INSECTICIDES FOR USE AGAINST *AEDES AEGYPTI*[1]

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Based on size, *Aedes aegypti* would appear to be a less formidable adversary than larger species such as *Culex pipiens quinquefasciatus* or *Anopheles quadrimaculatus*. Unfortunately, the reverse is true with regard to the effect of a number of insecticides upon chlorinated hydrocarbon resistant strains of these three species. This fact, coupled with the confirmed physiological resistance of *A. aegypti* to DDT and dieldrin in Puerto Rico and the Virgin Islands, indicates the magnitude of the task involved in eradicating this species from these areas and from the United States.

Renewed interest in the control of *A. aegypti* occurred in 1963 when an eradication program was established in the Public Health Service. Prior to that time the species had been one of several mosquito species commonly used in the study of new insecticides. Such evaluative data for *A. aegypti* will be used in the discussion of residual adulticides, temporary larvicides, and larvicides for possible use in drinking water. The experimental compounds and their formulae are given in Table 1.[2]

RESIDUAL ADULTICIDES. The results of tests in which adults of the DDT-resistant Trinidad strain were exposed to insecticidal deposits on plywood for 1 hour are given in Table 2. The compounds listed are restricted to those that gave 6 or more weeks of kills above 70 percent. Bayer 37344 was the most promising, followed by malathion. Compounds tested that were ineffective against *A. aegypti* include carbaryl, dicapthon, ronnel, and dimethrin.

TABLE 1.—Chemical composition of experimental compounds tested.

Designation	Chemical composition
Bayer 37342	o, o-dimethyl o-(3, 5-dimethyl-4 methylthiophenyl) phosphorothionate
Bayer 37343	o, o-diethyl o-(3, 3-dichloro-4-methylthiophenyl) phosphorothionate
Bayer 37344	4-(methylthio)-3, 5-xylyl methyl carbamate
Bayer 39007	*o*-isopropoxyphenyl methyl carbamate
Bayer 41831	o, o-dimethyl o-4-nitro-*m*-tolyl phosphorothioate
Bromophos	o, o-dimethyl-o-2, 5-dichloro-bromophenylthionophosphate
Deuterated DDT	2, 2-*bis*-(p-chlorophenyl)-2-deutero-1, 1, 1-trichloroethane
Dimethrin	2, 4-dimethyl benzylchrysanthamate
H-5727	3-isopropylphenyl N-methylcarbamate
HRS-1422	3, 5-diisopropylphenyl N-methylcarbamate
N-2404	o-isopropyl o-(2-chloro-4-nitrophenyl) ethylphosphonothioate
N-2788	o-ethyl S-*p*-tolyl-ethylphosphonodithioate
OMS-122	o-methyl o-(2, 4, 5-trichlorophenyl) isopropylphosphoramidothioate
RE-5305-3	*m-sec*-butylphenyl N-methylcarbamate
RE-5353	*m-sec*-amylphenyl N methyl carbamate
SD-7438	toluene-α, α-dithiol-*bis* phosphorodithioate
SD-7554	diethyl 1-(phenylthio) vinyl phosphate
SD-8447	Phosphoric acid, 2-chloro-1-(2, 4, 5-trichlorophenyl) vinyl dimethyl ester

Of interest is the fact that carbaryl and dicapthon, although effective for 14 to 22 weeks against *C. p. quinquefasciatus* and *A. quadrimaculatus*, did not give more than 1 week's satisfactory kill of *A. aegypti*.

TEMPORARY LARVICIDES. The results of larvicide tests with 16 compounds are

[1] From the Biology/Chemistry Section, Technology Branch, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

[2] Use of trade names is for identification purposes only and does not constitute endorsement by the Public Health Service.

TABLE 2.—Compounds effective as residues on plywood against DDT-resistant *A. aegypti*.

Toxicant [1]	Mg./sq. ft.	Weeks kill above 70%
Malathion	200	24
RE-5353	100	6
	200	13
Bayer 39007	100	10
	200	10
RE-5305-3	100	12[2]
OMS-122	100	16
Bayer 41831	100	12
	200	16
HRS-1422	200	20
Bayer 37344	50	15
	100	48
	200	48

[1] Residues obtained from suspension formulations.

