

DDT ^{M. H. GOODWIN, JR.} for the control of MURINE TYPHUS FEVER



FEDERAL SECURITY AGENCY

U. S. PUBLIC HEALTH SERVICE

MALARIA CONTROL IN WAR AREAS

ATLANTA, GEORGIA

May 1946



CONTENTS

I	INTRODUCTION	1
II	THE DISEASE - MURINE TYPHUS FEVER .	5
III	TYPHUS CONTROL WITH DDT	7
	1. DDT	
	2. DDT Dust	
	3. Where and When to Dust	
	4. Equipment for Applying DDT Dust	
	5. Planning the Work Program	
IV	PUBLIC RELATIONS SUGGESTIONS . . .	23
V	PRECAUTIONS IN THE USE OF DDT . .	24
	1. Toxicity	
	2. Storage and Use Precautions	
	3. What to Do "In Case"	
VI	INSPECTION FOR EFFECTIVENESS OF CONTROL WORK	26
VII	RELATION OF DDT DUSTING PROGRAM TO OTHER TYPHUS CONTROL PROGRAMS . .	27

INTRODUCTION

Murine typhus fever is a disease transmitted by rat ectoparasites, principally the rat fleas. In spite of the measures that have been taken against this disease, it is now apparently on the increase.

There are four organisms concerned in murine typhus fever: the causative parasite, the flea, the rat, and man. Rats, fleas, and man are links in the chain of typhus transmission. To control the disease, the chain of transmission must be broken at one of these links, preferably at the weakest, most vulnerable spot.

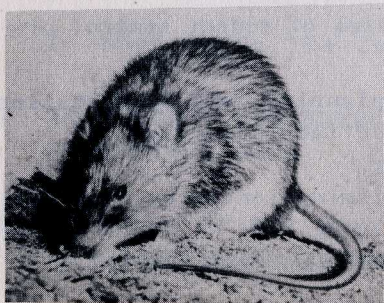
Until recently control of murine typhus fever in human beings has been aimed at the rat link only. There is much to be said in behalf of the rodent control method of combating the disease. Rat control is the most reliable method if it can be accomplished. Other rodent-borne diseases are controlled at the same time, and economic loss caused by rodent damage is reduced. The general sanitary benefits are obvious.

Conventional phases of rodent control programs are:

- (1) Promotion, planning, and organization
- (2) Initial reductional campaign
- (3) Rat-proofing
- (4) Harborage elimination through general sanitation
- (5) Control of residual rat population
- (6) Maintenance

The initial reductional control procedure is the extensive use of poison, distributed as quickly as possible. Rat-proofing or vent stoppage involves construction and repair work to buildings. Harborage elimination through general sanitation is self-explanatory. Residual rat population control utilizes gassing, trapping, and further poisoning in an effort to kill all of the remaining rat population. Rodent control measures must be maintained to prevent reinfestation.

Rodent control is a long-range activity requiring well-trained personnel. DDT residual dusting, which has come into general use recently, is aimed at the flea link of the typhus chain. Although this attack gives only temporary results, it is rapid, relatively inexpensive, and is effected quickly. Rat runs, debris piles, burrows, and other places of rat harborage and visitation are dusted with DDT powder. Premises treated are urban business establishments, selected urban residences, and, to some extent, rural premises. Only limited instruction is required for training dust-

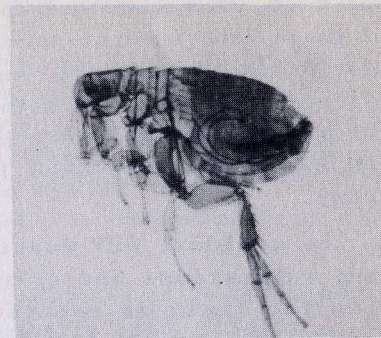


THE RAT

Reservoir
of Murine
Typhus Fever.

