POSSIBLE UTILIZATION OF THE NEWLY DEVELOPED AEROSOL METHODS IN APPLYING THE NEW JERSEY MOSQUITO LARVICIDE FOR OUTDOOR PROTECTION FROM ADULT MOSQUITOES *

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Even in areas where mosquito control work has been systematically conducted for many years it has not been possible with our present means and methods completely to eradicate the mosquito. Under conditions favorable for its rapid development, such as during summers of abundant rainfall, the mosquito seriously interferes at times with human comfort. Of course, under otherwise similar conditions, the discomfort is much worse in areas where no mosquito control extermination work is carried out than in areas where control work is in operation. Complete elimination of mosquitoes indoors can be readily accomplished by proper screening, spraying or fumigating. On the other hand, protection from mosquito annoyance outdoors constitutes a difficult problem.

During the last 12 years an oil pyrethrum emulsion which became known as the New Jersey (2, 3, 4) Mosquito Larvicide, proved an effective spray in protecting outdoor audiences from mosquito annoyance. It has the following composition: 66 per cent kerosene or similar light petroleum distillate; 0.07 per cent pyrethrins (equivalent to extract of 1 pound of flowers, analyzing 0.9 per cent pyrethrins, per gallon of kerosene); 33.5 per cent water; and 0.5 per cent of a neutral emulsifier, such as commercial sodium lauryl sulfate. The concentrated larvicide is diluted with 10–12 parts of water and sprayed on the area where the gathering takes place. In this case the larvicide performs two functions. It prevents outside mosquitoes from coming into the protected area while the adult mosquitoes within the sprayed area are either killed or paralyzed to such a degree that for several hours they remain inactive. When sprayed as directed, the larvicide causes no injury to grass, shrubs, trees, ornamental plants, man and higher animals. Since 1935, when this spray was first introduced, numerous outdoor evening concerts, carnivals, church parties, community gatherings, lawn parties, and similar small and large groups of people have been protected from mosquitoes. Extensive experiments conducted by the

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writer in cooperation with the County Mosquito Extermination Commissions in New Jersey have established a definite method of procedure for spraying, which is here briefly described.

Directions for Applying the New Jersey Mosquito Larvicide

The concentrated larvicide is first well shaken or stirred. It is then mixed with 12 parts of water (1 quart to 3 gallons) in the sprayer. This diluted mixture is ready for spraying. During the spraying operation it should be frequently shaken or stirred to ensure uniform distribution of the larvicide.

Procedure.—Before the affair starts, the entire area including grass, shrubs, bleachers, sheds, benches, or any other place where mosquitoes may rest during the day is thoroughly sprayed with the diluted larvicide. This should kill or incapacitate all mosquitoes hiding within the area. The next objective is to prevent outside mosquitoes from coming into the protected area. For this purpose the spray is directed upward so as to saturate the atmosphere with a fine mist or fog of the larvicide. The spray is best applied against the wind so that the fine mist or fog will drift with the wind throughout the area. Just about dusk or when the mosquitoes from the outside begin to fly in, the fogging operation is repeated, the spray being applied as high as the pressure of the sprayer permits, preferably on the side from which the wind is blowing. If no noticeable wind prevails it may be necessary to fog all around the area, directing the spray upward so as to keep the inflying mosquitoes away. One thorough fogging at this time is generally sufficient for the rest of the evening. Under very heavy infestations where the mosquitoes are coming in large numbers, another fogging about 9 P.M. may be necessary. The operator in charge should be on the alert for this last step.

The main principle of this procedure consists of saturating the atmosphere with a fine mist or fog of larvicide. The longer the spray remains in the air, the longer its lasting protection. Of course, the finer the size of the dispersed droplet, the slower will be its rate of settling. The most efficient results are obtained when a high pressure power sprayer is used. The application by power sprayer is rather slow and requires a large volume of liquid, which is an objectionable feature in the operation.

Aerosol Sprays

Now, the newly developed methods for dispersing aerosol sprays in extremely fine particles over large areas may offer a more efficient, less costly, and less cumbersome mechanism than the power sprayer. The term "aerosol," is employed in colloid chemistry (1, 9) to designate a dispersion of fine, solid or liquid particles in air or any other gaseous medium. Aerosols include a variety of natural and artificial systems, such as smoke, clouds, mist, fog, fumes, atomized oil in oil burners, and smoke-screens in chemical warfare, in which air constitutes the continuous external phase or the dispersion medium and the fine particles form the internal or dispersed phase.

The main object of aerosol spraying is to disperse concentrated (6) insecticides, mosquito larvicides (5), repellents, etc., in such a fine state of subdivision and in such a way that they remain suspended or floating in the air for long periods of time, thereby prolonging their effectiveness. The particle size may vary from a fraction of a micron (1/25,000 of an inch) to many microns in diameter. The particles of the dispersed phase tend to coalesce and settle downward. The rate of settling will vary with the density, viscosity, size and electrical charge of the dispersed particles (8), and the nature of the dispersion medium. Strongly charged particles prevent aggregation by mutually repelling each other and thus retard settling. The presence, in the dispersion medium of "nuclei" such as smoke, dust, and salts, on which particles of the dispersed phase condense may also retard

settling by presenting coalescence into large aggregates. All other conditions being equal the smaller the particle size, the longer it will remain suspended in air. Thus, the advantage of aerosols over coarse sprays lies primarily in the performance of fine particles. The range of fineness of oil-pyrethrum particles for optimum toxicity and repellency to adult mosquitoes has not been definitely determined and offers an interesting field for research.

Several methods are now in practice for producing aerosol sprays from concentrated insecticides such as:

1. Volatilization from a liquefied gas (7), containing the toxicant in solution. (Army aerosol "Bomb.")

2. Dispersion by high velocity wind produced by suitable fans, propellers, etc. (Buffalo Turbine, "Speed" Sprayer.)

3. Electric atomizers.

4. Heat-generated aerosols. Many devices are used, varying from a small hot plate from which the insecticide is volatilized, to the complex fog-machines, modified from the army screening smoke generator.

In this last group, the fog-generator, of which three models are at present available (Todd, LàMer, Besler), may offer a substitute for the power sprayer. In each of the three models mechanisms have been adjusted for regulating particle size and volume of liquid deposited from concentrated insecticides. Such a machine, if proved efficient, may possess the following advantages over the power sprayer:

1. Reduction in volume of spray. A small quantity of concentrated larvicide or pyrethrum extract may replace the large amount of diluted spray.

2. Speed of operation. A large area can be quickly covered several times, if necessary, within a short time.

3. Saving in labor. One man can perform the entire operation, whereas three men are generally required to apply the larvicide by power sprayer.

4. Saving in space. The fog machine can be placed on a small delivery truck and still leave enough space for one or more small drums of the concentrated larvicide.

Preliminary tests and observations made by the writer with the Todd fog generator during 1945 warrant further experiments with this or similar aerosol generators with the object of simplifying our present method of protecting outdoor gatherings from the mosquito annoyance.

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