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RESPONSE OF *MUSCA DOMESTICA* AND SEVERAL SPECIES OF MOSQUITOES TO VARIOUS INSECTICIDES

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In the laboratory evaluation of insecticides against mosquitoes and flies, the test insect used is frequently a single species, a restriction that may be due to (a) the difficulty of rearing other species, (b) a limitation of time and/or manpower, or (c) the assumption that the response of one species of mosquitoes will be representative of mosquitoes in general. The last point is the basis for this discussion inasmuch as studies over the past several years at the Communicable Disease Center Laboratory at Savannah, Georgia, have provided an opportunity for examining the effect of various experimental insecticides on the house fly, *Musca domestica,* and on four species of mosquitoes, *Anopheles quadrimaculatus, Anopheles albimanus, Culex pipiens quinquefasciatus,* and *Aedes aegypti.* The data presented relate to the toxicity of the insecticides to these insects as a residual deposit, as a vapor, and/or as a larvicide.

In the residual treatment studies the toxicants were applied to plywood panels and the adult mosquitoes and house flies exposed to the deposits for 60 and 30 minutes, respectively. At the end of these exposure periods, the specimens were removed to clean containers and retained for 24 hours with food and water before the female mortality determinations were made. In the vapor tests, caged female mosquitoes were exposed to

TABLE 1.—*Chemical composition of experimental compounds tested.*[1,2]

Designation	Chemical Composition
AC 52, 160	Confidential compound
B-37342	0, 0-dimethyl 0-(3, 5-dimethyl-4-methylthiophenyl) phosphorothionate
B-37344	3, 5-dimethyl-4-methylthiophenyl N-methyl carbamate
bromophos	0, 0-dimethyl 0-2, 5-dichloro-thionophosphate
carbaryl	alpha-naphthyl-N-methyl carbamate
dicapthon	0-(2-chloro-4 nitrophenyl)-0, 0-dimethyl thiophosphate
dichlorvos	0, 0-dimethyl-0-2, 2 dichlorovinyl phosphate
dimethrin	2, 4-dimethyl benzylchrysanthamate
H-9699	*o*-propargoxyphenyl N-methyl carbamate
OMS-9	0-ethyl 0-(2, 4, 5-trichlorophenyl) ethyl phosphoramidothioate
OMS-23	0-(2, 4-dichlorophenyl) methyl ethyl phosphoroamidate
OMS-122	0-methyl 0-(2, 4, 5-trichlorophenyl) isopropyl phosphoramidothioate
OMS-290	0-ethyl 0-(2, 4, 5-trichlorophenyl) isopropyl phosphoramidothioate
OMS-297	0, 0-diethyl S(N-methyl-carbamoylmethyl) phosphorodithioate
N-2788	0-ethyl S-*p*-tolyl-ethylphosphonodithioate
N-3054	0-ethyl 0-(2, 4-dichlorophenyl) ethylphosphonothionate
RE-5353	*m-sec*-amylphenyl N-methylcarbamate
SD-7438	toluene-*a, a* dithiol-*bis* phosphorodithioate
SD-8447	Phosphoric acid, 2-chloro-(2, 4, 5-trichlorophenyl) vinyl dimethyl ester

[1] OMS compounds are those furnished through the World Health Organization. In addition, bromophos, dicapthon, dimethrin, N-2788, N-3054 and RE-5353 were obtained through this organization.

[2] Abbreviations for company designations are: AC = American Cyanamid, B = Bayer, H = Hercules, N = Stauffer Chem. Co., RE = California Chem. Co., and SD = Shell Chem. Co.

the vapor for 1 hour and the mortality determined 24 hours later. The larval tests were patterned after the WHO technique (Anon., 1960) in which late 3rd and early 4th instar larvae of the various species were held in the treated water (toxicant in ethanol added to water) for 24 hours at which time the mortality was assessed. The experimental compounds and their formulae are given in Table 1.*

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

Table 2 presents a comparison of residual activity of eight compounds against *A. quadrimaculatus* (dieldrin-resistant), *C. p. quinquefasciatus* (DDT: dieldrin-resistant), and two strains of *M. domestica* — Roberds (dieldrin: DDT-resistant) and Bethesda (malathion-resistant).

OMS-23, OMS-290, and dimethoate were ineffective against the species of mosquitoes tested, yet each was highly active against *M. domestica* (Roberds strain). Only OMS-290 gave sustained kills of the Bethesda strain.

Compounds RE-5353 and B-37344 exhibited no effect on house flies but displayed good activity against mosquitoes. OMS-9, fenthion and H-9699 (Table 2) showed activity against both flies and mosquitoes. OMS-9 was much more potent against *C. p. quinquefasciatus* than against *A. quadrimaculatus*. H-9699, in addition to its activity against flies and mosquitoes, also has been highly effective against a chlordane-resistant strain of the cockroach, *Blattella germanica*.

Table 3 compares the responses of *A. quadrimaculatus* (dieldrin-resistant), *A. albimanus* (dieldrin-resistant), *C. p. quinquefasciatus* (DDT: dieldrin-resistant), and *A. aegypti* (DDT-resistant) to residues of five toxicants. OMS-9 and RE-5353 were highly effective against *A. albimanus, A. aegypti,* and *C. p. quinquefasciatus;* yet each showed only limited activity against *A. quadrimaculatus*. Dicapthon was ineffective against *A. aegypti* but gave 16 to 27 weeks of 70-percent kill against the other three species. With the three species tested OMS-297 was effective only against *C. p. quinquefasciatus,* but this species was the only one that did not succumb to OMS-122.

