municipal area were fairly resistant to DDT but *C. putoria* from the same area were susceptible to DDT. In houseflies tested from several rural areas of the island, there was considerable resistance to both dieldrin and DDT.

Bed-bugs tested from the unsprayed portion of Zanzibar town were moderately resistant to dieldrin and, at most, slightly tolerant to DDT. Bed-bugs from the dieldrin-sprayed rural areas were all highly resistant to dieldrin and slightly more tolerant to DDT. Similar results have been previously recorded elsewhere in East Africa, in Tanganyika,[c] where *C. hemipterus* from the dieldrin-sprayed South Pare region were highly resistant to dieldrin and almost as susceptible as normal bed-bugs to DDT.

Inasmuch as no control area, other than one area in Zanzibar town, was available, no conclusions could be reached as to what had been the effect, if any, of the development of dieldrin-resistance on the fly and bed-bug populations. The density of the housefly populations appeared to vary in accordance with the degree of environmental sanitation in the different places on the island. The bed-bug populations, although frequently heavy, showed considerable variation, even within an individual village, that could not be accounted for by the extent of insecticide-resistance. The substantial *C. putoria* populations result from the ubiquitous breeding of this species in the large number of pit privies in both the urban and rural areas of the island. This condition might be corrected without further use of insecticides by encouraging the introduction of water-seal latrines, which have proved effective against the same species elsewhere in Africa.[d]

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The author wishes to express his thanks to the Director and staff of the Zanzibar Medical Services and to the staff of the WHO Malaria Eradication Project in Zanzibar for their help in the survey.

[c] Smith, A. (1958) *Bull. Wld Hlth Org.*, **19**, 1124.

[d] As reported, for instance, by A. Lebrun at the WHO Symposium on Pesticides held in Brazzaville in 1959.

Toxicity of Diisopropyl 1,2,2,2-Tetrachloroethyl Phosphate and its Vinyl Analogue to Resistant Houseflies *

by R. L. METCALF *and* T. R. FUKUTO, *Department of Entomology, University of California, Riverside Calif., USA*

The discovery of insecticidal materials appreciably more toxic to insecticide-resistant strains of insects than to susceptible strains, i.e., with a negatively correlated pattern of cross-resistance, could represent a major development in the control of such resistant insects.[a] It was, therefore, with intense interest that we noted the report that a crude preparation of diisopropyl 1,2,2,2-tetrachloroethyl phosphate was from two to six times more toxic to a DDT-resistant strain of houseflies (Orlando-Beltsville) than to a susceptible strain (NAIDM).[b] It has also been further stated on the basis of preliminary information that selection with another crude preparation of this compound for three generations on a DDT-resistant strain containing 5 % of susceptible individuals transformed it into a DDT-susceptible strain.[c]

In order to determine whether the differential activity reported was specifically associated with the diisopropyl compound, since this compound was not purified and similar results were not observed with the corresponding methyl, ethyl, propyl, and butyl esters, we repeated the preparation of diisopropyl 1,2,2,2-tetrachloroethyl phosphate from both the purified and the crude starting product, i.e., diisopropyl 2,2-dichlorovinyl phosphate,[d] and characterized the pure compound. The insecticidal activity of both crude and pure preparations was evaluated to a susceptible strain of *Musca domestica* (NAIDM), to a strain resistant to a chlorinated hydrocarbons (Super Pollard), and to a chlorthion-

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[a] Ascher, K. R. S. (1958) *Bull. Wld Hlth Org.*, **18**, 675.

[b] Mitlin, N., Babers, F. H., & Barthel, W. F. (1956) *J. econ. Ent.*, **49**, 544.

[c] Brown, A. W. A. (1958) *Insecticide resistance in arthropods*, Geneva, p. 152 (*World Health Organization: Monograph Series*, No. 38).

[d] Babers, F. H. & Mitlin, N. (1955) *J. econ. Ent.*, **48**, 430.