THE FLEA

A Vector of
Murine Typhus
Fever.



ing personnel. DDT dusting is not a substitute for rodent control; it is a supplement.

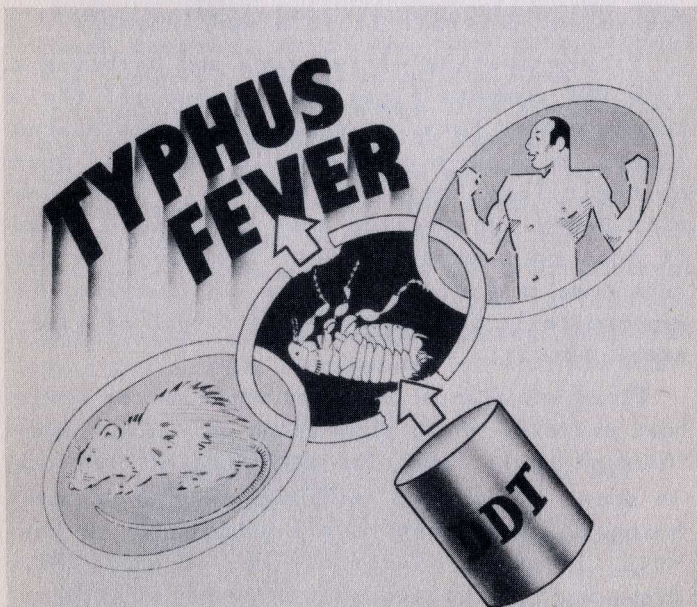
Proper dusting of rat runs and harborages with DDT combats fleas both on and off their rodent hosts. Rats, in passing over the dusted places, pick up a considerable amount of dust on their feet, bellies, and tails. Rat runs with heavy rat traffic have been wiped clean of dust on a single night. The fleas on the rats come in contact with the DDT dust and, if exposed to it for a sufficient length of time, are killed.

Fleas may also be attacked while not on their host animals, where they spend only about one-third of their time. The remainder of the time is spent in or near rat runs, nests, or harborages, where they have ready access to the rats. If these places are dusted with DDT, fleas will be killed when they hop off their rat hosts.

Experiments have been made to determine the most effective rate and methods of applying

DDT dust. This handbook discusses the results of these experiments, safety precautions, dosage, diluents, methods, equipment for the application of DDT, and methods of dealing with the public. The handbook supplements film strips and demonstrations used in training dusting crews.

The residual DDT dusting program is new. Many suggestions and criticisms should come from the field as experience and skill are gained. The handbook will be revised as new techniques are developed.



The Typhus Chain May Be Broken
By Controlling The Insect Vector.

THE DISEASE — MURINE TYPHUS FEVER

There are two principal types of typhus fever: (1) Louse-borne typhus, also referred to as epidemic or European typhus, and (2) murine typhus, which is frequently called endemic typhus, and sometimes mistakenly called Brill's disease. This handbook is concerned with the latter type.

Murine typhus is a disease of rodents, principally affecting domestic rats. Insofar as is known murine typhus fever has little effect on rats. It causes neither sickness nor death but does result in the production of antibodies which circulate in the blood stream. These can be detected by serologic tests. The disease is caused by *Rickettsia prowazeki*, a very small bacterium-like organism. *Rickettsiae* live and multiply within the cells which line the blood vessels and are found in all organs of the body.

Murine typhus fever is spread from rat to rat by fleas and, possibly, by other ectoparasites. The flea which has been definitely connected with the spread of this disease in the United States is *Xenopsylla cheopis*, the Oriental rat flea. The role of mites, lice, and other species of fleas is not definitely known, but there is evidence that most of them are capable of maintaining the disease in rats.

The exact mechanism of transmission is not fully understood. Murine typhus fever has been transmitted experimentally to rats and guinea pigs by the injection of crushed infected fleas

or of feces from infected fleas.