In limited outdoor tests using the technique described by Schoof *et al.*, 1962, carbaryl, OMS-122, and dicapthon were tested on plywood panels. Only 1 week of effective kill was obtained with OMS-122 (200 mg./sq. ft.) against *C. p. quinquefasciatus,* but deposits on the same surface produced 9 and 17 weeks against *A. quadrimaculatus* and *A. aegypti*. Carbaryl (200 mg./sq. ft.) gave 22 and 13 weeks of 90-percent kills of *A. quadrimaculatus* and *C. p. quinquefasciatus,* respectively, but failed to give even 1 week of satisfactory kill against *A. aegypti*. Dicapthon (100 mg./sq. ft.) gave similar results.

In Table 4 the response of four species of mosquitoes to dichlorvos vapor is shown. *A. albimanus* was the species most sensitive to this toxicant.

Table 5 summarizes the responses of the larvae of *A. quadrimaculatus, C. p. quinquefasciatus,* and *A. aegypti* to nine compounds. *C. p. quinquefasciatus* was the species most susceptible to the various compounds. It required the lowest concentration of fenthion, bromophos, dimethrin, and AC-52,160. With the remainder of the toxicants, except for N-2788, the same concentration was required for *C. p. quinquefasciatus* and one of the other two species. With certain toxicants (dimethrin, bromophos, and B-37342), the concentration required for 95-percent kill of *A. aegypti* was 5 to 25 times that necessary for the same level of kill for the other two species.

TABLE 2.—*Effectiveness of insecticidal residues on plywood panels against female mosquitoes and house flies.*

Compound	Mg./sq. ft	No. of weeks of 70 percent or greater mortality			
		A. quad.[1]	*C. p.q inq.*[1]	*M. domestica*[2] (Roberds)	(Bethesda)
OMS-23	80	0	0	21	0
Dimethoate	200	0	—	24	0
OMS-290	200	0	0	21	17
RE-5353	200	6	13	0	0
B-37344	200	48	—	0	0
OMS-9	200	4	23	24	8
Fenthion	200	28+	—	21	—
H-9699	100	28+	28+	23(CSMA)[3]	—

[1] 60-minute exposure of mosquitoes to residues from suspension sprays.
[2] 30-minute exposure of house flies to residues from emulsifiable formulations.
[3] Susceptible strain.

TABLE 3.—*Effectiveness of insecticidal residues against four species of mosquitoes.*

Compound	Mg./sq. ft.	No. weeks of 70% or greater female mortality[1]			
		A. quad.	*A. albimanus*	*C. p.quinq.*	*A. aegypti*
OMS-9	200	4	27	23	19
RE-5353	200	6	13	13	13
Dicapthon	200	16	18	27	0
OMS-297	200	0	—	17	0
OMS-122	100	8	—	0	16

[1] 60-minute exposure to residues from suspension formulations.

TABLE 4.—*Response of four species of mosquitoes to 60-minute exposures to dichlorvos vapor.*[1]

Age (weeks) of dispenser	Percent female mortality at 24 hours			
	A. quad.	*A. albimanus*	*A. aegypti*	*C. p. quinq.*
1	100	100	100	100
2	43	100	95	82
3	100	100	93	100
4	12	76	11	61
5	58	100	54	94
6	8	70	1	20

[1] One 20-percent dichlorvos-resin dispenser per 1,000 cu. ft. of air in an insulated plywood hut with eave ventilation.

TABLE 5.—*Concentration (ppm) required for 95 percent or higher kill of mosquito larvae exposed for 24 hours.*

Compound	*A. quad.*	*C.p. quinq.*	*A. aegypti*
Fenthion	0.01	0.005	0.02
bromophos	0.02	0.004[1]	0.1
dimethrin	0.5	0.1	2.5
AC-52, 160	0.004	0.0005	0.004
SD-7438	0.1	0.02	0.02
SD-8447	>2.5	0.5	0.5
N-3054	0.1	0.5	0.5
B-37342	0.5	0.5	2.5
N-2788	0.1	0.1	0.1

[1] Lowest concentration tested.

The data presented again emphasize that the response of different species of mosquitoes to an insecticide may vary considerably depending on the species and the toxicant (Jakob and Schoof, 1963). In certain instances (Table 2, H-9699; Table 5, N-2788), different species gave similar responses; in others a minor or major difference in response occurred (Table 3). The findings emphasize that reliance on a single species for test purposes can lead to erroneous conclusions, particularly when the toxicant is being considered for field use against several species. Thus, dicapthon (Table 3) tested against *A. aegypti* or OMS-297 (Table 3) against *A. quadrimaculatus* could result in both compounds being rejected for possible use against *C. p. quinquefasciatus,* a species against which either toxicant is highly effective. Likewise, compounds such as OMS-9 and RE-5353 (Table 3) processed against *A. quadrimaculatus* could be eliminated *in toto* for use against anopheline vectors when actually they are highly effective against *A. albimanus.*

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STRAUS: Thank you, Dr. Schoof. Our next paper will be read by J. Edmund Lafferty. "Mosquito Extermination and Control in Lands of the Union County Park Commission."

LAFFERTY: Mr. Chairman, Mr. Secretary, members of the Association. One reason for your poor attendance, Mr. Chairman, this morning is possibly the weather that the New York area is having. About 6 this morning it started snowing in New York. There's about 2 inches on the ground according to the WOR weather report and on the F.D.R. Drive there was a 34-car accident and an hour and a half later 15 of the cars were still there.