TOXICITY OF PHOSPHATES TO SUSCEPTIBLE AND RESISTANT HOUSEFLIES

Compound	I_{50} to fly cholinesterase (moles)	Topical toxicity (γ per fly)					
		^{S} NAIDM		^{R} Super Pollard		^{R} Stauffer Chlorthion	
		LD_{50}	LD_{95}	LD_{50}	LD_{95}	LD_{50}	LD_{95}
I. Diisopropyl 2,2-dichlorovinyl phosphate (pure)	3.9×10^{-8}	0.37	0.85	1.2	3.4	>10	—
II. Diisopropyl 1,2,2,2-tetrachloroethyl phosphate (pure)	1.2×10^{-7}	1.4	3.1	>10	—	>10	—
III. Pure I, chlorinated, undistilled	—	2.1	5.3	>10	—	>10	—
IV. Impure I, chlorinated, undistilled	—	0.64	1.5	4.0	7.0	7.6	15

and malathion-resistant strain (Stauffer chlorthion), by topical application of 1-microlitre drops of acetone solutions, and mortalities were determined after 24 hours at 60° F (15.6° C). Dosage mortality curves were replicated three times using 20 two- to four-day-old female flies at each point.

Diisopropyl 2,2-dichlorovinyl phosphate (compound I) was prepared as described by Perkow [e] and was obtained as a colourless oil, b.p. 78°-80° C at 0.5 mm, n_D^{29} 1.4366. Diisopropyl 1,2,2,2-tetrachloroethyl phosphate (compound II) was prepared from compound I by chlorinating with dry chlorine for 3½ hours in carbon tetrachloride. The solvent was removed and the product distilled under vacuum to give a pale yellow-green oil, b.p. 122°-126° C at 0.6 mm, n_D^{27} 1.4539. Analysis: Theory, C = 27.72%, H = 4.34%; found, C = 27.71%, H = 4.60%. Infra-red spectrophotometry with a Perkin Elmer Model 21 showed the following significant absorptions:

Compound I: P = O, 1275 cm^{-1}; POC, 1015 cm^{-1}; C = C, 980 cm^{-1}, 1650 cm^{-1}.

Compound II: P = O, 1280 cm^{-1}; POC, 1020 cm^{-1}; no absorption in vinyl regions. Therefore the identity of compound II was fully confirmed.

A summary of the toxicity data obtained is given in the table. No evidence of negative correlation of either pure or impure diisopropyl 1,2,2,2-tetrachloroethyl phosphate (compounds II, III, IV) or its vinyl analogue diisopropyl 2,2-dichlorovinyl phosphate (I) with either the chlorinated-hydrocarbon-resistant or phosphate-resistant strains, was observed. Compound I was about four times as toxic to the susceptible strain of flies as compound II, and the LD_{50} values for compound I to susceptible (0.37 γ per fly) and chlorinated-hydrocarbon-resistant strains (1.2 γ per fly) were in good agreement with the corresponding values of 0.30 and 0.90 obtained by Babers & Mitlin.[c]

However, with pure compound II the LD_{50} to susceptible flies (1.4 γ per fly) was considerably higher than that of the crude preparation of Mitlin Babers & Barthel [b] (0.77 γ per fly), and in our tests this compound did not kill either resistant strain of flies at the highest level tested (10 γ per fly). Additionally, we found compound II to be a good inhibitor of fly cholinesterase (median inhibition dose (I_{50}), 1.2×10^{-7} M) while Mitlin et al.[b] found an (I_{50} to red cell cholinesterase of 7.0×10^{-2} M. This, together with the fact that these authors did not purify their compound, suggests that the case of negative correlation cannot be laid to the pure diisopropyl 2,1,1,1-tetrachloroethyl phosphate.