Fleas live on the blood of their hosts. They become infected with *Rickettsia prowazeki* when they feed on an animal having typhus fever. Gluttonous in its feeding habits, the flea often feeds when it still has ample food in its stomach; and the blood passes undigested through its short tubular digestive tract. When an infected flea feeds on an uninfected host (rat), it may transmit typhus fever to the new host by one of three means:

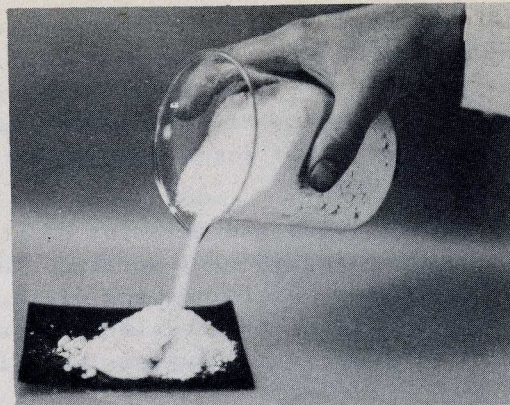
(1) through the bite

(2) by the undigested *Rickettsiae*-laden blood which passes through the flea's body and contaminates the bite wound

(3) or through the flea feces, which enter the bite wound or are rubbed into the broken skin of the new host.

It is also possible that rats become infected by inhaling or ingesting substances contaminated with flea feces or excreta from infected rats. Regardless of the mechanisms of transmission, the fact remains that fleas, and perhaps other ectoparasites, are vectors of typhus fever from rat to rat and from rat to man.

Murine typhus fever is not primarily a disease of man. Its transmission to man is accidental. Wherever the disease is prevalent in rats and the rat population is large, the natural consequences is a large number of infected fleas. The greater the number of infected fleas, the greater is the chance of man's being bitten and contracting the disease.



DDT — Dichloro-Diphenyl-Trichloroethane.

TYPHUS CONTROL WITH DDT

DDT. The chemical name of DDT is Dichloro-Diphenyl-Trichloroethane. The first letter in each of its parts gives the commonly used name, DDT. A slow but lasting poison, it is being widely used as an insecticide. DDT apparently does not repel insects. This is an advantage, since considerable exposure to DDT is often necessary to kill the insect.

DDT DUST. DDT dust is a whitish, practically odorless, flour-like substance which tends to lump. DDT is mixed with an inert dust when it is to be applied in small quantities. For residual dusting against rat fleas a commercial mixture of 10% DDT in pyrophyllite is used. Other diluents, such as Fuller's earth, calcium dusts, or walnut shell flour may be used. DDT in diluted dust form retains its killing effect against fleas for two or three months.

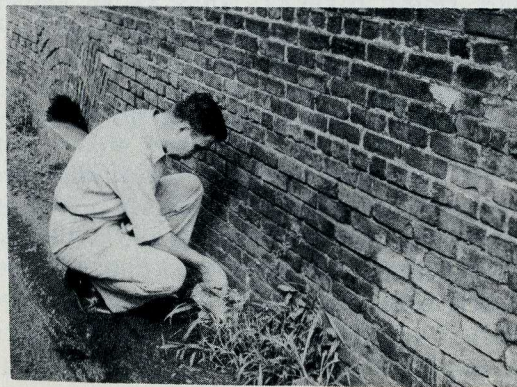
WHERE AND WHEN TO DUST. DDT dust should be distributed where rats and rat fleas will come in contact with the dust. Experience is essential in developing the skill required for the recognition of rat signs and places where rats nest and visit.

Both the exterior and interior of a premise or building should be inspected. The exterior inspection should be made first. This makes interior inspection easier because the places of rat egress and ingress are already known.

The exterior inspection should include examination of:

(a) **Foundations.** The foundations of buildings should be inspected for all openings. The ground in the vicinity of the foundation should be examined.