[2] Kills fluctuated between 40 and 100 percent through week 24.

shown in Table 3, in which the data are arranged in order of the acute oral LD-50 value of the compounds to rats. Effectiveness was based on the concentration required for 95-percent kill of larvae exposed for 24 hours to the compounds tested by the WHO technique (Anon., 1960). The most effective toxicants were those with acute oral LD-50 levels of less than 500 mg./kg. However, several compounds (fenthion, Shell 7438, and American Cyanamid 52,160) [3] were extremely potent against the larvae even though their levels of toxicity to rats were below that of DDT. AC 52,160 and B-37343 were superior to the fenthion standard while SD-7554 and SD-7438 were equal to it. Of the compounds with low mammalian toxicity levels, bromophos required the lowest concentration (0.1 p.p.m.) for an LC-95.

LARVICIDES FOR POSSIBLE USE IN DRINKING WATER IN SUBTROPICAL AREAS. As toxicants with a low order of mammalian toxicity are those of first consideration for the treatment of drinking water, each of the compounds tested had an acute oral LD-50 for female rats (or mice) of 2,000 mg./kg. or greater. A second requirement is that the treatment remain effective over an extended period.

Three compounds—dimethrin, Bayer 37342, and SD-8447—have received preliminary evaluation. In these tests the insecticide in ethanol is added to 250 ml. of tap water, and late 3rd-early and 4th instar larvae are exposed therein for 24 hours. The insects are then removed, and the treated water held until the next test is made. Before each test, the water volume is restored to its original level.

The data for dimethrin solution, granules, and emulsion are given in Table 4. Dimethrin solution was effective against the larvae of a susceptible strain for 6 weeks at 10 p.p.m. but was unsatisfactory against the DDT-resistant strain. As an emulsion, dimethrin at 20 p.p.m. persisted for 8+ weeks, but the best results again were evident with the susceptible strain. The granular formulations that contained piperonyl butoxide were definitely superior to the dimethrin alone against the resistant strain. All formulations were more effective against the susceptible strain.

Both B-37342 and SD-8447 gave effective results against the resistant strain

TABLE 3.—Concentration required for 95 percent kill of DDT-resistant *A. aegypti* larvae.

Compound	p.p.m.	Acute oral LD-50—Rats
Guthion	0.1	11
SD-7554	0.02	14
B-37343	0.002	14
H-5727	0.5	32
N-2404	0.1	32
Deuterated DDT	2.5	118 (DDT)
N-2788	0.1	127
Fenthion	0.02	245
SD-7438	0.02	280
AC-52,160	0.004	440
B-41831	0.1	503
Malathion	0.5	1,000
B-37342	2.5	3,000
Bromophos	0.1	3,000 (mouse)
SD-8447	0.5	5,000
Dimethrin	2.5	40,000

[3] Confidential compound furnished by American Cyanamid Company, Princeton, New Jersey.

TABLE 4.—Residual toxicity of dimethrin to *Aedes aegypti* larvae.

Strain	p.p.m.	Number of weeks of 95% kill				
				Granules		
		Solution	Emulsion	A	B	C
Susceptible	2.5	2	<2	4	6	6
	5.0	4	4	4	8+	8+
	10.0	6	8+	8+	8+	8+
	20.0		8+	8+	8+	
DDT-Resistant	2.5	<1	<2	<2	<2	<2
	5.0	<1	<2	<2	2	2
	10.0	<1	2	<2	6	4
	20.0		4	2	8+	

A=Dimethrin:bentonite 10:90.
B=Dimethrin:PB:bentonite 5:5:90.
C=Dimethrin:PB:bentonite 2.5:2.5:95.
Rat ♀ — Oral LD-50=40,000 mg./kg.

(Table 5), and the periods of effectiveness (4 to 8+ weeks) were achieved at a lower concentration (5.0 p.p.m.) than was true for the dimethrin formulations.

TABLE 5.—Residual toxicity of Bayer 37342 and Shell 8447 to *Aedes aegypti* larvae.

Compound	Strain	p.p.m.	No. weeks of 95% kill
B-37342*	Susceptible	2.5	4
		5.0	6+
		10.0	6+
	DDT-resistant	2.5	2
		5.0	4
		10.0	6+
SD-8447**	Susceptible	2.5	8+
		5.0	8+
	DDT-resistant	2.5	6
		5.0	8+

* Rat—Oral LD-50=>3,000 mg./kg.
** Rat—Oral LD-50=>5,000 mg./kg.

As the previous data reveal, there are a number of compounds of promising toxicity against the larvae and/or adults of *A. aegypti*. Whether these compounds can succeed against the species under field conditions must await such experimentation.

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