To determine whether the results observed by Mitlin et al. were due to an impurity formed during the reaction, the diisopropyl 2,1,1,1-tetrachloroethyl phosphate was resynthesized from a sample of compound I prepared as described by Perkow, but not distilled. The crude reaction product was chlorinated and the product isolated as compound IV. An additional fraction (compound III) was prepared by chlorinating pure compound I but not distilling the final product. These two fractions should contain all the possible impurities formed during synthesis of compound II. Topical toxicity tests showed that compound III was less toxic than compound II to susceptible flies, as would be expected since it was not distilled. However, compound IV was substantially more toxic, with an

[e] Perkow, W. (1954) *Chem. Ber.*, **87**, 755.

LD_{50} of 0.64 γ per fly, and of about the same activity as the crude product of Mitlin et al. However, compounds III and IV were both much less effective to the two resistant strains than to the susceptible strain.

Infra-red absorption spectra of compounds III and IV showed no trace of absorption in the vinyl regions, indicating the absence of unchlorinated compound I. The spectra of compounds III and IV differed from the spectrum of compound II only in the presence of a broad absorption band at 1500 to 1625 cm^{-1}.

Fractions I, II, III, and IV were examined in a nuclear magnetic resonance spectrometer (Varian Model 4330-C) using both hydrogen (56.4 mc) and phosphorus (24.3 mc) probes. The phosphorus and hydrogen spectra of compounds I and II indicated that these compounds were quite pure. The phosphorus spectrum of compound III indicated that it was predominantly a mixture of compound II and a compound different from compound I. The peak ratio of compound II and the unkown compound was about 3 : 1. The phosphorus spectrum of compound IV showed that it consisted mainly of compounds I and II in about equal quantities. The hydrogen spectra of compounds III and IV substantiated the information found with the phosphorus probe.

It is concluded that the data suggest the presence of a toxic impurity in fraction III, which is not the starting material, compound I. However, this impurity was of relatively low activity and no evidence of negative correlation with resistance could be detected. It is possible, of course, that examination of the toxicity of these compounds against other resistant strains might produce information of additional value. However, the over-all low degree of toxicity to flies displayed by the compounds of this series, and the lack of demonstrated negative correlation make it doubtful whether the laborious effort necessary to determine the nature of the impurity would be worth while.

The Control of Polyvalent Resistant Houseflies in Switzerland

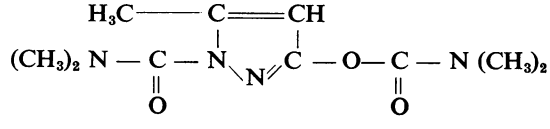
by R. WIESMANN, Ph.D., *Chief Entomologist, Research Laboratories, J. R. Geigy, S.A., Basle, Switzerland*

In the canton of Valais and some other districts of Switzerland polyvalent resistant strains of houseflies (*Musca domestica*) appeared for the first time in 1957. The application of chlorinated hydrocarbons and phosphoric esters such as parathion or diazinon proved to be ineffective. The subsequent use of newer phosphoric ester insecticides was a success for a short initial period only and led to a pronounced resistance within the same season. It was imperative, therefore, to look for other possibilities and methods for the control of houseflies in human dwellings as well as in stables.

As no new groups of contact insecticides have recently been discovered, ways and means for the use of baits in this particular field of pest control have been investigated. Dimetilane (Geigy), a chemical compound belonging to the carbamates, gave excellent results in 1958 under practical conditions in large-scale tests in the canton of Valais. In 1959 outstanding results were obtained all over Switzerland.

Physical properties and toxicity

The structural formula of Dimetilane is 2-dimethylcarbamyl-3-methyl-pyrozolyl-(5)-dimethyl-carbamate:



Dimetilane has a boiling-point of 200°-210°C and a melting-point of 68°-71°C. The water solubility is high.

The acute toxicity to the mouse is 40 mg/kg body-weight, and to the rat, 47 mg/kg body-weight.

Experiments with rabbits and rats exposed to Dimetilane fly bands at ten times the normal dose recommended for fly control in barns showed that under these much more severe conditions the cholinesterase activity in the blood was not reduced significantly. The treated animals showed even a higher weight gain than the control group.