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Literature Cited

Bohart, R. M. 1950. A new species of *Orthopodomyia* from California (Diptera:Culicidae). Ann. Entomol. Soc. Amer. 43(3):399–404.

Breeland, S. D., Snow, W. E., and Pickard, E. 1961. Mosquitoes of the Tennessee Valley, J. Tenn. Acad. Sci. 36:249–319.

Chapman, H. C. 1964. Observations on the biology and ecology of *Orthopodomyia californica* Bohart (Diptera:Culicidae). Mosquito News, 24 (4):432–439.

Howard, L. O., Dyar, H. G., and Knab, F. 1912. The mosquitoes of North and Central America and the West Indies. Wash. Carnegie Inst. 1:156–179.

Jenkins, D. W., and Carpenter, S. J. 1946. Ecology of the tree hole breeding mosquitoes of Nearctic North America. Ecol. Monogr. 13:33–48.

Lake, R. W. 1954. Some biological observations on the tree hole mosquitoes in Passaic County, New Jersey. Proc. N. J. Mosq. Ext. Assoc. 41:193–197.

MacGregor, M. E. 1929. pH and mosquito larvae. J. Parasitol. 21(1–2):132–157.

Usinger, R. L. 1956. Aquatic insects of California, p. 21. Univ. of California Press, Berkeley and Los Angeles.

Wilkins, O. P., and Breland, O. P. 1951. The larval stages and the biology of the mosquito, *Orthopodomyia alba* Baker (Diptera:Culicidae). J. New York Entomol. Soc. 59:225–240.

Williams, F. M., and Linam, J. H. 1967. Some physical and chemical factors of tree rot holes. In press, Proc. Utah Mosq. Abate. Assoc.

PROMISING CHEMICALS FOR CONTROL OF ADULT MOSQUITOES[1]

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Screening candidate compounds for insecticidal activity is an essential part of any research concerned with the control of mosquitoes. Thus, in the past 2 years, we evaluated 114 new compounds for their toxicity to adult *Aedes taeniorhynchus* Wiedemann in wind-tunnel tests in the laboratory. This paper presents the results obtained with 11 of the most promising compounds (compared with a malathion standard). Also, data are presented on eight other promising compounds characterized by high or unknown mammalian toxicity.

Test Procedures. The insecticides were evaluated by exposing adult female mosquitoes from our laboratory colony to deodorized kerosene sprays of each insecticide in a wind tunnel. (This apparatus has been described previously by Lofgren *et al.* 1967.) A series of concentrations bracketing the 0 to 100-percent toxicity range were tested with each chemical. One-fourth ml. of each insecticide concentration was used per test; it was atomized at 1 p.s.i. and drawn through the wind tunnel at 4 m.p.h. All tests were replicated 3 times with duplicate lots of twenty-five 4- to 5-day old female mosquitoes in each replicate, except the tests with the 8 compounds of high or unknown mammalian toxicity. With these compounds only 1 replicate with duplicate cages was run. After exposure, the mos-

[1] Mention of a proprietary product does not necessarily imply endorsement of this product by the USDA.

quitoes were anesthetized with carbon dioxide, transferred to one-half pint ice cream cartons with screen tops, and provided with 10 percent sugar-water for food. Mortality was recorded after 24 hours, and the LC_{50} and LC_{90} were computed for each insecticide. Table 1 lists the insecticides in descending order of toxicity based on the LC_{90}'s. The chemical composition of each test compound is given in Table 1a.

The most effective compound was Bay 62863, which was about 4 times as effective as the malathion standard at the LC_{90} level. Bay 78182 was twice as effective, and Dursban®, Bay 77488, and Montecatini L 561 were 1¾ times as effective as malathion. Upjohn U-24157, Upjohn U-18120, and CIBA C-9643 were about equal to the standard in effectiveness, and Neopynamin® was about ⅔rds, Stauffer B-11163 ½, and DuPont Ins. 1519 ⅓rd as effective as malathion.

The data on mammalian toxicity (Table 1) show that four out of the seven best compounds (Bay 78182, Bay 77488, Montecatini L 561, and Upjohn U-24157) had relatively low mammalian toxicities (oral LD_{50}'s exceed 1000 mg./kg.). None appeared exceedingly toxic to mammals, and all will be considered for field testing to determine their potential usefulness.

Hercules 13462 was the most effective (LC_{90}=0.004 percent) of the eight compounds given only preliminary testing

TABLE 1.—Effectiveness of 11 insecticides (compared with malathion standard) in contact-spray tests against adult females of *A. taeniorhynchus*.