(b) **Vents.** Vents are frequently used by rats to enter buildings. Vents may be found in any



Inspection of Foundations.

part of the building from below the ground to the top of the roof. All should be checked for rat signs.

(c) **Doors.** Doors should be examined to see if rats can pass under them and to detect actual signs of rats, such as gnawing.



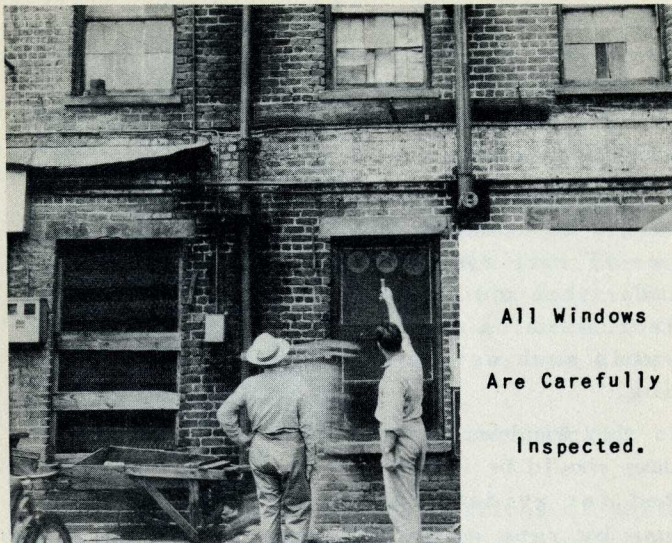
Rats Can Enter Through Doors.

(d) **Windows.** Windows should be inspected for evidence of use by rats as an entrance to the building. Windows at all levels should be examined.

(e) **Pipes and wires.** Pipes and wires on the walls of a building should be inspected for evidence of rats' climbing on them. Wires leading from main lines or from other buildings should be followed to the place where they enter the building to see if there are openings that would permit the entry of rats.

(f) **Underground pipes.** Pipes that go below the surface of the ground before they enter the building should be inspected for rat burrows.

(g) **Meter boxes.** Exterior meter boxes of all kinds should be located and examined for rat signs. The lids should be opened and the interior examined also.



All Windows
Are Carefully
Inspected.

(h) **Fire escapes.** Fire escapes should be followed to the roof. Windows and doors, as well as any cracks or holes in the building, should be examined.

(i) **Drainpipes.** Drainpipes from the interior of the building should be carefully examined for rat signs.

(j) **Shrubbery.** Trees, shrubs, and vines may overhang or lead to a window, thus providing rats an entry to the building.

(k) **Rubbish.** Rubbish and old piles of lumber, brick, etc., should be examined for rat harborage.

(l) **Garbage.** Garbage storage places should be carefully examined for rat signs, particularly if the garbage is stored in a shed or other enclosure.

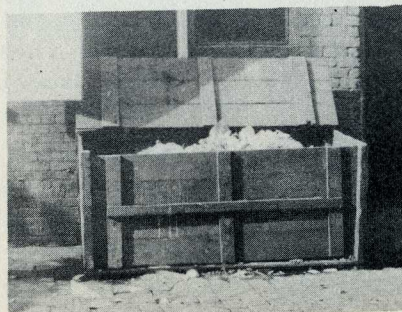
(m) **Sidewalks and curbs.** Vents or light wells and other openings leading from the sidewalk may be used by rats in entering a building. Rats may enter a building by burrowing under a sidewalk by way of a broken curb.

(n) **Roofs.** If wires and pipes lead to the roof before entering a building, the roof should be inspected for signs of rat entry.

The exterior inspection of a building is concerned primarily with the location of cracks, holes, and other openings that might allow rats to enter. The interior inspection involves the recognition of other rat signs, such as rat droppings, rat runs, tracks, gnawings, eating and drinking places, and nests and harborage. These signs must be demonstrated by experienced observers. After an observation period, the new worker will be able to recog-



Pipe Inspection.



