



**INSECTICIDES and
REPELLENTS for the
control of insects of
medical importance to
the ARMED FORCES**

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UNITED STATES DEPARTMENT OF AGRICULTURE

taining 3 to 10 percent of blackstrap molasses, sugar, or corn syrup. TEPP hydrolyzes rapidly in water and must be used fresh, but the other compounds will remain effective in water for several weeks or more. In these tests the baits were sprinkled on the floor of dairy barns at various locations where the flies congregated. An ordinary garden sprinkling can having about half the holes closed with solder to reduce the flow was used. Treatments made daily 5 days each week gave excellent control.

Malathion, Diazinon, Bayer L 13/59, and Chlorthion mixed with granulated sugar make highly effective dry baits. One percent of these insecticides is recommended, but good results have been obtained with concentrations as low as 0.25 percent. Wettable powders are preferred in making dry baits, but emulsifiable concentrates or the technical insecticide may be employed. A small amount of black or yellow food coloring should be added to dry sugar baits in order to minimize the possibility of their being mistaken for and used as regular sugar.

The dry bait is distributed from a shaker-top can or fruit jar with holes punched in the lid. Dry bait should be sprinkled thinly in strips on the floor or other places where flies congregate but where it will not contaminate animal feed, human food, or utensils. Usually about 1 ounce is needed for each 500 to 1,000 square feet, depending on the number of flies. Daily applications may be necessary to control flies under certain conditions, but after 2 or 3 weeks breeding may be reduced so that satisfactory control can be maintained with 2 to 4 applications per week.

Dry sugar bait is most effective on dry surfaces that are not very porous. On loose material such as straw the bait may fall beyond the reach of the flies, and on damp surfaces the sugar usually dissolves before the flies have a chance to eat it. In such cases the dry bait should be applied on feed sacks, sections of heavy paper, wood, or tin placed in locations where flies congregate.

An alternate bait for use on damp surfaces, especially outdoors, may be prepared with coarsely ground cornmeal. The meal is first coated with vegetable oil, 2 tablespoonfuls to 1 pound, and then are added 6 tablespoonfuls of a 25-percent malathion or Diazinon wettable powder and 4 tablespoonfuls of powdered sugar. If desired, 3 tablespoonfuls of lampblack may be added for coloring. The material should be thoroughly mixed with a paddle or mechanical stirrer. Cornmeal bait is applied in the same manner as dry sugar bait.

In view of the high toxicity of organic phosphorus insecticides to man, great care must be used in handling the concentrates. Because of the low concentrations in the bait and the method of application, they are not regarded as particularly hazardous if reasonable care is taken to avoid spillage on skin or clothing.

LARVICIDES

For military purposes fly larvicides are employed chiefly for control of larvae in latrines, garbage dumps, and other accumulations of waste. In combat areas the control of fly breeding in dead bodies is also imperative at times. Paradichlorobenzene, sodium arsenite, DDT, dieldrin, BHC, or lindane may be used as larvicides.

In deep-pit latrines that are tight and fairly dry, the fumes of paradichlorobenzene will not only destroy the larvae but prevent oviposition by repelling the adults. The granular material is applied at the rate of about 8 pounds per eight-seat latrine initially and 2 pounds twice a week thereafter. Sodium arsenite is used at a concentration of about 1 percent and is more effective than paradichlorobenzene in wet or shallow latrines. However, it is a deadly poison and should be used only with proper precautions and not at all if there is a possibility of contaminating ground water supplies or poisoning growing plants. If a sodium arsenite powder is available, it may be dissolved in water at the rate of about 1 pound to 10 gallons. A solution containing 54 percent of sodium arsenite is a stock item (No. 17) and is diluted 1 to 53 for treating latrines.

Oil solutions containing 5 percent of DDT or BHC are applied at the rate of 1 quart per seat per week. The treatments are more effective, especially in overloaded latrines, if they are divided into two or more applications per week. If a lindane emulsion is used, a concentration of 1 to 2.5 percent is suggested for preliminary tests to determine the minimum effective dosage and interval of treatment. A DDT-xylene emulsion was found to be more effective than a fuel oil solution, but it should not be used in enclosed spaces because of the danger of explosion when the xylene fumes are concentrated. However, the DDT nonexplosive emulsifiable concentrate, now a stock item (No. 8), may be used in latrines.

Residual sprays should be applied to the walls of the latrine and vault to reduce the number of adults that visit the latrine or emerge from the fecal medium in spite of the larvicides.

All these insecticides except paradichlorobenzene may be used for spraying fly-breeding places in the open, such as garbage dumps, manure piles, and other refuse, as well as dead bodies or animal carcasses that become infested before proper disposal can be made. Such bodies should be thoroughly sprayed on all sides as well as the ground underneath and for several feet around them. If sodium arsenite is used, a concentration of 2.5 percent is recommended. A 5-percent BHC emulsion with benzene as the solvent is also highly effective and rapid in action. The sprays will not destroy larvae inside the corpse or carcass, but the DDT and BHC residues should kill most of the adults feeding or ovipositing on the bodies and also those that emerge from escaping larvae.

