WIND-TUNNEL TESTS WITH PROMISING INSECTICIDES AGAINST ADULT SALT-MARSH MOSQUITOES, *AEDES TAENIORHYNCHUS* (WIED.)

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INTRODUCTION. Salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.), the principal pest mosquitoes along the coastal areas of Florida, were first reported to have developed resistance to DDT by Deonier *et al.* (1950) and Deonier and Gilbert (1950). Between 1950 and 1955 BHC was the principal insecticide used against these species, but by the fall of 1955 this compound did not give satisfactory control in many areas of Florida. Gahan *et al.* (1956) found malathion, when tested as aerial sprays of fuel-oil solutions applied at dosages of ¼ to ½ pound per acre, to be effective against resistant adults of these two species. Since 1955 malathion has been the most widely used adulticide in Florida and today, 5 years after its first trial, is still producing excellent control. If these salt-marsh mosquitoes eventually do become resistant to this material, replacements will be urgently needed. Thus a continuous search is being conducted to find additional insecticides that can be used.

A laboratory testing program was initiated in 1957 to evaluate promising chemicals against adults of *A. taeniorhynchus*. This study is being conducted with selected chemicals that have produced at least 50 percent mortality of larvae of *Anopheles quadrimaculatus* Say at 1.0 p.p.m. The results of previous tests against *taeniorhynchus* adults have been reported by Davis and Gahan (1958) and Davis (1959). This paper presents the results obtained with the most effective of 53 additional compounds.

TESTING TECHNIQUE. Pupae from a laboratory colony were placed in small containers of water in groups of 1,000 to 2,000. The containers were placed inside cylindrical screen cages, 18 inches in length and 12 inches in diameter, close on one end with plywood and on the othe end with cloth sleeves (Fig. 1). Withi

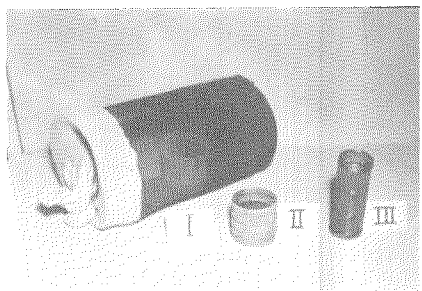

FIG. 1.—I, emergence cage; II, test cage; I holding cage.

3 days after emergence the adults we immobilized in a room with a consta temperature of 36° F. and distributed in testing cages made of galvanized met sleeves covered on each end with scree wire (Figs. 1, 2). Both males and femal were used and each cage received about adults. The mosquitoes were allowed recover fully from the low temperatu before being exposed to the insecticide.

The insecticides were dissolved in odc less kerosene and tested at concentratio ranging from 0.0025 percent to 0.25 pe cent in a wind tunnel, a cylindrical tube inches in diameter through which a c umn of air was moved at 4 m.p.h. by suction fan (Fig. 2). The cages of m quitoes were placed in the center of t tube. One-fourth ml. of insecticidal so tion was atomized at a pressure of 1 p. into the mouth of the tunnel, and the m quitoes were exposed to the solution n mentarily as it was drawn through t cage. Duplicate tests were run at ea

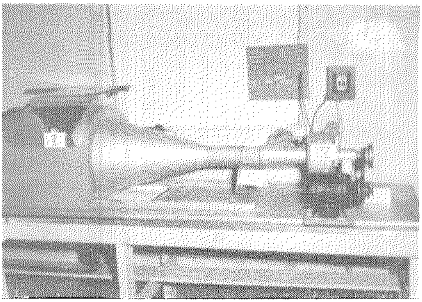

FIG. 2.—Wind tunnel. I, atomization chamber; , funnel; III, test cage; IV, suction fan.

oncentration. After treatment the mosuitoes were anesthetized with carbon ioxide, transferred to untreated screen olding cages (Figs. 1, 3), and held at a emperature of 84° F. and relative humidty of about 70 percent. A cotton pad satuated with a 20 percent honey-water soluion was placed on the top of each cage nd the mortality was recorded after 24 ours.

EFFECTIVE INSECTICIDES. The 15 insecticides listed below produced the highest mortalities and are considered sufficiently effective to merit testing in the field. The detailed results with these compounds and a malathion standard are given in Table 1.