Insecticide	LC_{50} (%)	LC_{90} (%)	LC_{90} reciprocal ratio to malathion	Mammalian toxicity (Oral LD_{50} mg./kg.) [a]
Bay 62863	0.0037	0.0086	3.5	100
Bay 78182	.0068	.015	2.0	>1000
Dursban®	.0084	.017	1.76	145
Bay 77488	.010	.017	1.76	>1000
Montecatini L 561	.010	.017	1.76	>1000
Upjohn U-24157	.0094	.025	1.2	1000
CIBA C-9643	.012	.025	1.2	110
Malathion	.012	.030	1	1375
Upjohn U-18120	.013	.033	.91	70
Neopynamin®	.015	.046	.65	>20000
Stauffer B-11163	.024	.052	.57	2710
DuPont Ins. 1519	.012	.08	.37	90

[a] Values for Upjohn U-24157 are based on tests with mice; all others are on tests with rats.

TABLE 1a.—Chemical composition of compounds listed in table 1.

Bay 62863: (2,3-dihydro-2-methyl-7-benzofuranyl methylcarbamate)
Bay 78182: (*O,O*-diethyl phosphorothioate *O*-ester with (*o*-chlorophenyl) glyoxylonitrile oxime)
Dursban® (*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate)
Bay 77488: (*O,O*-diethyl phosphorothioate, *O*-ester with phenylglyoxylonitrile oxime)
Montecatini L 561: (ethyl mercaptophenylacetate *S*-ester with *O,O*-dimethyl phosphorodithioate)
Upjohn U-24157: (*m-tert*-butylphenyl acetylmethylcarbamate)
CIBA C-9643: (*o*-(4-methyl-1,3-dioxolan-2-yl)phenyl methylcarbamate)
Upjohn U-18120: (*o*-isopropoxyphenyl (methoxyacetyl) methylcarbamate)
Neopynamin® (2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylic acid ester with *N*-(hydroxymethyl)-1-cyclohexene-1,2-dicarboximide)
Stauffer B-11163 (*O,O*-dimethyl phosphorothioate *O*-ester with 4-hydroxy-*m*-anisonitrile)
DuPont Ins. 1519 (*o*-(1,3-dioxolan-2-yl)phenyl methylcarbamate)

TABLE 2.—Insecticides with high mammalian toxicities evaluated only in preliminary screening tests.

Insecticides	Estimated LC_{90}	Acute oral toxicity to rats (LD_{50} mg./kg.)
Hercules 13462	0.004	11.6
Union Carbide UC-21149	.009	1.0
Schering 34615	.024	35
Hercules 9200	.025	Unknown
Bay 48772	.037	3
Azodrin®	.038	23
Murfotox®	.040	49
Bay 48792	.044	2.5

(Table 2). Union Carbide UC-21149 had an LC_{90} of 0.009; the other compounds were about as effective as malathion in the previous tests. The chemical composition of each of the test compounds listed in Table 2 is given in Table 2a.

TABLE 2a.—Chemical composition of compounds listed in Table 2.

Hercules 13462: (*O,O*-dimethyl phosphorodithioate *S*-ester with N-(1-mercaptoethyl)succinimide)
Union Carbide UC-21149: (2-methyl-2-(methylthio)propionaldehyde *O*-(methylcarbamoyl) oxime)
Schering 34615: (*m*-cym-5-yl methylcarbamate)
Hercules 9200: (*m*-(methoxymethoxy)phenyl methylcarbamate)
Bay 48772: (*O*-methyl *O*-[4-(methylsulfinyl)-*m*-tolyl] methylphosphonothioate)
Azodrin®: (3-hydroxy-*N*-methyl-*cis*-crotonamide dimethyl phosphate)
Murfotox®: (65% E. C. of mecarbam)
Bay 48792: (*O*-ethyl (*O*-[*p*-(methylsulfinyl)-phenyl] ethylphosphonothioate)

Literature Cited

LOFGREN, C. S., MOUNT, G. A., and GLANCEY, B. M. 1967. Update on USDA research for control of adult mosquitoes. Pest Control 9(35):38–43.

LABORATORY BIOASSAY OF PESTICIDE-IMPREGNATED RUBBER AS A MOSQUITO LARVICIDE [1]

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The use of rubber as a carrier for mosquito larvicides represents a new variation of a known technique. Raley and Davis (1949) combined casting plaster and sawdust with a DDT-lindane mixture to control mosquitoes in California. Evans and Fink (1960); Symes, Thompson, and Busvine (1962); and Laird (1967) similarly achieved control using various chlorinated hydrocarbons impregnated into plaster of paris or cement. Barnes *et al.* (1967 and 1968) obtained control of mosquito larvae in laboratory and field experiments using Abate® (o,o,o′,o′-tetramethyl o,o′-thiodi-*p*-phenylene phosphorothioate) formulated into plaster of paris briquettes. Whitlaw and Evans (1968) achieved laboratory control of larval mosquitoes using Abate®, Dursban®, Dibrom®, or malathion impregnated into plastic pellets of polyvinyl chloride, polyurethane or polyamide.

The United States Army Environmental Hygiene Agency is currently involved in the development of long lasting, slow release, polymer-larvicide formulations for seasonal mosquito control. The following characteristics should be considered in the

[1] Mention of a proprietary product is for identification purposes only and does not necessarily imply endorsement by the United States Army.

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