRY WOOD TERMITES

6. No holes or other openings in wood; galleries within the wood extensive, galleries lined with earth; mud or earthen tubes penetrate soil or surrounding woodwork; no sawdust in the galleries . . . . . .

SUBTERRANEAN TERMITES

7. Oval, smooth holes opening to outside of wood; extensive galleries which are smooth and with rounded edges; galleries contain no saw-dust, but coarse saw-dust may be found near the damage . . . . . .

CARPENTER ANTS

8. Wood with 3/8" - 1/2" round holes on side, edge, or end; holes lead to long tunnels . .

CARPENTER BEES

BIOLOGY AND HABITS OF COMMON PESTS

There are a variety of four-, six-, and eight-legged pests that are associated with homes and food-service operations. Many of these pests are accidental invaders and are actually harmless, but some can damage foods, clothing, furniture, and other materials if not controlled. Pesticide applicators should be able to distinguish between the casual invader and the pest.

The chemical methods and materials used to control these pests change continuously. New chemicals and improved application methods will always be available. However, the basic biology and habits of these pests does not change. Pesticide applicators should be knowledgeable about the basic life cycle and feeding habits of the common household and food-service pests.

ANTS

Several different kinds of ant invade buildings, but they do not all nest in structures. Ants usually enter in search of food to carry back to their nest. They may have a nest close to the building or far from it. The best control method is to find the ant's point of entry to the building (doorway, crack in foundation, etc.) and apply control.

Ants do not spread disease and are not a serious health hazard.

BED BUGS

These insects are cousins to stink bugs and plant bugs. Bed bugs have piercing-sucking mouthparts and suck blood from man (and some birds). They feed at night and hide in the bedstead during the day. They require several blood meals to become adults and lay eggs. The bite is nearly painless, but may produce a swelling and some irritation.

Bed bugs are often introduced into homes through secondhand beds, bedding, and furniture. Although they suck blood, bed bugs do not spread any diseases to man.

BEES

(Honey Bees)

Honey bees occasionally build a nest in the eaves or siding of a house. If the nest is located early, it can be removed easily. A well-established colony will have a large store of honey, several thousand worker bees and be difficult to remove. When possible, work around the nest after dark. The bees will be less active, and if you use a red light, they can not see you very well. Complete control of a nest of honey bees includes removing the nest and all the honey. Contact a local beekeeper for advice on handling honey bees.

BOOKLICE

These very small insects frequently occur in houses and other buildings. Most of the species found in buildings are wingless, and because they often live among books or papers, are often called "booklice." They feed on molds, fungi, cereals, fragments of dead insects, and similar material. Booklice rarely cause much damage. Old books and newspapers should be kept dry and periodically removed.

BOXELDER BUGS

Adults of these red and black bugs often come together in large groups to spend the winter. They may gather under porches, rocks, or boards around the outside of the house. They feed on boxelder and other trees. Although they occasionally invade homes, boxelder bugs are harmless to man. They may stain rugs, drapes, etc. if squashed.

CARPET BEETLES

There are many different kinds of carpet beetle -- and they don't all feed on carpets! Besides wool carpets, carpet beetles feed on a variety of materials including fruit cake, smoked ham, feathers, leather, dead animals, and other similar animal materials. The small (¼ inch), elongate, brown larvae do most of the damage. The adults and larvae have chewing mouthparts. The adults frequently fly to windows in the house.

CENTIPEDES AND MILLIPEDES

"Hundred-legged worms" (centipedes) are closely related to insects. They have chewing-biting mouthparts and feed on insects and other small arthropods. In houses, they are often found in bathrooms, basements, and garages. Centipedes usually enter houses in search of food. They do not nest in houses. They may give a severe bite if handled.

"Thousand-legged worms" (millipedes) have chewing mouthparts. They feed on dead and decaying organic matter (plant and animal). In houses they are usually found in lower-level rooms and the basement. Large numbers of these pests indicate an abundance of mulch-type material around the house and a prolonged wet spell. Millipedes will not damage household materials and will not bite man.

CLOTHES MOTHS

Adult clothes moths are very small, whitish moths. Unlike other moths, they are <u>not</u> attracted to lights. The larvae (caterpillars) feed on a variety of natural fiber materials, but are most common on wool. They are not common household pests.

CLUSTER FLIES

These household pests are common throughout the state. The adults spend the winter clustered in the attics of houses. They begin invading houses in September, crawling through small cracks and crevices to enter the attic. The larvae live in the soil as predators of earthworms. The adults don't bite or sting, but are a nuisance by their presence in the house.

COCKROACHES

Cockroaches are pests in the homes of all income groups -- not just low-income people. They are difficult to control. Partly because some are slightly resistant to chemical insecticides, and partly because of their behavior and feeding habits. Cockroaches hide during the day and are active at night. They can feed on a great variety of material. The adults deposit egg cases that contain many eggs. Nymphs and adults have chewing mouthparts. There are four common species of cockroach that invade houses in the state: German Cockroach, American Cockroach, Oriental Cockroach, and Brown-banded Cockroach.

CRICKETS

Crickets are closely related to cockroaches. They have chewing mouthparts and sometimes invade houses to feed on plant material, food scraps, and cloth. They do not permanently infest houses. Crickets lay their eggs (one at a time) outside in moist soil. They are attracted to lights at night and can fly into houses and even upper-floor apartments.

MOTH FLIES

These very small, moth-like flies are common in houses, restrooms, food service operations, and similar places. The larvae of these flies live in wet, moldy areas in clogged drains, around toilet and sink fixtures. A thorough clean-up in these areas usually gives control. Adult moth flies are usually seen walking on windows and walls near lights.

Moth flies do not spread disease and are not a serious health hazard.

FLEAS

Fleas are external parasites of animals. In the house they suck the blood of dogs and cats (and sometimes man!). Because of their small size and rapid movement, they are difficult to control. The adults spend most of their time on the animal. They may hop off onto furniture, rugs, beds, etc. for a short time. The larvae live in and around bedding of the animal -- larvae do not live on the dog or cat. The larvae feed on food scraps and organic matter that may fall around the animal's sleeping area. The adults have piercing-sucking mouthparts (feed on blood); the larvae have chewing mouthparts (feed on organic matter).

SILVERFISH AND FIREBRATS

These small, fast-moving insects are usually found in warm, dry places such as attics and furnace rooms. However, they may inhabit kitchen cabinets and clothes closets. The nymphs are similar to adults (slightly smaller) and have the same chewing mouthparts. Silverfish feed on mildew, starch, glue, old clothing, and scrap food material. They rarely occur in large enough numbers to be a serious pest -- usually just a nuisance.

HOUSE FLIES

The common house fly is a pest all over the world. The larvae or maggots live in garbage of all kinds. They may live and feed in cattle manure, but rarely in dog or cat droppings. Light screens and fly paper will help control them. Garbage cans should be cleaned regularly in the spring and summer.

House flies can fly a great distance, so garbage clean-up and sanitation is the best control.

SPIDERS

Spiders are usually a household pest in the spring and fall seasons. They are abundant in the spring when males and females are mating, and in the fall when some seek shelter from the cool weather. It may be very difficult to eliminate this pattern. But there is some relief in knowing that spiders are beneficial animals -- feeding on insects and other spiders.

The black widow and the brown recluse spider are the only poisonous species in eastern U. S.

PANTRY PESTS:

MEAL MOTHS
PEA WEEVILS
GRAIN BEETLES
FLOUR MOTHS
CARPET BEETLES
MEALWORMS

There are a great variety of pantry pests, including several different species of moth and beetle. In the case of the moths, the caterpillar stage

does the damage (by feeding) and the moths are harmless. The adult moths usually leave the infestation site and fly about the house. With beetles, both the larvae and adults feed. The adult beetles may occasionally be found at lights or windows.

A great range of food and grain products can be infested by insect pantry pests. Flour, dry pet food, bird seed, dry peas, and beans are only a few examples. Thorough clean-up is the first step to control.

TICKS

Ticks are not usually a household pest. However, "seed" ticks (young brown dog ticks) are often encountered by homeowners in the fall season. Household pets may be infested with brown dog ticks in the fall. The females leave the animal and crawl to a crack in the floor and deposit a large number of eggs. The eggs hatch in several days and the young ticks swarm all over the immediate area.

Humans as well as pets may be attacked by seed ticks.

HOUSE MOUSE

Mice can cause a great deal of damage to household materials. Because of their habit of nibbling, they contaminate much of the material not actually destroyed. A knowledge of house habits is important in developing effective control programs. Each male mouse stakes out a territory around his nest. He may not travel more than ten feet from his nest if food is close by. For this reason, baits should be placed 10-20 feet apart. Mice are not suspicious of new foods and eagerly sample them. Mice also investigate any new object in their territory, so that changing bait or trap placements will improve control.

RATS

Rats are serious pests because they contaminate and destroy food products, carry diseases and external parasites, and often bite man. A knowledge of rat behavior is essential to successful control.