CONTROL OF HUMAN LICE AND SCABIES

Three kinds of lice infest man—the body louse, the head louse, and the crab louse. They differ considerably in habits and therefore require different methods of control. Since the body louse is the vector of epidemic typhus and other diseases, emphasis has been placed on development of measures for its control. The head louse is closely related to the body louse and presumably may also transmit disease. The crab louse is not known to transmit any disease, but does cause much irritation of the skin. All three species are cosmopolitan in distribution.

Scabies, or human itch, is caused by the itch mite, which burrows through the outer layer of the skin. The disease is common, but its

incidence usually is not high in military personnel. It is prevalent in some foreign countries and is considered to be an important military problem.

At the Orlando laboratory an emulsifiable concentrate was developed for use in a spray or wash for controlling both lice and scabies. Research at this laboratory led to recommendations for louse control that were adopted by the military during World War II and were applied extensively under various field conditions. During the Korean war body lice that were highly resistant to DDT were encountered, and further research was required to develop a substitute insecticide.

The following control measures are those developed or investigated for the Armed Forces at Orlando, although other methods, such as methyl bromide fumigation and steam sterilization (No. 15, table 3; Nos. 2 and 3, table 4) of clothing, are also in use.

BODY LICE

The body louse spends its life in the clothing except for a short time on the skin while feeding. The eggs are laid on the cloth, attached to the fibers. Woolen cloth is much preferred to other kinds. In looking for infestations one should examine the clothing along the seams and folds, especially on the inside of the underwear. Because of the habits of this louse, control measures are directed largely toward the treatment of clothing.

Louse Powders

Three kinds of louse powders are carried as stock items or are under specification—10 percent of DDT in pyrophyllite (No. 5), 1 percent of lindane in pyrophyllite (No. 3), and MYL-type powder (No. 6), containing pyrethrins with or without allethrin, a pyrethrum synergist, and a louse ovicide.

The 10-percent DDT powder is the standard material issued for louse control. It is packaged in 2-ounce sifter-top cans for individual use and in 5- and 25-pound containers for mass use. With the sifter-top can the powder should be applied over the inner surface of the underwear (fig. 24), with special attention to the seams, and evenly distributed by hand. The seams inside the shirt and trousers should be treated in a similar manner. The socks should also be treated. About 1 ounce of powder is necessary for one treatment. If it is not feasible to remove the clothing, the powder may be shaken into the clothing through the openings in the shirt and trousers.

DDT is rather slow in action, but the lice are usually immobilized in less than 6 hours. It is not ovicidal, but owing to its long-lasting effect a single application can eradicate an infestation since the eggs normally hatch in less than 2 weeks.

Mass treatment has been employed with great success for the control of lice in large units of troops and prisoners of war and for control of epidemic typhus in civilian populations. A hand-operated plunger duster (fig. 25) and a gasoline-powered unit with 10 duster heads (fig. 26) are issue items (Nos. 6 and 7). The powder is blown between the underwear and the skin. It is blown down the neck of the shirt, up the sleeves, and into the loosened trousers from as many

directions as possible, front and back. In delousing women an extra quantity may be blown down the neck of the dress and application at the waistline omitted. About 1½ ounces per person is sufficient for winter dress. The hair, hat or cap, extra clothing, and bedding should be included. One such treatment with DDT is generally adequate to control infestations.

Powder containing 1 percent of lindane has been approved for military use in areas where DDT-resistant lice are encountered. This material was used successfully on a large scale in Korea after DDT powder became ineffective. Directions for its application are the same as for DDT powder. However, since it is not so long lasting, a second application within 7 to 10 days is advocated.

The MYL powder was developed before DDT became available. The original formula contained 0.2 percent of pyrethrins, 2 percent each of *N*-isobutylundecylenamide (synergist) and 2,4-dinitroanisole (ovicide), and 0.25 percent of Phenol S (antioxidant). Upon the discovery of DDT-resistant lice in Korea, further tests were made with this preparation and the formula was slightly changed by reducing the amount of Phenol S to 0.1 percent and substituting sulfoxide as the synergist. One type also contained 0.3 percent of allethrin in addition to the pyrethrins.

The MYL powder has a very rapid action on the lice. In tests at Orlando they were all immobilized within 15 minutes, and unable to take blood meals after 10 minutes. On cloth impregnated with DDT, a 2-percent solution or a 10-percent dust, lice continued to feed for 1 or 2 hours.



FIGURE 24.—GI applying DDT to underwear from a sifter-top can for louse control.