Hercules AC-5727 (*m*-isopropylphenyl methylcarbamate)
Bayer 29952 (*O*-ethyl *O*-(*p*-methylthio) phenyl methylphosphonothioate)
Bayer 30554 (*O*-methyl *O*-(*p*-methylsulfinyl)phenyl methylphosphonothioate)
Dibrom (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate)
Bayer 30237 (*O*-methyl *O*-(*p*-methylthio)phenyl methylphosphonothioate)
Bayer 30468 (*O*-ethyl *O*-(*p*-ethylthio) phenyl methylphosphonothioate)
Dimethoate
Phosphamidon
American Cyanamid 12415 (*O,O*-diethyl *O*-[6-(3(2*H*)-pyridiazinonyl)] phosphorothioate)
DDVP
Union Carbide C&C-8305 (*p*-chloro-5-

ABLE 1.—Effectiveness of various insecticides in contact-spray tests against *Aedes taeniorhynchus* adults (6 tests)

	Percent mortality after 24 hours at indicated concentration (percent)							LC-90		
Insecticide	0.25	0.1	0.05	0.025	0.01	0.005	0.0025	Percent	Reciprocal ratio to malathion	Slope[a]
ercules AC-5727	..	..	..	..	100	84	27	0.0057	5.75	4.6
ayer 29952	..	..	..	100	91	50	..	.0103	3.18	3.5
ayer 30554	..	..	100	99	94	49	..	.0108	3.04	3.3
ibrom	..	..	..	100	83	17	2	.0133	2.47	4.7
ayer 30237	..	100	99	97	87	51	10	.0162	2.02	2.7
ayer 30468	100	98	99	96	67	27	..	.0251	1.31	2.2
alathion	..	..	96	87	30	..	..	.0328	1.00	3.3
imethoate	100	99	97	86	51	12	..	.0338	.97	2.7
hosphamidon	..	100	98	92	27	..	..	.0348	.94	3.8
merican Cyanamid 12415	100	97	96	93	33	..	..	.0374	.88	2.3
DVP	..	100	93	77	27	..	..	.0401	.82	3.2
nion Carbide C&C-8305	..	100	96	63	4	..	..	.0454	.72	4.3
onsanto CP-13206	100	99	97	51	13	..	..	.0571	.57	2.8
olan	99	97	93	79	23	..	..	.0576	.57	2.1
ilan	97	93	93	41	29	..	..	.0881	.37	1.9
ilan	95	79	55	24	3	..	..	.0993	.33	2.6

[a] Slope of log dosage-probit mortality regression line.

methyl-*p*-thio-2,4,3-dioxaphosphabicyclo[4.4.0]decane)
Monsanto CP-13206 (*S,S'*-thiodimethylene bis(*O,O*-diethyl phosphorodithioate)
Prolan (1,1-bis(*p*-chlorophenyl)-2-nitropropane
Bulan (1,1-bis(*p*-chlorophenyl)-2-nitrobutane)
Dilan (1 part of 1,1-bis(*p*-chlorophenyl)-2-nitropropane plus 2 parts of 1,1-bis (*p*-chlorophenyl)-2-nitrobutane)

Based on the computed LC-90 for each insecticide, six compounds were more toxic to adult mosquitoes than the malathion standard; Hercules AC-5727 was about 6 times as toxic, Bayer 29952 and Bayer 30554, 3 times, Dibrom and Bayer 30237, 2 times, and Bayer 30468, 1.3 times. The standard was about equal to dimethoate and phosphamidon, slightly better than American Cyanamid 12415 and DDVP, less than twice as effective as Union Carbide C&C-8305, Monsanto CP-13206, and Prolan, and more than twice as toxic as Bulan and Dilan.