Rats which have become conditioned to eating a particular food approach new food cautiously. If it tastes bad or makes them sick, they won't eat it again (= bait shyness). When baiting, more effective control can be obtained by using a bait that is fresh and identical to the food the rats are using. If different food is used, it may be necessary to prebait a few nights before adding a toxicant to the bait. Rats also require free water to drink. If water sources can be eliminated, liquid baits are effective. Rats, especially males, establish "territories" and fight to

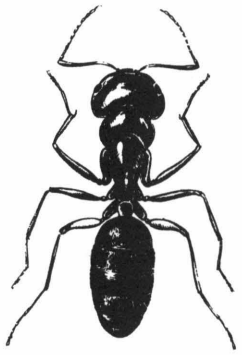
protect this area from strange males. By reducing or eliminating food sources and harborage, this competition is increased, and the rat population decreases. Rats also prefer to run next to walls or other surfaces; therefore, traps and baits should be placed in these runways.

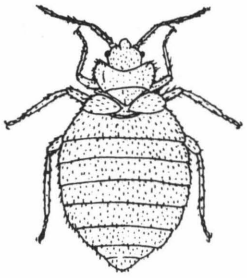
The first part of any good rat control program consists of determining just where the rats are living, feeding, and traveling, and the extent of the infestation. Once this has been done, it is essential to eliminate their shelter areas and their food and water supplies. These sanitation measures are the backbone of successful control. However, in many instances, it may be best to poison or trap before upsetting the environment so that the rats do not scatter. It is also necessary to close off all entrances and exits rats can use to come and go from buildings. This is called rat-proofing, and must be done in many instances to obtain adequate control.

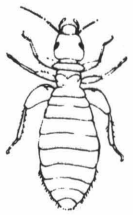
IDENTIFICATION AIDES FOR COMMON PESTS

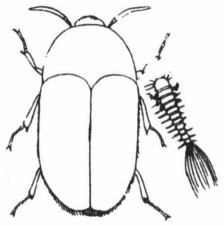
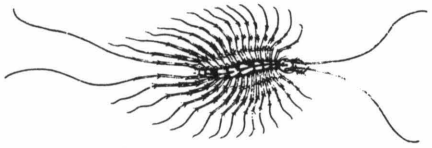
Certainly, the first step in solving a pest problem is determining the precise species involved. Not all cockroaches have exactly the same habits, not all pantry pests do the same damage. Pest control programs must be designed for specific pests. Broad spectrum applications of pesticides are dangerous and unnecessary. Modern methods fit the pesticide to the pest.

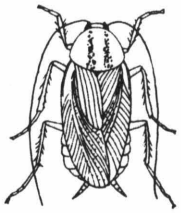
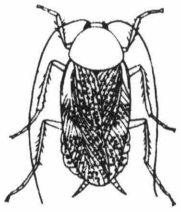
Pesticide applicators involved with industrial, institutional, structural, and health related pest control should be able to recognize some common pests. The following table provides some identification aides.

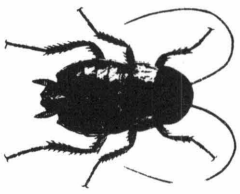
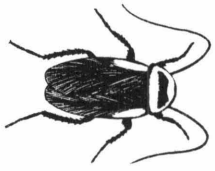
Pest	Identification
ANTS  (length, 1/6 - 3/4")	Large head, elbowed antennae. Narrow waist. Wings usually absent. Large jaws. Chewing-biting mouthparts.

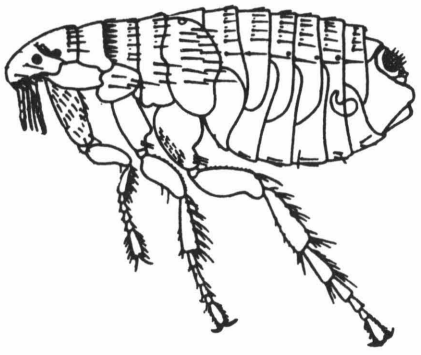
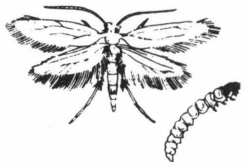
Pest	Identification
BED BUGS  (length, 3/16")	Small, rounded, dark brown colored. Wings absent. May be engorged with blood. Piercing-sucking mouthparts.
BEES   (length, 3/4")	Honey bees are light brown, with a "hairy" body. Abdomen brown colored. Chewing-lapping mouthparts.

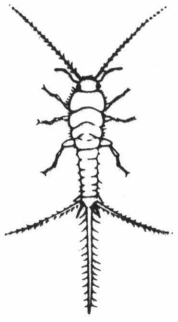
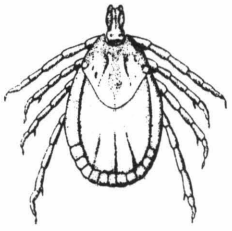
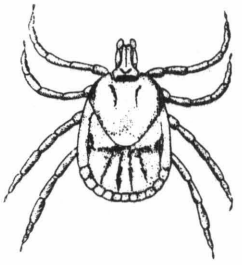
Pest	Identification
BOOKLICE  (length, 1/16")	Minute, pale colored body. Wings usually absent. Chewing mouthparts.
BOXELDER BUGS  (length, 5/8")	Brightly colored red and black. Long antennae. Narrow head with beak. Piercing-sucking mouthparts. Feed on plants.

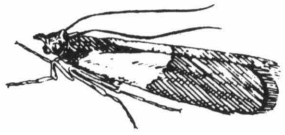
Pest	Identification
CARPET BEETLES  (length, 3/16")	Adult beetles small, rounded, usually brown. Larvae elongate, brown body with long brown "hairs" at sides and tail end. Chewing mouthparts.
CENTIPIDES  (length, 1 - 2")	Apparently one pair of legs per body segment. Long antennae. Chewing-biting mouthparts. 

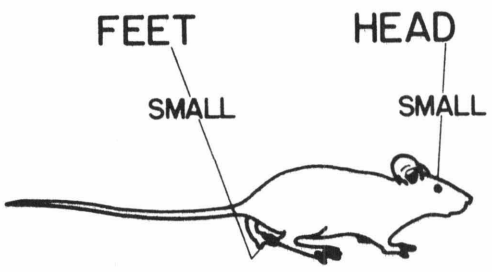
Pest	Identification
MILLIPEDES  (length, 1 - 3")	Apparently two pair of legs per body segment. Short antennae Chewing mouthparts.
COCKROACHES:	
1. German Cockroach 	Adult pale yellowish brown in color with two dark brown longitudinal stripes on body region behind head. Both sexes are fully winged. Chewing mouthparts.
2. Brown-Banded Cockroach 	Adult resembles the German cockroach in appearance but is smaller and has two brown cross bands on the wings: one at the base and the other farther back. Both sexes winged. Chewing mouthparts.

Pest	Identification
3. Oriental Cockroach 	Adult dark brown to black in color. The wings of the female are short, and those of the male do not quite reach the tip of the abdomen. Chewing mouth-parts.
4. American Cockroach 	Adults are very large (1 - 1½"), and chestnut brown in color. Both sexes have long wings. Chewing mouth-parts.
MOTH FLIES  (length, 1/8")	Adults are small, oval shaped. Wings pointed and covered with "hairs." Body small and covered with "hairs."

Pest	Identification
FLEAS  (length, 3/32")	Adults very small, laterally compressed. Wingless. Bloodsucking external parasites of warm-blooded animals. Piercing-sucking mouthparts.
CLOTHES MOTHS  (length, ½")	Adults very small, pale white colored. Wings pale white, without spots. Damage: loose tunnel-like silk tubes attached to fabric.

Pest	Identification
SILVERFISH  (length, 3/8")	Small pale gray, elongate. Antennae long. Tail with three long spines. Chewing mouthparts.
TICKS   (length, ¼")	Adults brown to dark brown, sometimes with white spots. Eight legs. Nymphs (seed ticks) light brown. Six legs. Adults and nymphs blood-sucking external parasites of mammals.

Pest	Identification
PANTRY PESTS:	
1. Saw-Toothed Grain Beetle  (length, 1/10")	Adults small, dark brown, with small spines on body region behind the head. Larvae pale white. Damage: adults and larvae infest flour.
2. Indian Meal Moth  (length, ½")	Adult moth with bicolored wings: inner 1/3 pale gray; outer 2/3 reddish brown. Damage: larvae web together flour, dry pet food, and other grain products.

Pest	Identification
HOUSE MOUSE  	Adults can be distinguished from small rats by their small eyes and small feet. Tail as long as the body. Adults are 2½ - 3½" in head and body length.

FUMIGATION REVIEW

Fumigation can be defined as the use of gaseous poisons to kill insects and other pests. Application is generally limited to plants or products in tight enclosures or to those which can be enclosed in relatively gas-tight tents or wrappings. These categories encompass a wide range of commodities and conditions. Many of these are beyond the scope of this manual and will not be presented. The intent of this section is to review the common fumigants used in the pest control industry and to alert the reader to some methods, materials, and techniques used in structural fumigation. A more complete coverage of fumigation is presented in the category 7d manual.