Garbage and Waste
Containers
Often Show
Signs Of
Rat Infestation.

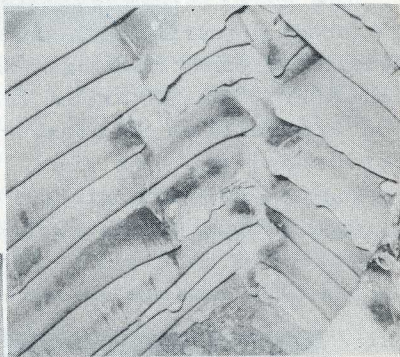
nize rat signs and know the most likely places to find them.

In the interior inspection the following places should be examined:

(a) **Basement.** The interior inspection should begin here. All openings into the basement should be examined closely for rat runs. Basement openings into adjoining buildings should receive special attention. The adjunct of the wall and basement floor should be followed around its entire length. An overhead inspection should be made to locate rat runs and to find places through which rats might go to the floor above. Rubbish piles, boxes, and mer-

RIGHT — Rat Signs:

Rat Runs,
Cuttings,
or Droppings.



**LEFT — Adjunct of
Basement Floor
and Wall
is Inspected.**



Stored Material is Examined.

chandise stored in the basement should be examined for harborages and nests.

(b) **Ground floor.** In buildings with no basement a detailed examination of the ground floor should be made. If the floor is constructed of wood, very thorough inspection will be necessary. Every portion of the floor must be inspected, especially the part adjoining the walls. It may be necessary to move furniture or stored stock to permit complete inspection. All shelves, closed closets, and small cabinets should be inspected. Kitchens and bathrooms, which are two of the most likely places to find rat signs, should be especially noted.

(c) **Upper floors.** The upper floors should receive the same careful attention as the lower floors. This is especially important if there are housekeeping rooms in the upper story or if it is used for storage.



Attics Are Inspected For Rat Signs.

(d) **Attics.** Attics should be inspected. Rats may live in the attic and have access to the lower floors by means of hollow walls. If the attic itself cannot be inspected, all openings into it should be examined carefully for any signs of rat travel.

(e) **Miscellaneous.** Search should be made for all places which might provide water for rats. Built-in ice boxes, elevator shafts, clothes chutes, etc., should not be overlooked.

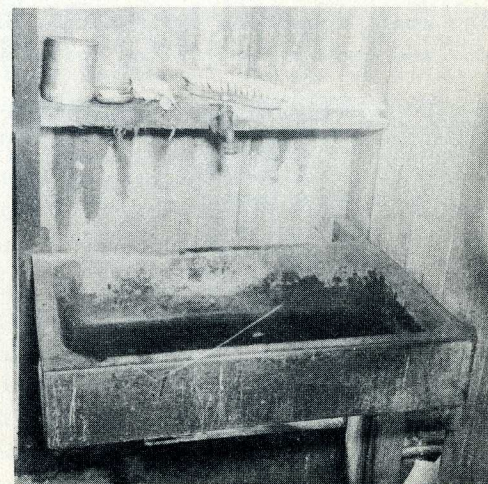
As a rule, inspection and dusting is carried on simultaneously. As the rat runs, harborage, and eating and drinking places are found, they are dusted. It is unnecessary to use large quantities of dust. Long rat runs may be dusted at intervals. The narrow confines and both ends of a rat run should always be treated. A light layer of the dust about four inches wide is sufficient. Small patches of dust are spread around food, water,

and harboring places. To expedite the dusting of overhead runs, every other rafter or beam space may be left undusted.

Household pets and chicken coops are dusted whenever possible. This is important because rat fleas are often found on cats and dogs and in chicken coops. Cat fleas, dog fleas, and chicken fleas are often found on rats. About three tablespoonfuls of 10% DDT is sufficient for dusting a dog. The dust should be rubbed thoroughly into the hair on the dog's stomach, legs, and back. One tablespoonful is sufficient to dust a cat. To avoid any possible harm to the animal, small kittens should be dusted only on the head and neck.