The residual action of the MYL powder was much shorter than that of DDT, but it did give complete control of lice for 1 week and a high degree for 3 or 4 days longer. Although this length of time took care of most of the nymphs that emerged from eggs present at the time of treatment, the inclusion of the ovicide was thought desirable. However, it was difficult to reach all the eggs with the powder, and for safety two treatments a week apart are recommended.

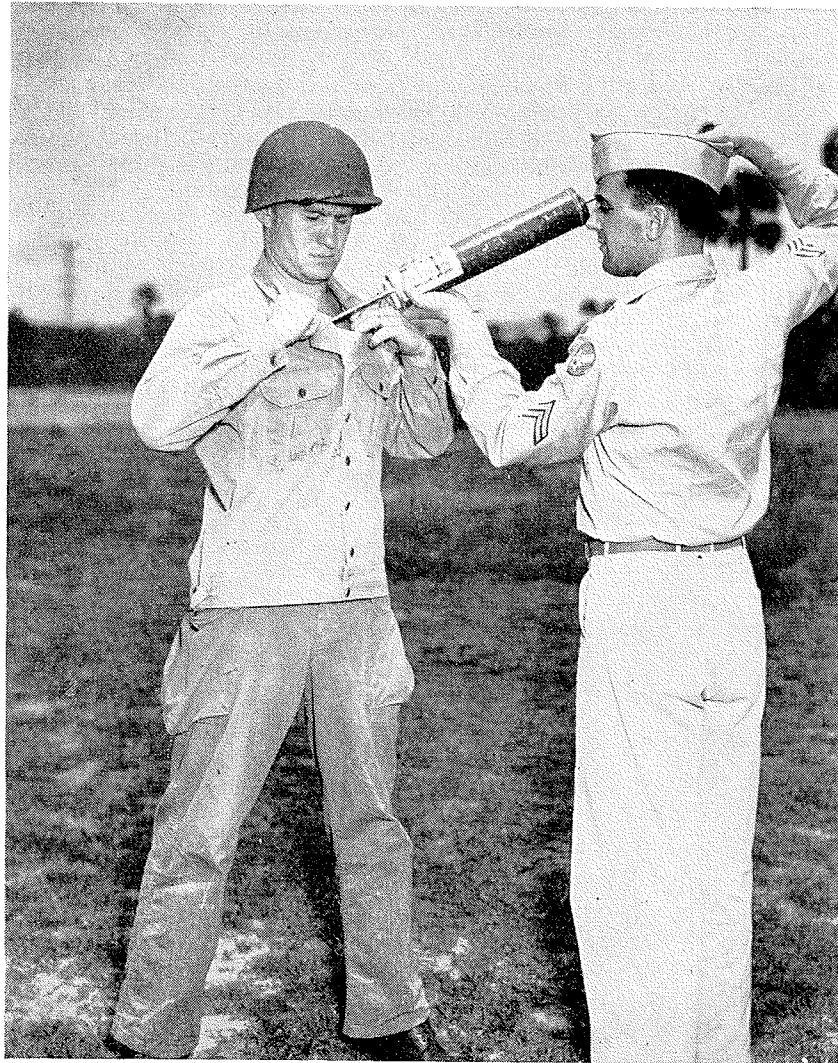


FIGURE 25.—Applying DDT to clothing with a plunger-type hand duster.



FIGURE 26.—Mass treatment of troops with a motor-driven duster for louse control. (Courtesy of Capt. R. M. Altman, U. S. Army.)

Impregnation of Garments

DDT is very effective and long lasting when used to impregnate clothing. If the clothing is treated in mass before issuance or during laundering, the method largely eliminates the personal factor and provides more permanent louse control than powders. Properly impregnated garments remain effective through 6 to 8 launderings. Troops provided with two suits of impregnated winter underwear should remain free of lice during an entire winter, the season when lice are most prevalent. In general, a dosage of DDT equivalent to about 2 percent of the dry weight of the garment is recommended. This dosage is 15 to 20 grams (0.5 to 0.7 ounce) for the regular issue, winter-weight, 50-percent-wool underwear.

Garments may be impregnated with DDT in a volatile solvent or in an emulsion. In the first method the underwear is dipped into a solution, such as a cleaning solvent containing the desired amount of DDT, the excess solution is removed by wringing, and the solvent is allowed to evaporate before the garments are worn. This method is especially useful where dry-cleaning equipment is available. In the second method a 25-percent DDT emulsifiable concentrate (containing xylene as the solvent) diluted with water to the desired concentration is used for wetting the garments. They may be dipped individually in a pan or helmet, or by batches in a larger container, such as a drum, or in laundry equipment. This

method is especially adaptable for use in portable or other laundry facilities (see pp. 79-80).