SAFE HANDLING OF FUMIGANTS

All fumigants have appreciable toxicity towards humans and animals, but since they differ considerably, it is difficult to write general instructions for fumigating procedures. In all cases, the fumigator must read and understand the manufacturer's label, and comply with the registered uses. If the instructions on the label are not adequate, the fumigator should obtain more detailed instructions from the supplier or manufacturer. The supplier and manufacturer are obligated to provide adequate information to the user as to registered uses, toxicity, and handling and may be expected to do so if requested.

The symptoms described as resulting from excessive exposure to most of the fumigants in this manual are non-specific in that they are observed in many different illnesses. The diagnoses of poisoning due to a fumigant as opposed to a diagnoses of illness resulting from natural causes can be made only by a physician who is capable of objective consideration of all the facts that can be developed from an examination of a patient and a consideration of possible exposure. This

objectivity is important. Self-diagnosis is dangerous, even for the well-trained. The best policy is always to report any illness to the physician.

Information concerning the effects of a chemical as well as the symptoms to be expected should be known to the local physician prior to the use of the fumigant. This kind of information can be obtained for the doctor from the supplier of the fumigant. The supervisor of the fumigation should make it a point to get the information from the supplier and transmit it to his physician before using the material. The advantages of this are that it allows the physician time to examine the literature prior to any difficulty and to procure needed supplies.

Safety Equipment

Every person who is working with fumigant materials should be well informed regarding the hazard of the materials, the appropriate protective devices to be used with each, and the limitations of such devices. A choice of a gas mask depends upon the material to which the person is likely to be exposed, the intensity of exposure anticipated, and the availability of an adequate oxygen or air supply. Small respirators equipped with cartridge-type canisters are effective in the same way as full-face masks, but the capacities are much smaller and they give no protection to the eyes where irritants or lacrymators are encountered. An ordinary full-face gas mask with a suitable standard or large-size canister is effective against vapor concentrations up to 2% by volume in air. The duration of the use of a canister must not exceed 20 minutes. Both the respirator and the gas mask can be used only where the oxygen content of the air is not depleted to less than 16%.

The choice of a canister to be used with a full-face mask or a respirator depends upon the toxicant involved. An organic vapor canister is designed to provide protection

against such materials as methyl bromide, ethylene dibromide, carbon tetrachloride, ethylene dichloride, chloropicrin, carbon disulfide, and similar substances. For protection against sulfur dioxide, an acid gas canister must be used. For acrylonitrile, a canister designed for both organic vapors and acid gases is recommended. For protection against hydrogen cyanide, phosphine, and sulfuryl fluoride, special canisters must be used. Read the instructions on the fumigant label. In all cases, the recommendations of the manufacturers of the fumigants, canisters, and masks should be followed.

It is the responsibility of the person in charge of fumigations to see that an adequate supply of canisters and other necessary safety equipment is available before beginning a fumigation. This equipment should be inspected and tested prior to starting each fumigation. All used canisters should be destroyed. The use of halide leak detectors, Thermal Conductivity Units (TCU), or other equipment for the detection and estimation of the concentrations of fumigants is recommended to prevent excess exposure.

METHYL BROMIDE

CHARACTERISTICS:

- Odorless at fumigating concentrations
- Turns to a gas at 38.5°F
- Heavier than air
- Non flammable
- Comes in liquid form, is pressurized in steel cylinders, and in 1.5 lb. cans

DISADVANTAGES

- Causes off odors in materials containing sulfur such as foam rubber, hides, etc.

HAZARDS

- Threshold value - 20 ppm 8 hours per day
- The following should be maximum lengths of single exposures repeated not more than once per week:

  7 hrs. at 100 ppm

  1 hr. at 200 ppm

  5 min. at 1,000 ppm
- Vapors are not injurious to the eyes
- Liquid methyl bromide, if allowed to contact skin, can cause burns and local dermititis
- Poisoning symptoms are delayed

PROTECTION

- Gas mask with black mine safety canister.

DETECTION

- Halide Detector
- Fumiscope

Methyl bromide is a colorless, odorless gas at room temperature, and is approximately 3.3 times as heavy as air. It is slightly soluble in water and nonflammable. In fact, it has been used as a fire extinguishing agent. Methyl bromide comes in pressurized cylinders (hence in liquid form) and when used in structural fumigation is usually dispensed through a heat exchanger. Its vapors can be detected with a halide gas detector, and concentration can be measured with a conventional thermal conductivity gas analyzer. It has been successfully used in structural, warehouse, and mill fumigations. Methyl bromide has good penetrating qualities and will kill insects in all stages, including adults, larvae, and eggs.

From a toxicological viewpoint, methyl bromide is highly toxic to man and animals. Because of it high toxicity, high volatility, and lack of warning properties such as odor and irritation, it is quite hazardous to handle. Handling and use,

therefore, must be carried out in such a way that exposure does not occur or is limited in intensity to levels known to be safe. The addition of chloropicrin as a warning agent is required by regulation in some usages and is prohibited in others, particularly if food is involved.

The following is a list of materials that should not normally be exposed to methyl bromide:

A. These products may produce malodors following exposure:

1. Foodstuffs
   (a) Iodized salt
   (b) Full-fat soya flour
   (c) Any kind of material that may contain reactive sulfur compounds, such as some soap powders, some baking sodas, and some salt blocks used for cattle licks
2. Certain rubber goods
   (a) Sponge rubber
   (b) Foam rubber, as in rug padding, pillows, cushions, and mattresses
   (c) Rubber stamps and other similar forms of reclaimed rubber
3. Furs, horsehair, and pillows (especially feather pillows)
4. Leather goods - particularly white kid or any other leather goods tanned with sulfur processes
5. Woolens - extreme caution should be used in the fumigation of any angora woolens, and some adverse effect has been noted on the fumigation of woolen suits, coats, blankets, hand-knit woolen socks, sweaters, shawls, and woolen yarn
6. Viscose rayons - those rayons processed or manufactured by a process in which carbon bisulphide is used
7. Paper
   (a) Silver-polishing papers
   (b) Certain writing papers cured by sulphide processes

8. Photographic chemicals (this does not mean camera or film but photographic chemicals used in dark rooms)
9. Rug padding
10. Cinder blocks
11. Mixed concrete, which occasionally picks up odors
12. Any materials that may contain reactive sulfur compounds

B. These products may hinder effectiveness of the fumigant:
   1. Charcoal materials - charcoal absorbs the methyl bromide. As a result, not only is the charcoal contaminated but the gas concentration is reduced to a point where an adequate fumigation job might not be obtained

C. These products may be physically injured:
   1. Seeds to be used for planting
   2. Bulbs to be used for planting
   3. Pets, fish, and birds
   4. Living plants or nursery stock
   5. Fresh fruit and vegetables

SULFURYL FLUORIDE

CHARACTERISTICS:

- Odorless
- Turns to a gas at well below $0^{o}F$
- Heavier than air
- Non flammable
- Comes as liquid in pressurized steel cylinders

DISADVANTAGES:

- Eggs of many insects are resistant to the gas

HAZARDS:

- Threshold value - 5 ppm 8 hrs. per day

- The following should be maximum lengths of single exposures repeated not more than once per week:
  - 7 hrs. at 200 ppm
  - 1 hr. at 400 ppm
  - 5 min. at 2,000 ppm

PROTECTION:

- Gas mask with white mine safety canister

DETECTION:

- Fumiscope

Vikane (Sulfuryl Fluoride) fumigant is a compressed gas with a wide range of biological activity. It is practically insoluble in water, stable to heat, and nonflammable in atmospheric concentrations. It possesses remarkable penetrating powers and has a boiling point lower than any other fumigant. Due to its high vapor pressure, it diffuses rapidly. It requires no special equipment for dispensing, is relatively unreactive to household effects, and, to date, has shown no odors or staining when used under normal conditions.

Its presence is detected with the Davis Detector. Thermal conductivity units are used to measure concentration. Manufacturers provide instrumentation to calculate tailored dosages.

The high volatility of Vikane precludes adverse effects upon the skin except for possible "frostbite" should a container be discharged directly on the person. Because of its high vapor toxicity, high volatility, and lack of warning properties, such as odor and irritation, handling and use must be carried out in such a way that exposure does not occur or is carefully limited to concentration known to be safe. The use of chloropicrin as a warning agent prior to fumigation is generally recommended in all fumigations with sulfuryl fluoride and is required by regulation in many areas. Since sulfuryl fluoride

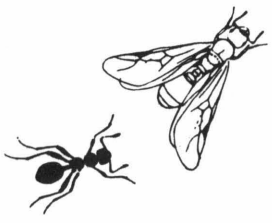
has a very rapid diffusion rate, aeration of structures is rapid and the hazard to occupants after appropriate aeration is nil.