Many materials that are highly effective against adult mosquitoes cannot be used in some situations because of their toxicit to mammals. For example, parathion which must be used cautiously, has a acute oral LD-50 to rats of 3.5 mg./kg (Lehman 1948), and DDT, which is con sidered relatively safe, has an acute ora LD-50 of 250 mg./kg. (Lehman 1950) Malathion has an acute oral LD-50 o 1,000 to 1,375 mg./kg. (Durham 1957) and is one of the safest insecticides know Table 2 lists the acute oral toxicity to rat and some of the physical properties of th insecticides in Table 1 as given by thei manufacturers. Based on this informatio Bayer 29952, Bayer 30554, and Bayer 3023 were more toxic than parathion and Baye 30468 was only slightly less toxic. Pho phamidon and American Cyanamid 1241 also were highly toxic. DDVP, Hercule AC-5727, and Monsanto CP-13206 wer 16, 4, and 2½ times, respectively, as saf as parathion. Dibrom was about twice a safe and Union Carbide C&C-8305 abo ½ as safe as DDT, whereas dimethoa was about equal to DDT. The acute or toxicities of Bulan and Dilan were abo the same as reported for malathion.

SUMMARY. Wind-tunnel tests were co

TABLE 2.—The physical properties of various insecticides and their toxicity to mammals [a]

Insecticide	Physical properties: State	Color	Odor	Acute ora toxicity (LD-50)[b]
Hercules AC-5727	Crystalline solid	White	Nearly odorless	15
Bayer 29952	Liquid	Yellowish	Very slight	1–2½
Bayer 30554	Liquid	Yellowish	Very slight	1
Dibrom	Liquid	Yellow	Slightly pungent	430
Bayer 30237	Liquid	Yellow	Rotton odor—strong	2½
Bayer 30468	Liquid	Yellowish	Sweet and weak odor	5–10
Malathion	Liquid	Amber	Pungent	1,000–1,3
Dimethoate	Solid	White	Pungent	185–325
Phosphamidon	Liquid	Off-white	Mild	c
American Cyanamid 12415	Crystalline solid	Yellow	Mild	Very toxi
DDVP	Liquid	Brownish	Nearly odorless	56–80
Union Carbide C&C-8305	Liquid	Clear amber	Mild	120
Monsanto CP-13206	Liquid	Amber	Slightly pungent	9
Prolan	Sticky semi-solid	Brown	Almond-like	d
Bulan	Sticky semi-solid	Brown	Almond-like	950
Dilan	Sticky semi-solid	Brown	Almond-like	1,100

[a] Based on information given by their manufacturer.
[b] Value for rats, based on mg./kg.
[c] LD-100, 50 mg./kg.
[d] No information available.

ducted with adults of *Aedes taeniorhynchus* (Wied.), to compare the toxicity of a malathion standard and a group of organic compounds known to be toxic to other species of insects. Among the chemicals superior to the standard were a carbamate and five organophosphorus compounds—Hercules AC-5727 (*m*-isopropylphenyl methylcarbamate), Bayer 29952 (*O*-ethyl *O*-(*p*-methylthio)phenyl methylphosphonothioate), Bayer 30554 (*O*-methyl *O*-(*p*-methylsulfinyl)phenyl methylphosphonothioate), Dibrom (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate), Bayer 30237 (*O*-methyl *O*-(*p*-methylthio)phenyl methylphosphonothioate), and Bayer 30468 (*O*-ethyl *O*-(*p*-ethylthio)phenyl methylphosphonothioate).

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CARBAMATE INSECTICIDES AS POTENTIAL MOSQUITO CONTROL AGENTS[1]

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The appearance of mosquito resistance to chlorinated hydrocarbons and more recently to organophosphorus insecticides makes it imperative that every new insecticide be thoroughly tested as a potential mosquito control agent.

Among the new types of insecticides, the carbamic acid esters have attracted much attention as a promising group of toxicants, especially since the introduction of Sevin ® (1-naphthyl *N*-methylcarbamate) as an agricultural insecticide. A number of laboratories are now actively engaged in synthesizing carbamates for potential use as insecticides, and many such compounds have already passed the initial laboratory screening stage.

In the present work we have investigated the activity of a large number of carbamates in the laboratory against larvae and adults of the mosquitoes *Culex 5-fasciatus* and *Anopheles albimanus*. We present here the results obtained with the more toxic carbamates against these mosquitoes, and compare them with data on chlorinated hydrocarbon and organophosphorus insecticides.

Table 1 shows the LC_{50} values obtained with some typical chlorinated hydrocarbon, organophosphorus, and carbamate insecticides against *C. 5-fasciatus* and *A.*

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