sollicitans were infected with an average of 61.2 parasites per individual, and one showed host resistance. Only one other *Aedes taeniorhynchus* was infected. *Aedes aegypti* was the least resistant of the species, however, it was considerably more resistant than *Aedes sollicitans*. It appears that when *Agamomermis culicis* gains entrance to a host and resistance occurs, it occurs in the larval state; the method of resistance is not known.

Since mortality was high in *Aedes sollicitans* parasitized by *Agamomermis culicis*, the parasite significantly reduced some populations of *Aedes sollicitans* in southwestern Louisiana. Therefore, the nematode is sometimes an effective biological control agent for *Aedes sollicitans* and it might be well worth the effort to disseminate it into new areas.

ACKNOWLEDGMENT. The authors thank F. E. Glenn, Jr., R. V. Cloud, V. W. Smith, and H. C. Chapman, Entomology Research Division, ARS, USDA, Lake Charles, Louisiana, for their assistance.

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COMPARATIVE TOXICITY OF DURSBAN® AND ITS DIMETHYL ANALOG (OMS 1155) TO INSECTICIDE-SUSCEPTIBLE AND RESISTANT *CULEX* AND *ANOPHELES* MOSQUITOES[1]

G. P. GEORGHIOU, R. L. METCALF AND RUTH MILHOLLIN

Department of Entomology, University of California, Riverside

The introduction of Dursban® (*O-O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate) as a wide spectrum insecticide (Gray 1965, Kenaga *et al.* 1965) has aroused considerable interest in this and other pyridyl phosphate compounds (Rigterink and Kenaga 1966). Of particular importance is the high order of toxicity of Dursban to mosquito larvae and adults. Our data indicate that against larvae of *Culex pipiens fatigans* Wied., Dursban toxicity exceeds that of malathion by a factor of 37, DDT by 12, fenitrothion by 10, and fenthion by 3 (Georghiou *et al.* 1966); it also exceeds that of Abate® (*O,O*-dimethyl phosphorothioate *O,O*-diester with 4,4′-thiodiphenyl) by a factor of 2 against larvae of *Aedes taeniorhynchus* (Wied.) (Gahan *et al.* 1966). In field tests Dursban was found effective against a variety of mosquito species (Lewis *et al.* 1966, Ludwig and McNeil 1966), and at recommended dosages, it was reported to be safe to fish (Ferguson *et al.* 1966) shrimp and crabs (Ludwig *et al.* 1967).

The mammalian toxicity of Dursban (LD_{50} oral, rats, 135 mg/kg) is somewhat higher than that of other new larvicides such as fenthion (215–245 mg/kg), fenitrothion (250–670 mg/kg), and Abate (1766 mg/kg). Among other pyridyl phosphates, the dimethyl analog of Dursban, OMS 1155 (*O,O*-dimethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate) (Rigterink and Kenaga 1966) exhibits remarkably low mammalian toxicity (>1600

[1] This study was supported in part by Public Health Service research grant CC 00301 from the National Communicable Disease Center, Atlanta, Georgia.

mg/kg) (Dow Chemical Co., personal communication); our screening data show this compound to be nearly as toxic to mosquitoes as Dursban itself. Since new insecticides are more likely to be used against mosquito populations that are already resistant to older compounds, our tests were performed against larvae and adults of susceptible as well as resistant strains of *Culex p. fatigans* and *Anopheles albimanus* Wied.

MATERIALS AND METHODS. The following strains of mosquitoes were used:

Culex p. fatigans

- Susceptible standard reference strain maintained in our laboratory for over 18 years without intentional exposure to insecticides.
- DDT-resistant strain, derived from a field strain (Coachella Valley of southern California) by DDT selection pressure. It is now fully resistant to DDT (LC_{50}, larvae, 6.4 p.p.m.).
- Arprocarb-resistant strain, also derived from the Coachella strain, and showing 25-fold resistance to this carbamate (arprocarb = Baygon®) (Georghiou *et al.* 1966).
- Fenitrothion-selected strain, derived from the Coachella strain by fenitrothion pressure over 30 generations but showing only 2.2-fold tolerance to this compound (LC_{50}, larvae, 0.048 p.p.m.) (Georghiou and Calman 1968).

Anopheles albimanus

- Susceptible strain, received from Mexico through the University of Illinois.
- DDT-resistant strain, derived from a Panamanian strain by DDT pressure. Moderately resistant to DDT (LC_{50}, larvae, 0.21 p.p.m.).
- Dieldrin-resistant strain, also derived from the Panamanian strain. Fully resistant to dieldrin (LC_{50}, larvae, 3.3 p.p.m.)