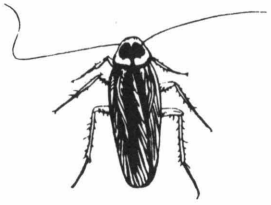
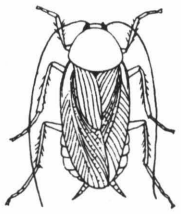
Following is a list of items to be removed before fumigation with Vikane:

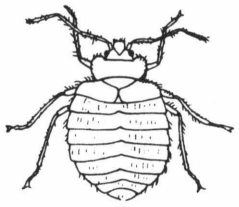
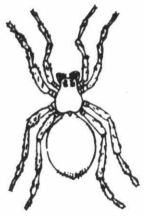
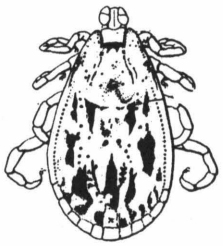
1. People
2. Plants
3. Pets
4. Food and medicinals not sealed can be removed or placed in polyethylene bags and closed with tape

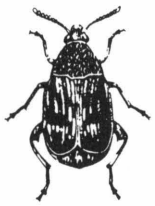
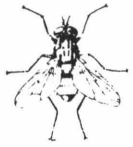
APPLICATION TECHNIQUES

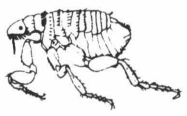
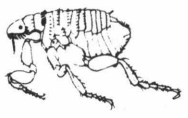
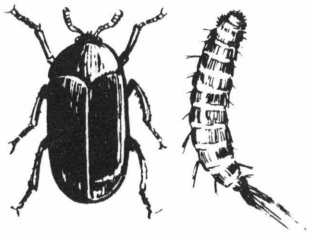
The equipment and methods for applying pesticides change constantly. New methods, equipment, and materials are available every year. Consequently, it is not practical to recommend specific kinds of equipment. But, because the habits and behavior patterns of the pests remain the same, certain methods and techniques of pest control can be suggested.

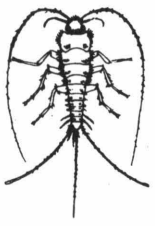
Pest	Application Technique
Ants - Inside 	Manual spraying to interrupt trails. Brush application. Manual dusting.
Ants - Outside 	Power spraying - yard and crawl space. Power dusting can be used in crawl space and attics. Thoroughly soak nest of mound building species. Prepared baits can be used.

Pest	Application Technique
Cockroaches - Food Areas 	Crack and Crevice Specially equipped plastic tubes at nozzle end of aerosol crack and crevice applicators are preferred. Keep the tip moving approximately 1 foot per second. Do not allow solution to remain on surface surrounding the crack. If dust is used, be sure that all dust is brushed into cracks and crevices.
Cockroaches - Non-food Areas 	Manual spraying with fine mist nozzle for residual treatment. Pinpoint nozzle for nesting places. It may be necessary to power spray or power dust for Oriental and American cockroaches because they often infest crawl spaces and basements. It is important that the proper distance from nozzle to surface be maintained to prevent excessive fallout. Also, the speed that the nozzle moves is important in order to ensure proper amount of solution being applied in the right place.

Pest	Application Technique
Bed Bugs 	Manual spraying with fine fan spray for mattresses and pinpoint spray for cracks, moldings, bed springs, and other hiding places.
Spiders 	Doors, thresholds, window sills, and other entries can be sprayed manually with residual pesticide. Power spraying with wettable powders or emulsions in yards.
Ticks 	Power spraying or power dusting with residual insecticide in yards, crawl spaces, and dog runs. Manual spraying with close attention to baseboards, window casings, and under rugs. Sometimes necessary to treat upholstered furniture with fine spray.

Pest	Application Technique
Stored Food Pests BEAN WEEVIL 	Manual spraying with residual insecticide in cabinets and shelves. Fine pinpoint spray in cracks. Clean up after drying or put shelf paper down before replacing utensils. Fogging or U.L.V. can be used in storage areas or warehouses. If food is present, use contact insecticides only, avoid contamination.
Flies 	Space fogging with knock-down spray will help in diminishing the adult population, but does not figure as effective measure of control. Power spraying of harborages will prevent breeding to some extent. Fly strips can be used in patios or Bar-B-Que areas. Larvacides applied to infested areas around dairies, chickens, or horses. Sanitation is the key to fly control.

Pest	Application Technique
Fleas - Inside 	Manual spraying with fine spray around walls, rugs, and upholstered furniture. Hand-held misting machines can be used but need only be directed downward. Fleas are seldom found higher than 3 feet in living quarters.
Fleas - Outside 	Power spraying in yards and dog runs. Power spraying or power dusting in crawl spaces.
Bees, Wasps, Hornets, and Yellow Jackets 	Blowing of dust with either a good hand-cranked duster or power duster directly into nest. Some baits are effective against yellow jackets.
Clothes Moths, Carpet Beetles, and Carpet Moths 	Manual spraying with coarse, wet spray pattern. Residual pesticides with oil or water emulsions can be used. Do not soak rugs with oil-based sprays. Sufficient pressure and volume must be used to drive solution into fiber of rugs and upholstery to reach infestation. Pay special attention to areas next to walls.

Pest	Application Technique
Sow Bugs, Pill Bugs, Springtails, Earwigs, Crickets, Millipedes, and Centipedes	Power spraying of all harborages with low pressure, high volume.
Silverfish 	Manual spraying with pinpoint pattern applied to cracks, behind drawers, and molding with residual insecticide. Power dusting of attics may be necessary.
Clover Mites 	Power spray a band around the exterior of house extending into the yard at least 10 feet and up the walls to window height. Manual spray inside, around edges of windows and doors.
Snails and Slugs	Baits scattered on moist ground. Remove dead snails and repeat baiting until control is established.

PICTORIAL KEY TO SOME COMMON ADULT COCKROACHES

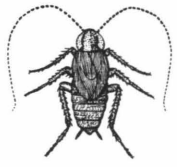
SMALL, ABOUT 5/8" OR SHORTER

PRONOTUM WITH 2 LONGITUDINAL BLACK BARS

GERMAN COCKROACH
(Blattella germanica)

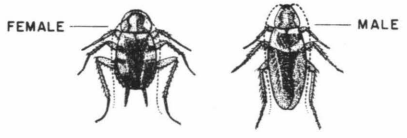
PRONOTUM WITHOUT LONGITUDINAL BLACK BARS

WINGS COVERING ABOUT HALF OF ABDOMEN PRONOTUM ABOUT 1/4 INCH WIDE



WOOD ROACH
(Parcoblatta spp.)

WINGS COVERING NEARLY ALL OF ABDOMEN OR EXTENDING BEYOND. PRONOTUM NARROWER



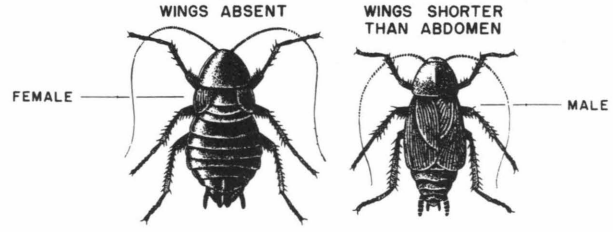
BROWN-BANDED COCKROACH
(Supella supellectilium)

MEDIUM TO LARGE, LONGER THAN 5/8 INCH

WINGS ABSENT, OR SHORTER THAN ABDOMEN

WINGS ABSENT

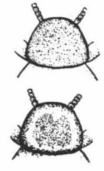
WINGS SHORTER THAN ABDOMEN



ORIENTAL COCKROACH
(Blatta orientalis)

WINGS COVERING ABDOMEN, OFTEN EXTENDING BEYOND

PRONOTUM MORE THAN 1/4 INCH WIDE

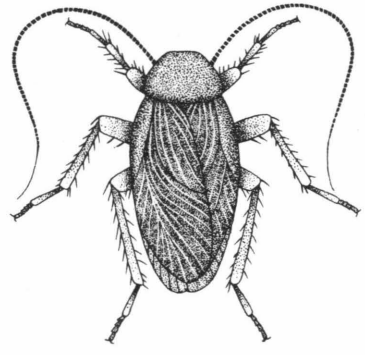


PRONOTUM ABOUT 1/4 INCH WIDE WITH PALE BORDER

WOOD ROACH
(Parcoblatta spp.)

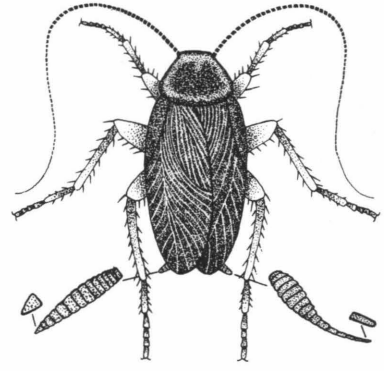
FRONT WING WITHOUT PALE STREAK. PRONOTUM SOLID COLOR, OR WITH PALE DESIGN ONLY MODERATELY CONSPICUOUS

PRONOTUM SOLID DARK COLOR. GENERAL COLOR VERY DARK BROWN TO BLACK.