Treatment of premises and buildings should be repeated at intervals of two or three months throughout the flea breeding season.

Sources of
Water
Usually Show
Signs
If Rats
Are Present.



EQUIPMENT FOR APPLYING DDT DUST. —

(a) **Large hand shaker.** A large hand shaker which holds approximately five pounds of DDT dust has been developed for dusting exposed rat runs along the base of walls or foundations or near floor level. The shaker is rectangular, with a handle that can be attached to either the broad or the narrow side. It is made of heavy galvanized metal and is provided with a screen sifter and baffle at one end. The screen sifter is incorporated in a detachable lid, which is fastened to the body of the shaker with two bolts and wing nuts.

Dust is dispensed by shaking the duster while holding the screen sifter directly over the run or other place to be dusted.

(b) **Small hand shaker.** A one- to two-pound capacity shaker is used for dusting rat runs difficult to reach with the large hand shaker. The small shaker is cylindrical, with a cap at one end and a screen-fitted collar at the other.



Using the
Large
Hand Shaker.



Using the Small Hand Shaker.

This type of duster is of particular value in dusting rat runs and eating and drinking places located in narrow confines. When attached to a long handle or stick, it is exceptionally useful in applying dust to overhead beams and rafters.

The small hand shaker must be refilled frequently. A supply of dust should be carried in a convenient container.

If the shaker is fitted with a 16- to 20-mesh screen wire sieve, a baffle is not necessary to keep the dust from being dispensed in too great quantities. If coarser screen is used a baffle should be attached to the removable cap. If small perforations are made in the cap, no baffle is necessary.



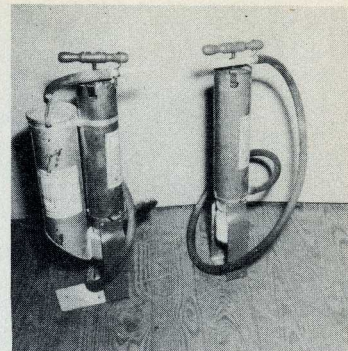
Using the Small Shaker With Attachment
for Overhead Dusting.

(c) **Foot pump.** The regular cyanogas foot pump of either one-pound or five-pound capacity is the best type of equipment for dusting burrows. The one-pound foot pump consists of a pump cylinder with a handle at the upper end and foot strap, dust container, and discharge tube at the lower end. The five-pound pump has the dust container adjacent to the lower half of the dust cylinder. Both types are fitted with valves to regulate air and dust flow.

The flexible rubber discharge hose on the cyanogas foot pump can be inserted as far into the burrow as is desired. Dust is forced into the burrow until it comes out of the opening being dusted or out of some other opening of the burrow network. In some instances it will be apparent that the burrow is so extensive that the dust will never come back through the opening. Twenty or thirty strokes should be sufficient in these instances.

The foot pump is also useful for dusting enclosed harborages and debris, stone, brick, and lumber piles, and for broadcasting dust over small areas.

(d) **Hand pump.** The pump type of duster is used to force DDT into narrow crevices. These dusters are equipped with pumps, dust res-



Foot Pumps of 5-Pound
and 1-Pound Capacity.

ervoir, and discharge tube, the latter usually about two feet in length, with an adjustable nozzle for straight or angle discharge. These dusters are easily carried and operated.



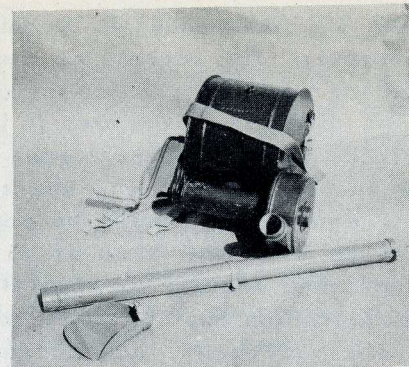
Dusting a Rat Burrow With the Foot Pump.