Before either method is used, the approximate amount of solution or emulsion retained in the garments after wringing or spinning should be determined. From 1 to 2 pints is required for a suit of winter-weight underwear. The concentration is then adjusted to give the desired amount of DDT per garment. If the volume is 2 pints, the recommended dosage would be attained with a 2-percent solution, containing approximately 18 grams, or 0.64 ounce.

Studies have shown that lindane is also effective as a clothing impregnant for louse control, although much less persistent than DDT. A set of winter-weight underwear impregnated with 2.5 to 3 grams of lindane in about 2 pints of a 0.3-percent solution or emulsion will give effective control of lice for a week or 10 days. Garments treated with this small amount of lindane are not effective after laundering and must therefore be re-treated. The Army Environmental Health Laboratory is investigating the toxicity of lindane to humans, but has not yet approved its use as a clothing impregnant for control of lice.

Sprays for Louse Control on the Body

A spray formula (No. 11) developed primarily as a treatment for head and crab lice and scabies is also issued for the control of body lice where it is desirable to eradicate all lice present on groups of personnel in a short period, as at a port of debarkation in the United States in connection with methyl bromide fumigation of the clothing of returning troops.

The formula is an emulsifiable concentrate known as NBIN and contains the following materials (all percents by weight): Benzyl benzoate 68, DDT 6, benzocaine 12, and Tween 80 (polyoxyalkylene derivative of sorbitan mono-oleate) 14. It is diluted with 5 volumes of water for application. The individuals are stripped, and while their clothing is being deloused by fumigation they are required to take a bath and are then sprayed with the NBIN emulsion with a power compressor and a paint-spray nozzle. The spray is applied to the pubic and anal regions, the armpits, and other hairy parts of the body to destroy body and crab lice, and to the head to destroy head lice. The spray should be kept out of the eyes by covering them with the fingers. Treated persons should not bathe again for at least 24 hours. Benzocaine is a very effective ovicide, so that the eggs as well as the active stages are killed. About 20 ml. of finished emulsion is required per individual, or about 5 gallons per 1,000 men.

HEAD AND CRAB LICE

Head and crab lice live continuously on the body, and their eggs (nits) are attached to hairs. Eggs of the head louse are found chiefly on the hairs of the head, and those of the crab louse chiefly on the hairs of the pubic region but also occasionally on other hairy parts of the body. The presence of either species can be readily determined by examining for nits.

The NBIN formula (see above) diluted 1 to 5 in water is highly effective against both species. It may be applied as a spray or for individual

treatments poured onto the hairy parts of the body and distributed with the fingers.

The DDT and MYL powders issued for the control of body lice are also effective against head and crab lice and are easily applied from the 2-ounce sifter cans. Either powder will usually eradicate an infestation if the hair is not washed within a week after treatment. To be certain of destroying all the nymphs that hatch from eggs, a second treatment after 7 to 10 days is suggested. For a heavy infestation the MYL powder is preferred, as it stops the activity of the lice very quickly. With DDT the lice become abnormally active and cause intense irritation of the skin. The MYL powder may be used if strains of DDT-resistant lice are encountered.

SCABIES

Research on scabies treatments was carried out at the Orlando laboratory in Florida and in cooperation with Army Medical and Sanitary Corps officers in other areas. Benzyl benzoate by itself has been used rather extensively for scabies control, but is more effective in the NBIN formula (see p. 64). Benzocaine was included primarily as an ovicide, but it is also a local anesthetic that relieves the itching caused by lice and the scabies mite.

The NBIN formula has practically no odor, and does not leave an undesirable residue on the body or irritate the skin. For treating a case of scabies, this formula is diluted 1 to 5 with water, as for lice, and applied as a spray or with a sponge. The entire body except the head should be treated, with particular attention to the areas where lesions are apparent. About 60 to 75 ml. of the dilute emulsion is ordinarily required for one treatment. The patient should be instructed not to bathe for 24 hours. One thorough treatment usually eliminates an infestation, but if a second treatment is required, it should be made about a week later.

CONTROL OF OTHER MEDICALLY IMPORTANT ARTHROPODS

BED BUGS

DDT was found to be highly effective against bed bugs. With its long residual action it seemed to provide the solution of a problem that has long been difficult to handle in army barracks, as well as under many conditions in civilian life. A 5-percent DDT spray applied to the beds (fig. 27) and into cracks and crevices in walls has eradicated these insects from infested buildings. Either a kerosene solution or an emulsion may be applied with a pressure sprayer or power equipment. The spray should be fairly coarse and wet in order to leave an effective residue.

In treating a bed it is important to cover completely the mattress, springs, and bedstead, directing the spray particularly to the corners and other places where the bugs hide. This requires about 100 ml. of spray. Cracks in the baseboards and walls, to a height of several feet, should also be treated. Although not all the bugs can be reached with the spray, the DDT residue will kill those that later crawl on the