SMOKY BROWN COCKROACH
(Periplaneta fuliginosa)

PRONOTUM USUALLY WITH SOME PALE AREA. GENERAL COLOR SELDOM DARKER THAN REDDISH CHESTNUT



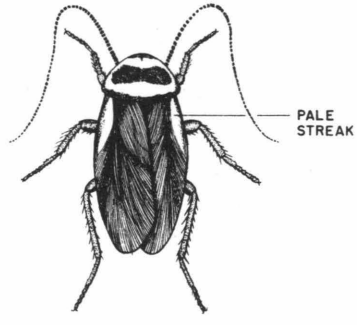
LAST SEGMENT OF CERCUS NOT TWICE AS LONG AS WIDE

BROWN COCKROACH
(Periplaneta brunnea)

LAST SEGMENT OF CERCUS TWICE AS LONG AS WIDE

AMERICAN COCKROACH
(Periplaneta americana)

FRONT WING WITH OUTER PALE STREAK AT BASE. PRONOTUM STRIKINGLY MARKED



AUSTRALIAN COCKROACH
(Periplaneta australasiae)

PREPARED BY
H.D. PRATT
DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
COMMUNICABLE DISEASE CENTER
ATLANTA, GEORGIA
OCTOBER, 1953

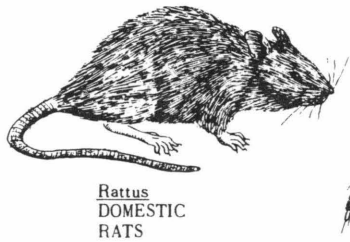
0 1/2 1
SCALE IN INCHES

DHEW-ATLANTA, GA.

RODENTS: PICTORIAL KEY TO SOME COMMON UNITED STATES GENERA

Harold George Scott and Margery R. Borom

tail almost naked, scaly
large (9-17"long) — small (5-7"long)

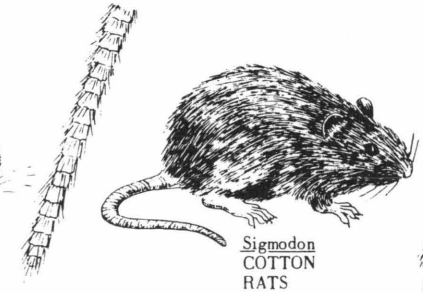


Rattus
DOMESTIC
RATS

Mus
HOUSE
MICE

tail almost naked, annulate
tail long — tail short

Oryzomys
RICE
RATS



Sigmodon
COTTON
RATS

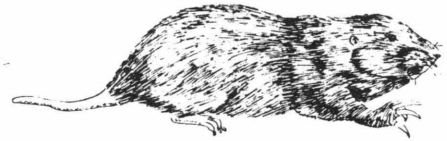
tail hairy
hair short — hair long

tail bones longer than 1/2 body
large (about 16"long) — small (7-9"long)

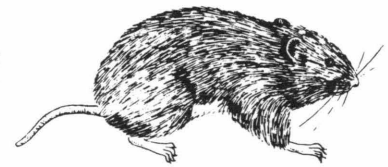
tail bones shorter than 1/2 body
front feet enlarged — front feet not enlarged

Neotoma
WOOD
RATS

Peromyscus
WHITE-FOOTED
MICE



Geomys-East
Thomomys-West
POCKET GOPHERS

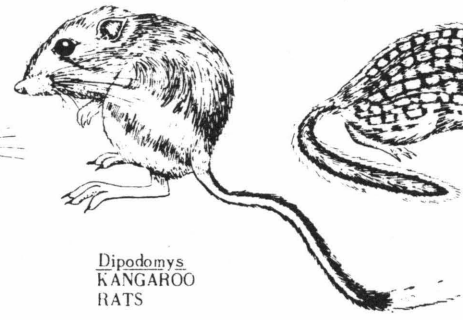


Microtus
MEADOW
MICE

tail bones longer than body
tail bushy — tail not bushy

tail bones shorter than body
large (about 15"long) — small (about 9" long) — very large (about 26"long)

Sciurus
TREE
SQUIRRELS



Dipodomys
KANGAROO
RATS

Citellus
GROUND
SQUIRRELS

Tamias-East
Eutamias-West
CHIPMUNKS

Marmota
WOODCHUCKS

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, Communicable Disease Center, Training Branch, Atlanta, Georgia – 1962

BASICS OF INSECTICIDES, RODENTICIDES, AND AVICIDES

Pesticide applicators conducting health, industrial, and institutional, structural, and health-related pest control should have a basic understanding of the commonly used pesticides. The paragraphs that follow will present information on: 1) chemical structure; 2) common commercial products; 3) toxicology; and 4) frequent symptoms of poisoning.

Insecticides

A large number of the pesticides used today are for the control of insects. Most of the insecticides produced are "contact poisons"; that is, they must actually come in contact with the insect to exert their toxic action. The toxic action most important for insecticides is acute toxicity. Insecticides that kill insects rapidly display the property of chronic toxicity.

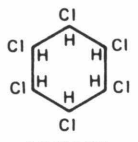
Insecticides are often classified into groups according to their chemical structure. The groups of insecticides important to most commercial pesticide applicators include:

1. ORGANOCHLORINE PESTICIDES
2. ORGANOPHOSPHATE PESTICIDES
3. CARBAMATE PESTICIDES
4. PENTACHLOROPHENOL
5. BOTANICAL PESTICIDES
6. BIOLOGICAL PESTICIDES
7. FUMIGANTS

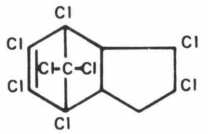
In some cases, the chemical structures of pesticides in the groups will be presented. These structures will help show similarity between different compounds; it is not necessary for the reader to commit them to memory.

ORGANOCHLORINE PESTICIDES

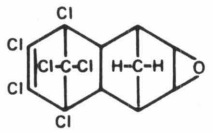
CHEMICAL STRUCTURE



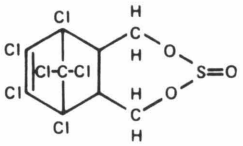
LINDANE



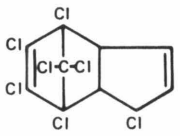
CHLORDANE



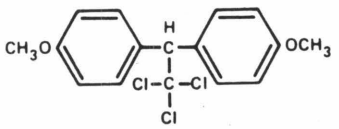
DIELDRIN



ENDOSULFAN



HEPTACHLOR



METHOXYCHLOR

COMMON COMMERCIAL PRODUCTS

Highly toxic: endrin (Hexadrin), a stereoisomer of dieldrin. Moderately toxic: aldrin (Aldrite, Drinox), lindane (Isotox, Gammexane), chlordane (Chlordan).

TOXICOLOGY

In adequate dosage, these chemicals interfere with axonic transmission of nerve impulses and, therefore, disrupt the function of the nervous system, principally that of the brain. This results in behavior changes, sensory and equilibrium disturbances, involuntary muscle activity, and depression of vital centers, particularly that controlling respiration.

SYMPTOMS OF HUMAN POISONING

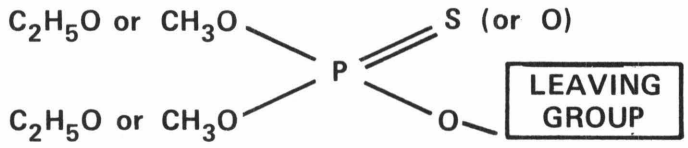
APPREHENSION, excitability, dizziness, HEADACHE, DISORIENTATION, weakness, PARESTHESIAE, muscle twitching, tremor, tonic and clonic CONVULSIONS (often epileptiform), coma. Soon after ingestion, nausea and vomiting are prominent. When chemicals are absorbed by parenteral routes, apprehension, twitching, tremors, and convulsions may be the first symptoms. Respiratory depression is caused by the pesticide and by the petroleum solvents in which these pesticides are usually dissolved.

REMARKS

Chemically, organochlorine pesticides are very stable compounds. They persist in the environment and are sometimes considered pollutants. Organochlorine compounds have a long residual activity and are broad-spectrum insecticides--they kill many types of insects.

ORGANOPHOSPHATE PESTICIDES

GENERAL CHEMICAL STRUCTURE



COMMON COMMERCIAL PRODUCTS

Highly toxic: TEPP, phorate (Thimet), mevinphos (Phosdrin), and ethyl parathion (Parathion, Thiophos).

Moderately toxic: dichlorvos (DDVP, Vapona), chlorpyrifos (Dursban), diazinon (Spectracide), trichlorfon (Dylor, Dipterex, Neguvon), and malathion (Cythion).

TOXICOLOGY

Toxicants of this group phosphorylate almost irreversibly varying amounts of the acetycholinesterase enzyme of tissues, allowing accumulation of acetylchloline at cholinergic neuro-effector junctions (muscarinic effects), and at skeletal muscle myoneural junctions and in autonomic ganglia (nicotinic effects). Poison also impairs central nervous system function. Toxicants can be absorbed by inhalation, ingestion, and skin penetration.

SYMPTONS OF HUMAN POISONING

Symptoms of acute poisoning develop during exposure or within 12 hours after contact. HEADACHE, DIZZINESS, EXTREME WEAKNESS, ATAXIA, TINY PUPILS, blurred or dark vision, muscle TWITCHING, TREMOR, sometimes convulsions, mental confusion, incontinence, unconsciousness, NAUSEA, vomiting, abdominal cramps, diarrhea. Tightness of chest, SLOW HEARTBEAT, wheezing, productive cough, sometimes PULMONARY EDEMA (up to 12 hours after poisoning). SWEATING, rhinorrhea, tearing, salivation. Severe poisoning may cause sudden unconsciousness or TOXIC PSYCHOSIS resembling acute alcoholism.