Hand Pump in Use.

Hand pump dusters are useful in dusting overhead lofts and beams and other spaces difficult to reach with the foot pump. Care should be exercised in operating the pump. Forceful strokes of the plunger tend to blow the dust away from the places where residue is needed. Short and easy strokes should be used, so that small piles of dust may be deposited. Some dusters discharge in a better pattern when operated in an inverted position. It is sometimes necessary to enlarge the holes into the dust chamber.

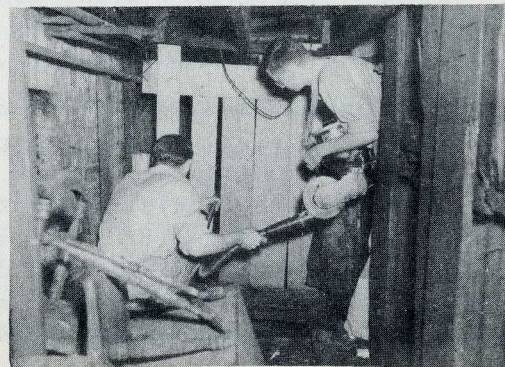
(e) **Hand rotary dusters.** Hand rotary dusters are suitable for dusting certain types of rat-frequented places. Those used for typhus control are standard commercial models designed for crop and orchard dusting. The hop-



Rotary Duster.

pers of the various makes hold about seven or eight pounds of dust. When loaded the duster weighs approximately 20 pounds. The rate of discharge can be regulated by a valve at the hopper end.

The hand rotary duster can be used to advantage in forcing dust into large spaces between hollow walls and double floors. Attics which are too low to admit the worker may be dusted with the hand rotary duster.



Using Rotary Duster in Enclosed Space.

PLANNING THE WORK PROGRAM. Careful planning is essential for success of the DDT residual dusting program. Organization of the dusting crew, division of the area to be treated into blocks and districts, order in which areas are to be treated, and the selection of dusting equipment should be considered in connection with the size of city, type of buildings, and density of population. Detailed consideration must be given to amounts of material, equipment, and personnel required.

A sufficient supply of dust should be on hand at all times. On an average, approximately 5 lbs. of DDT dust will be required to treat an average-sized business establishment, about 2½ lbs. to treat a rural premise, and about 1 lb. per urban residence. Preliminary reports show an average of 2.9 lbs. of DDT dust per premise (all types of premises considered), with an average expenditure of 0.8 man hour per premise. As crews become experienced, the man hours per premise should show a decrease.

Residual dusting crews should be carefully selected. Physical fitness, dependability, ability to talk to owners, and general intelligence are important points to consider in the selection of the dusting personnel. The success of the residual dusting program will depend to a great extent on the efficiency and conduct of the dusting crew.

PUBLIC RELATIONS SUGGESTIONS

Permission should always be obtained before a premise is inspected or worked. The program cannot be forced on the people. The attitude of the public toward the program will depend largely on the manner in which individuals are approached.

Respect Private Property Rights. The worker should briefly but courteously introduce himself in his official capacity. He should explain his purpose and what he wishes to do. He should answer courteously all questions asked him in connection with his work, but he should not take any more time than is absolutely necessary. After permission to inspect and dust has been given, the worker should start immediately.

SAMPLE INTRODUCTION. "How do you do, sir? I am with the City Health Department. As you probably know, we are conducting a campaign against typhus fever. This involves putting DDT dust where rats are found. May I look over your premises and apply dust if any likely places are located?"

ANSWERS TO COMMON QUESTIONS.

Q. What will this cost me?

A. Nothing. The DDT and labor are furnished by the Health Department. Later, when the Health Department stops giving this service, occupants and owners should do it themselves.