The rearing and testing methods used were described in earlier publications (Georghiou and Metcalf 1961, Georghiou *et al.* 1966). Each test was replicated at least four times with populations reared on different days, and the results were subjected to probit analysis by the method of Finney (1952) on a programmed IBM 7040 computer. Most of the tests were run on larvae, since the resistant strains had been selected at this stage and, in consequence, resistance was more pronounced in larvae than in adults. The adult tests were limited to the susceptible strains and were intended to supplement the data on the comparative toxicity of the two compounds. Technical grades of Dursban and OMS 1155 were supplied by the Dow Chemical Company and were used as received.

RESULTS AND DISCUSSION. The LC_{50} values of each compound on each strain, the degree of tolerance (RR = resistance ratio) of each R strain as compared with the respective S strain, and finally the toxicity ratio of OMS 1155 vs. Dursban are given in Table 1.

The LC_{50} and RR data indicate that both compounds are extremely toxic to the susceptible, as well as to the resistant, strains. It is noteworthy, although not surprising, that neither the highly DDT-resistant strain of *Culex* nor the highly dieldrin-resistant strain of *Anopheles* show cross-tolerance toward either compound. Small but significant levels of tolerance are present only in the fenitrothion and arprocarb strains, the highest level (2.4-fold) being toward OMS 1155 in the arprocarb strain of *Culex*.

After this study was completed, Gillies *et al.* (1967) reported that in o-p multiresistant field strains of *Aedes nigromaculis* (Ludlow) in California, a 10-fold increase in tolerance to fenthion was accompanied by a 6- to 7-fold increase in tolerance to EPN and Dursban, and by a 12-fold increase in tolerance to Abate. Although the problem of extremely high o-p multiresistance appears at present to be confined to *Aedes nigromaculis* in the Central Valley of California, it illustrates the disconcerting fact that cross-resistance may place some otherwise extremely promising in-

TABLE 1.—Comparative toxicity of Dursban® and its dimethyl analog (OMS 1155) to susceptible and resistant strains of *Culex pipiens fatigans* and *Anopheles albimanus*.

Strain	Dursban LC50 (and 95% fiducial limits)	Dursban RR[a]	OMS 1155 LC50 (and 95% fiducial limits)	OMS 1155 RR[a]	Toxicity ratio LC50 OMS 1155 / LC50 Dursban
		Larvae[b]			
Culex Suscept.	0.00174 (0.00157–0.00194)	...	0.00255 (0.00237–0.00274)	...	1.5
Culex Fenitrothion	0.00338 (0.00329–0.00347)	1.9	0.00401 (0.00391–0.00411)	1.6	1.2
Culex Arprocarb	0.00327 (0.00314–0.00341)	1.9	0.00602 (0.00538–0.00686)	2.4	1.8
Culex DDT	0.00173 (0.00168–0.00179)	1.0	0.0024 (0.0023–0.0025)	0.9	1.4
Anopheles Suscept.	0.00631 (0.00598–0.00666)	...	0.0168 (0.0160–0.0177)	...	2.7
Anopheles DDT	0.00741 (0.00683–0.00796)	1.2	0.0166 (0.0157–0.0176)	1.0	2.2
Anopheles Dieldrin	0.00692 (0.00649–0.00738)	1.1	0.016 (0.015–0.017)	1.0	2.3
		Adults[c]			
Culex Suscept.	0.383 (0.361–0.407)		0.119 (0.111–0.129)	...	0.31
Anopheles Suscept.	0.386 (0.323–0.463)		0.168	...	0.44

[a] RR (resistance ratio) = LC_{50} resistant strain ÷ LC_{50} susceptible strain.
[b] LC_{50} in p.p.m.
[c] LC_{50} in $\mu g/cm^2$.

secticides in jeopardy even before their field use.

Data in Table 1 also indicate that *A. albimanus* larvae are more tolerant of both compounds by a factor of 3- to 6-fold than are larvae of *Culex p. fatigans*. This appears to be the case, as well, with most other compounds studied earlier (Georghiou and Metcalf 1961). Finally, the toxicity ratios of OMS 1155 vs. Dursban show that the latter is more toxic (1.2–2.7x) to larvae of both species studied while the former is more toxic to adults. High toxicity toward adult mosquitoes is an especially valuable asset of OMS 1155 since its low mammalian toxicity renders it promising for use in human habitations.

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