REMARKS

This is a very large group of poisons. A conservative estimate is that at least 100 organic phosphate insecticides have reached the commercial market. Some examples include diazinon, malathion, parathion, and methyl parathion.

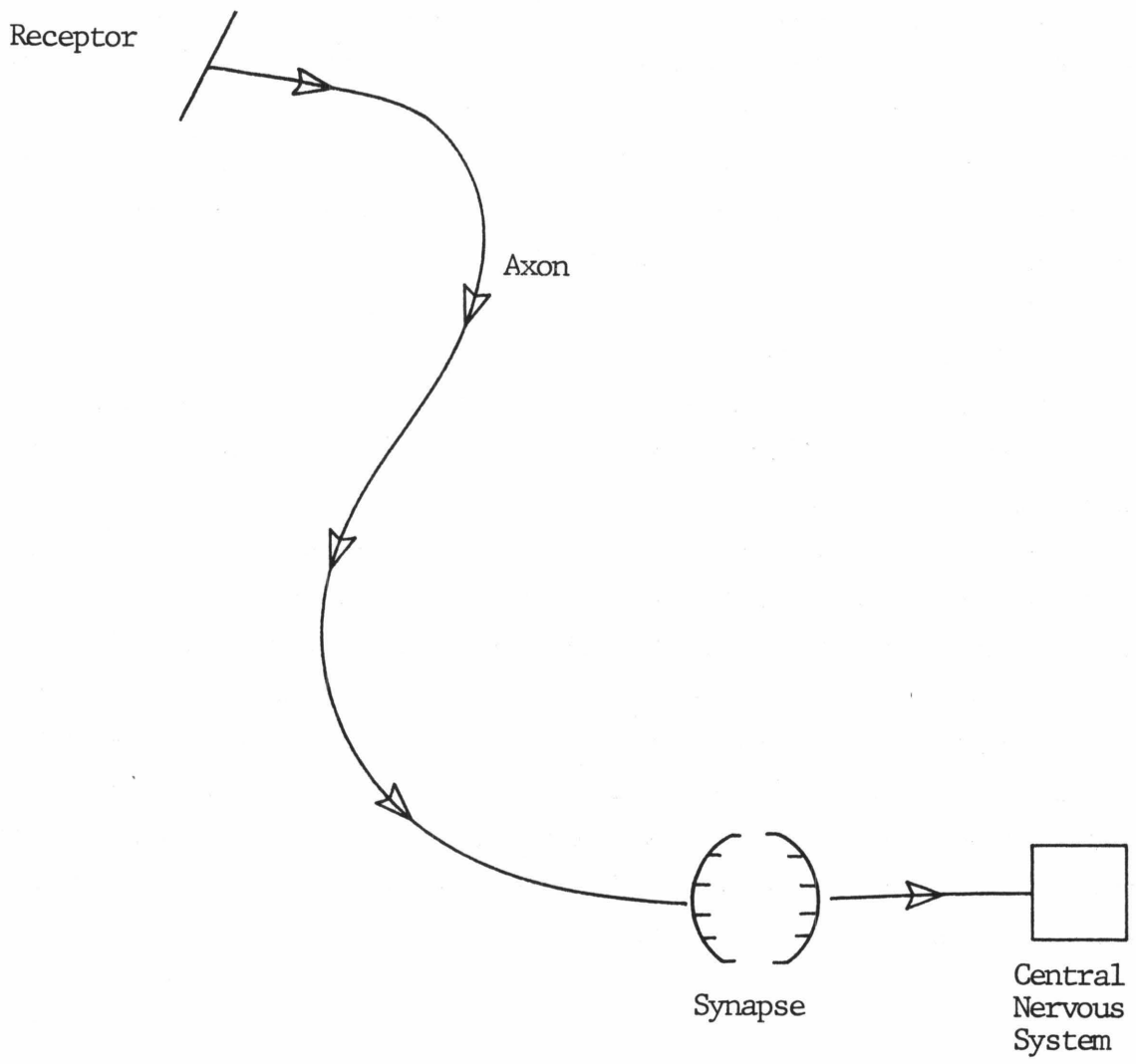
The chemicals in this group have several properties which we need to know something about. An important property is that they are easily broken down under alkaline conditions. This means that they are not particularly stable chemicals and are often short-lived as insecticides. They do not persist in the environment and, from a practical point of view, they often have to be applied repeatedly to bring about insect control.

Organic phosphate insecticides have a wide variability in their toxicity to mammals. Malathion, for example, is quite safe for use around mammals while others, such as parathion and methyl parathion, are very toxic to mammals. The organic phosphate chemicals are only slightly soluble in water, but are completely soluble in organic solvents. They are used for a variety of purposes including insecticides, acaracides, plant systemics, and others.

The mode of action of the organic phosphates is fairly well understood. These chemicals act upon the insect's nervous system to cause death.

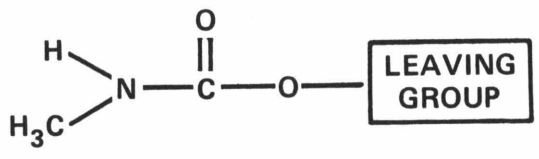
The nervous system works much like an electric light and an on/off switch. When you flip the switch on, the electricity travels rapidly to the light bulb and it lights. Similarly, when an insect is touched or stimulated in some way, the message is received at the receptor and travels along the nerve wires (axon) to the central nervous system (CNS). Before the message reaches the CNS, it must pass over a break in the axon. This break is called a synapse. The message is carried across the synapse by the help of a chemical called acetycholine. This

chemical is produced for a very short time -- just long enough to transfer the message from one side to the other. After this, another chemical is produced to break down acetycholine so the axon is ready for another message. When an organic phosphate insecticide is introduced into this nervous system, the effect is to prevent the production of the chemical that breaks down acetycholine. Under these conditions, the chemical acetycholine accumulates at the synapse. It is toxic to the synapse. The insect nervous system is damaged and is not capable of carrying out its normal function. As a result of this, the insect dies.



CARBAMATE PESTICIDES

GENERAL CHEMICAL STRUCTURE



COMMON COMMERCIAL PRODUCTS

Highly toxic: aldicarb (Temik), carbofuran (Furadan).

Moderately toxic: propoxur (Baygon), carbaryl (Sevin).

Some chemicals of this class are "systemic," i.e., they are taken up by the plant and translocated into foliage and sometimes into the fruit.

TOXICOLOGY

Toxicants of this group cause reversible carbamylation of the acetylcholinesterase enzyme of tissues, allowing accumulation of the acetylcholine at cholinergic neuroeffector junctions (muscarinic effects), and at skeletal muscle myoneural junctions and autonomic ganglia (nicotine effects). Poisons also impairs central nervous system function.

A few of the carbamate insecticides are formulated in methyl (wood) alcohol. In cases of ingestion of these formulations, the toxicology of the methanol must be taken fully into consideration: severe gastroenteric irritation, acidosis, and central nervous system injury.

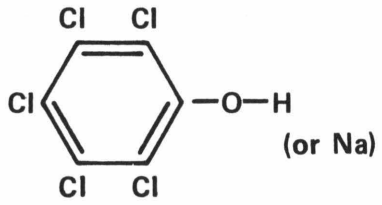
SYMPTOMS OF HUMAN POISONING

Symptoms of acute poisoning develop during exposure or within 12 hours after contact. HEADACHE, DIZZINESS, WEAKNESS, ATAXIA, TINY PUPILS, blurred or "dark" vision, muscle TWITCHING, TREMOR, sometimes convulsions, mental confusion, incontinence, unconsciousness. NAUSEA, vomiting, abdominal cramps, diarrhea.

Tightness in chest, SLOW HEARTBEAT, wheezing, productive cough, occasionally pulmonary edema. Sweating, rhinorrhea, tearing, SALIVATION. Severe poisoning may cause sudden unconsciousness, or a toxic psychosis. RESPIRATION DEPRESSION may result from actions of the toxicant and solvent.

PENTACHLOROPHENOL

CHEMICAL STRUCTURE



COMMON COMMERCIAL PRODUCTS

PCP, Dowicide-7 Penchlorol, Pentacon, Penwar, Weedone, Veg-I-Kill, Wood Preserver, Wood Tox 140, Purina Insect Oil Concentrate, Gordon Termi Tox, Usol Cabin Oil, Certified Kiltrol-74 Weed Killer, Ciba-Geigy Ontrack OS 3, 4, or 5, Ortho Triox Liquid Vegetation Killer, Black Leaf Grass, Weed and Vegetation Killer Spray.

Pentachlorophenol has many uses as a weed killer, defoliant, wood preservative, germicide, fungicide, and mulluscicide. It is an ingredient of many other formulated mixtures sold for one or more of these purposes.

TOXICOLOGY

Pentachlorophenol irritates the skin, eyes, and upper respiratory mucous membranes. It is efficiently absorbed through the skin, the lungs, and the gastrointestinal lining. It stimulates oxidative metabolism of tissue cells by uncoupling oxidative processes from the normal stepwise phosphorylation reactions. In common with other phenols, it is toxic to the liver, kidney, and central nervous system.