Q. Will this DDT kill rats?

A. No, it will kill only the fleas on the rats.

Q. Is DDT dust poisonous to human beings?

A. Only slightly. Not as poisonous as regular roach powder. We are careful to keep the dust away from foods.

Q. How often is dusting necessary?

A. About once every two or three months.

Q. Should the DDT be left on the floor, or can we sweep it up?

A. It should be left. We will try not to put too much dust where it will be conspicuous.

Q. Does DDT kill other insects besides fleas?

A. Yes, many of them. For example, cockroaches that walk in the dust will be killed.

PRECAUTIONS IN THE USE OF DDT

TOXICITY. Although DDT is highly toxic to many insects, it is not harmful to man if properly applied. It is much less poisonous than sodium fluoride, the common roach powder. No



Hands Should
Be Washed
Thoroughly.

Respirator

And Goggles

Should Be Worn

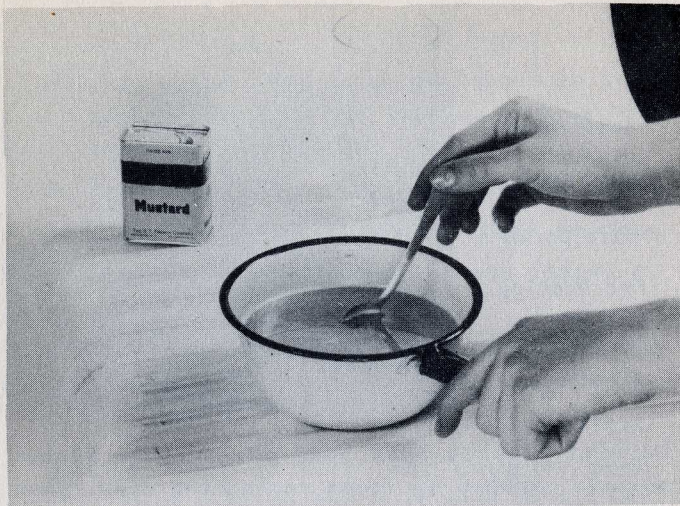
For Dusting.



harmful effects have been observed in higher animals exposed in rooms containing many times the concentrations of DDT dust recommended for insecticidal use.

DDT in dust form is not absorbed through the skin unless the skin is greasy or oily. Nevertheless, dust containing DDT should not be allowed to stay on the skin. Hands should be washed frequently. Careless use and excessive exposure to high concentration should be avoided.

STORAGE AND USE PRECAUTIONS. In order to avoid its being mistaken for flour, which it closely resembles, DDT dust should be stored in strong containers bearing conspicuous labels. It should never be applied directly on sacks of flour, salt, sugar, cornmeal, stored grains, or other foodstuffs. A respirator of the type approved for cyanogas A—dust should be worn when the rotary duster is being used.



Mustard Water — A First-Aid Measure.

WHAT TO DO "IN CASE." If DDT is swallowed accidentally, mustard water should be taken immediately. This is made by adding one tablespoon of dry mustard to a glass of warm water. The mustard will cause vomiting. If no mustard water is available, soapy water is a good substitute. A physician should be called.

INSPECTION

As a means of evaluating the effect of the residual dusting program, rats are trapped, bled for serological determinations, and combed for ectoparasites before and after dusting has been undertaken. Only a small percentage of the premises are sampled. The primary purpose of this inspection is to get

results of the overall program, not to check the efficiency of any one project.

Inspection of dusted premises should be done by the foreman and area supervisor to maintain an effective check on operational procedures.

RELATION OF THE DDT DUSTING PROGRAM TO OTHER MURINE TYPHUS CONTROL PROGRAMS

The DDT residual dusting program is not intended to supplant other control methods for murine typhus fever. It is a supplement to other measures, such as vaccination and rat control. Permanent rat-proofing and eradication measures should be urged in all localities. If a rat-proofing program cannot be inaugurated, a rat eradication program by poisons can very easily be correlated with a DDT dusting program.



DDT Dust Partially Scattered By Heavy Rat Traffic.