The majority of severe poisonings have occurred in workers exposed when in hot environments.

SYMPTOMS OF HUMAN POISONING

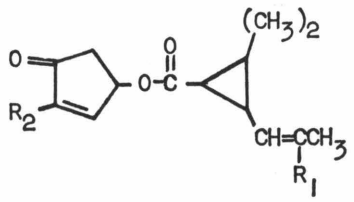
IRRITATION of nose, throat, eyes, and skin is the most common symptom of exposure to PCP. Severe or protracted

exposure may result in a CONTACT DERMATITIS. Intensive occupational exposure has resulted in chloracne.

PROFUSE SWEATING, HEADACHE, WEAKNESS, AND NAUSEA are the most consistent symptoms of systemic poisoning by absorbed PCP. FEVER is usually present but may be minimal or absent.

BOTANICAL PESTICIDES

CHEMICAL STRUCTURE



Pyrethrin I: $C_{21}H_{28}O_3$
$R_1 = -CH_3$
$R_2 = -CH_2CH{=}CHCH{=}CH_2$

Pyrethrin II: $C_{22}H_{28}O_5$
$R_1 = -C(=O)-OCH_3$
$R_2 = -CH_2CH{=}CHCH{=}CH_2$

Cinerin I: $C_{20}H_{28}O_3$
$R_1 = -CH_3$
$R_2 = -CH_2CH{=}CHCH_3$

Cinerin II: $C_{21}H_{28}O_5$
$R_1 = -C(=O)-OCH_3$
$R_2 = -CH_2CH{=}CHCH_3$

COMMON COMMERCIAL PRODUCTS

The natural pyrethrins which include Pyrethrins I and II, Cinerins I and II, and Jasmolins I and II.

Synthetic pyrethrin-line (pyrethroid) compounds that duplicate the activity of natural pyrethrin compounds include allethrin, barthrin, cyclethrin, dimethrin, furethrin, Neopynamin, phytholthrin, resmethrin.

TOXICOLOGY

Pyrethrum and allethrin may be absorbed through the gastro-intestinal and respiratory organs. They are not absorbed to a significant degree through the skin; however, allergic reactions may result from dermal exposure.

The nervous systems produced by pyrethrum and allethrin poisoning resemble those of veratrin intoxication, proceeding from excitation to convulsions to tetanic paralysis, except the pyrethrins cause muscular fibrillation as well. Death is due to respiratory failure. If recovery occurs, it is usually complete. Injury to man from pyrethrum has most frequently resulted from the allergenic properties of the material rather than its direct toxicity.

Under practical conditions, pyrethrum and allethrin are probably the least toxic to mammals of all the insecticides currently in use.

SYMPTOMS OF POISONING

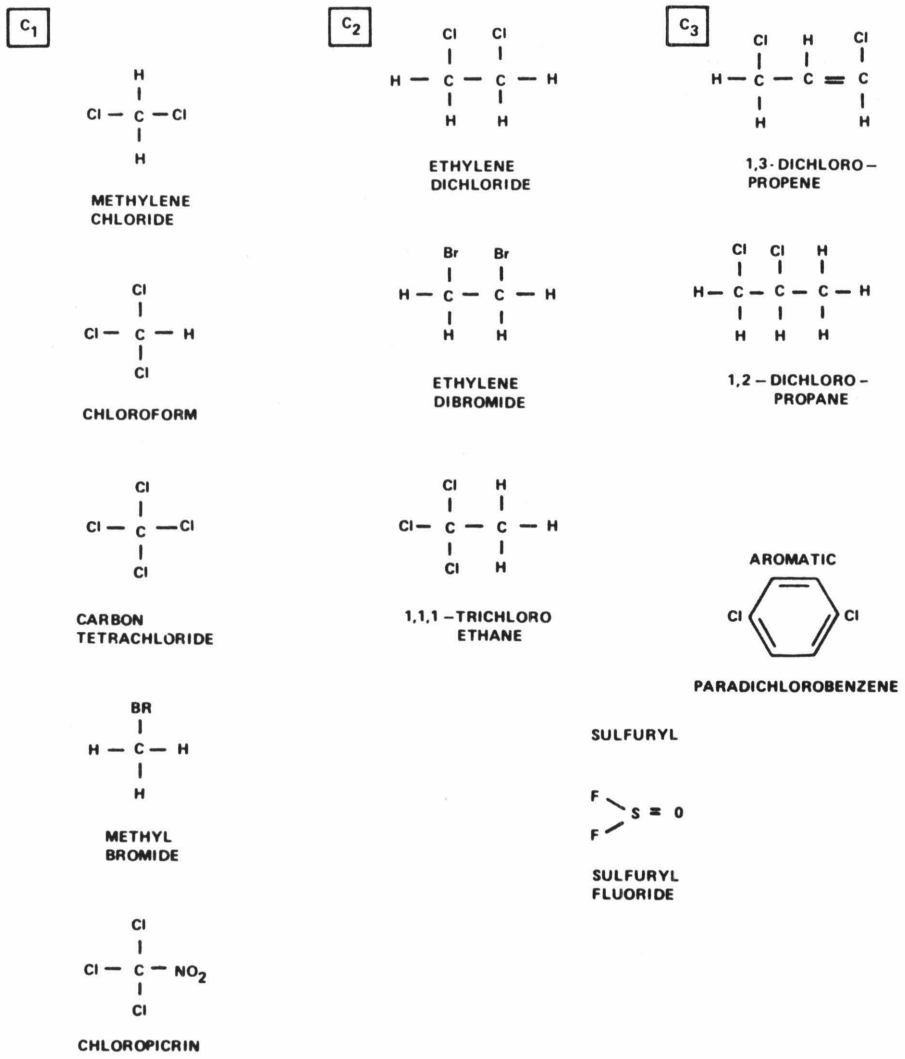
Pyrethrum toxicity may manifest itself in several forms in man. Contact dermatitis is by far the most common. The usual picture is a mild erythematous, vesicular dermatitis with papules in moist areas, and intense pruritus. A bullous dermatitis may develop. Some individuals show manifestations of pyrethrum sensitivity similar to those seen in pollinosis, including sneezing, serious nasal discharge, and nasal stuffiness.

BIOLOGICAL PESTICIDES

The materials in this group are toxins of bacterial origin, most commonly from Bacillus thuringiensis. These materials are probably composed of proteins and must be eaten by the insect. They are often quite specific and work on only one species or one group of insects. Apparently, they have to be eaten in fairly large quantities in order to be effective. Their mode of action seems to be an interference with insect gut membrane. Once this has happended, a variety of secondary effects probably set-in which eventually cause the death of the insect. Use of this kind of an insecticide represents a form of biological control of insects. Because the pathogens or their toxins seem to be specific for insects, they probably do not constitute an environmental pollution hazard.

FUMIGANTS

CHEMICAL STRUCTURES



COMMON COMMERCIAL PRODUCTS

ALIPHATIC - Carbon tetrachloride, methyl bromide; Chloropicrin (Acquinite, Chlor-O-Pic, Pic-Clor, Picfume, Trichlor); ethylene dichloride (EDC); ethylene dibromide (EDB, Bromofume, Celmide, Dowfume W-85, Kip-Fume, Nephis, Pestmaster EDB-85, Soilbrom).

AROMATIC - Paradichlorobenzene (PDB, Paracide, Paradow)

SULFURYL - Sulfuryl fluoride (Vikane)

TOXICOLOGY

Except for the solid paradichlorobenzene moth chrystals, these chemicals are gases or highly volatile liquids at room temperature. As fumigants, they have a remarkable capacity for penetration. Some, especially the bromine compounds, pass readily through human skin and rubber protective gear, thus complicating the protection of exposed workers. In varying degrees, they irritate the skin, eyes, and respiratory tract. When held on the skin by an occluding cover, such as contaminated gloves, these chemicals not only irritate, but cause acute dermatitis and vesiculation. Repeated contact with the liquid halocarbons defats the skin, leading to chronic dermatitis. All are capable of producing pulmonary edema and/or hemorrhage in persons heavily exposed by inhalation, ingestion, or dermal absorption. Death following exposure to the halocarbon fumigants is usually due either to pulmonary edema or to respiratory depression.

Inhalation of pyrolysis products of these fumigants has caused massive necrosis of respiratory tract linings in exposed firemen.

Toxic action on the central nervous system is generally depressant, causing unconsciousness, seizures, and general muscle weakness, including weakened respiratory effort. The neurotoxic action of methyl bromide apparently include the basal ganglia as well as the cerebrum, causing not only sensory and motor impairments but also behavioral and emotional disturbances. These may or may not progress to epileptiform seizures and coma. In some cases, behavioral and neurologic manifestations have first appeared several hours or even days after exposure, then they have persisted for days to months.

The chlorocarbons, notably chloroform, increase myocardial irritability and impair contractile strength. Large inhalation dosages may cause death by inducing ventricular fibrillation.

In varying degrees, these fumigants damage the liver and kidneys. In laboratory animals, and in autopsy specimens from fatal human cases, this is commonly manifest as fatty degeneration. More severe poisoning causes centrilobular necrosis of the liver and acute tubular necrosis of the kidney. Fatty degeneration of the myocardium and corneal opacities have been observed in dogs following systemic absorption of ethylene dichloride.

Methyl bromide and ethylene dichloride (and possibly other chemicals of this series, by analogy) are alkylating agents in mammalian tissues; they can inhibit multiple enzyme systems, including the sulfhydryl enzymes and hexokinases in multiple tissues. This may be a major mechanism of toxicity of this series of chemicals.

Paradichlorobenzene is substantially less toxic to humans than are the gaseous and liquid fumigants. It has neither the hemolytic nor the cataractogenic properties of naphthalene fumigant, which it has largely displaced. Given at extreme dosage to laboratory animals, it causes liver injury and neurologic disturbances.

RODENTICIDES AND AVICIDES

Rat and bird control are important aspects of industrial, institutional, structural, and health-related pest control. There are a variety of factors that influence the effectiveness of rodenticides and avicides. Such factors include: 1) toxicity; 2) dosage levels; 3) acceptance and reacceptance; and 4) the development of tolerances. Odor and taste must be considered in some instances. Safety precautions are an essential part of any procedure. An understanding of the mode of action will enable you to use rodenticides and avicides more effectively and safely.

RODENTICIDES

Rodenticides are pesticides used to control rodents such as rats, mice, and squirrels. They are normally employed in solid baits, liquid forms, as dusts, or as volatile chemicals used as fumigants. The most effective rodenticides are those with a high toxicity and palatibility, and with one or more safety features. Rodenticides used in solid baits or liquid forms can be divided into two groups based on the mode of action: 1) the acute rodenticides; 2) the chronic rodenticides.

The acute rodenticides are those in which a lethal quantity of poison is ingested in a single dose with the food or drink of a rodent. They cause death by heart paralysis, gastrointestinal and liver damage, or by attacking the central nervous system. The target animal must consume a lethal dose before the onset of poisoning symptoms. A sub-lethal dose may produce side effects which will make the rodent "bait shy". Pre-baiting is recommended before applying acute rodenticides so the animal will be conditioned to the bait. The unpoisoned bait is first presented to the rodents until they freely feed regularly and then it is replaced by bait containing the poison.

Chronic rodenticides bring about death of an animal only after the poisoned bait or liquid has been consumed on a number

of occasions. Because the poison is consumed over a period of time, a low dosage is lethal. For example, a brown rat can survive a single 50 MG/KG dose, but succumbs to 5 consecutive doses of 1 MG/KG taken on successive days. The symptoms of poison are so delayed that the animal never learns to associate discomfort with the bait consumption, and continues to feed until a lethal dose has been ingested. The main components possessing chronic poisoning action are the anti-coagulants, which interrupt the systhesis of blood-clotting factors so the poisoned animals die from internal bleeding. Chronic rodenticides are relatively nontoxic to domestic animals and man; however, there is no such thing as a "safe rodenticide".

However toxic a chemical poison might be, it will not be lethal unless a rodent, of its own volition, consumes a lethal dose. Additives are sometimes included in the bait to improve performance. Attractants such as flavoring or oils are sometimes added to bait to make it more appealing by enhancing the taste or masking disagreeable odors. Anticoagulants may be made more lethal by adding potentiating agent that accentuate the action of the anticoagulants. Preservatives and binders are used in baits to keep them from deteriorating over time. To guard against accidental consumption of the poisoned bait by nontarget animals, safety additives may be incorporated. Since rodents are unable to vomit, it is often the practice to incorporate an emetic agent in the bait. The emetic agent will induce vomiting and provide a safety factor for the non-target animals.

Secondary poisoning to animals which feed on dead or dying rodents should be anticipated. The danger may be reduced by removing rodent carcasses whenever possible.

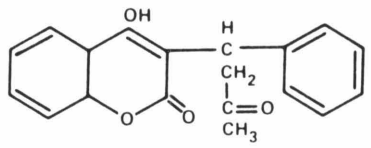
Acute or chronic poisons may be used in dust formulations. A poisoned dust is placed in the holes and burrows of rodents where it adheres to their feet and fur and is transferred to

the mouth during normal cleaning and grooming activities. This method requires a high concentration of poison since the animal can only be expected to consume small amounts. The advantage of contact dusts is that rodents do not suspect the source of illness.

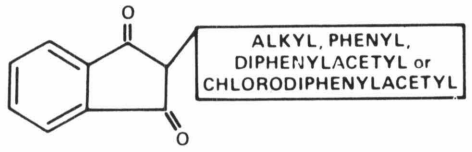
In situations where rodents do not respond to poisoned baits or dusts, a fumigation technique can be used. Rodents breathe the volatile substances and gases which cause death.

ANTICOAGULANT RODENTICIDES

STRUCTURES OF PRINCIPAL CLASSES



WARFARIN (COUMARIN-TYPE)



1,3-INDANDIONE TYPE

COMMON COMMERCIAL PRODUCTS

Coumarin type: warfarin (Kypfarin, Warf-42, D-Con, Warficide, Prolin), coumafuryl (Fumarin), Dethmor, Rax.

1,3-indandione type: diphacinone, or diphenadione (Ramik), chlorophacinone (Drat, Caid, Liphadione, Microzul, Ramucide, Rotomet, Raviac, Topitox), pindone (Pivalyn, Pivacin, Tri-ban, Pival), valone, (PMP).

TOXICOLOGY

Gastrointestinal absorption of these toxicants is efficient, beginning within minutes of ingestion and continuing 2-3 days. Apparently, warfarin can be absorbed through the skin, although the circumstances under which this has occurred are extraordinary.

Both types of anticoagulant depress and hepatic systhesis of substances essential to normal blood clotting.

Unlike the coumarin anticoagulants, the indandiones cause symptoms and signs of neurologic and cardiopulmonary injury in laboratory rats; these injuries often lead to death before hemorrhage occurs. These actions may account for the somewhat greater toxicity of this class of anticoagulants.

SYMPTOMS OF POISONING

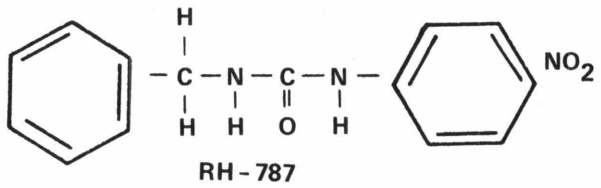
In most instances of accidental ingestion by man of anti-coagulant baits, victims have remained asymptomatic, due to the small dosage taken. Even in cases involving ingestion of sub-

stantial doses, hypoprothrombinemia occurs without symptoms of poisoning. Hemorrhage appears only when extraordinary amounts have been absorbed. In these cases, the anticoagulants were either taken deliberately, were absorbed over long periods out of neglect of elementary hygienic standards, or were injested by starving indigents who used quantities of rodent bait for food.

Victims of large doses exhibit HEMATURIA, NOSEBLEED, HETATOMATA, BLEEDING GUMS, AND MELENA. ABDOMINAL PAIN AND BACK PAIN PROBABLY REFLECT HEMORRHAGE IN THE ABDOMINAL AND RETROPERITONEAL TISSUES.

VACOR AND DLP-787

CHEMICAL STRUCTURE



RH-787

COMMON COMMERCIAL PRODUCTS

Vacor Rat Killer (2% RH-787 in vehicle resembling corn meal); DLP-787 Bait (2% RH-787 in vehicle resembling corn meal); DLP-787 House Mouse Tracking Powder (10% RH-787 in a light green powder vehicle). Compound RH-787 is the active ingredient of both formulations.

TOXICOLOGY

The exact mechanism of RH-787 toxicity is not know. It has no anticoagulant action, and is, therefore, entirely different from the coumarin or indandione rodenticides.

FREQUENT SYMPTOMS OF POISONING

Human poisonings of a significant nature have occurred only after deliberate ingestions of RH-787. Symptoms vary, depending on dose and individual susceptibility.

Symptoms may not appear until 4-48 hours after ingestion of the formulated rodenticide. EARLY symptoms include NAUSEA, VOMITING, ABDOMINAL CRAMPS, CHILLS, AND MENTAL CONFUSION.

AVICIDES

Avicides are pesticides used to control birds in pest situations. Some common avicides include compound DRC 1339 and avitrol. Most avicides are acute poisons which act on the central nervous system. The reaction time required to kill a bird varies with the type of poison. Strychnine used as an avicide will kill birds shortly after the bait is consumed while the avicide containing the compound DRC 1339 does not kill the birds for several hours, generally after they go to roost. This difference in mode of action is important in reducing the effects of secondary poisoning to animals that consume dead birds. Birds dying at the roost sites can be easily picked up and disposed of.

No avicide has been found that is specific for a given bird; thus, there is always a danger that non-target birds will be affected. A poison such as strychnine is lethal to all animals while DRC 1339 is more lethal to starlings and blackbirds, but will also kill smaller birds. Avitrol is an avicide which is used to control blackbirds. Birds ingesting avitrol react with distress symptoms and calls which frighten away the remainder of its flock from feeding area with a minimum of mortality. The advantage of avitrol is that only few birds need to ingest the bait, thus a relatively small amount of bait needs to be put out.

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THIRD CLASS — BULK RATE