SUSCEPTIBILITY OF *TOXORHYNCHITES RUTILUS RUTILUS* TO FIVE ADULTICIDES CURRENTLY USED FOR MOSQUITO CONTROL[1]

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ABSTRACT. One pyrethroid and four organophosphorous (OP) insecticides were evaluated as contact aerosols in wind tunnel tests against adult *Toxorhynchites rutilus rutilus* (Coquillett). The data indicate that *Tx. r. rutilus* and *Culex quinquefasciatus* Say were not significantly different in susceptibility to malathion (*0,0*-dimethyl phosphorodithioate of diethyl mercaptosuccinate), fenthion (*0,0*-dimethyl *0*-[4-(methylthio)-*m*-tolyl] phosphorothioate), naled (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate), and chlorpyrifos (*0,0*-diethyl *0*-(3,5,6-trichloro-2-pyridyl) phosphorothioate). Resmethrin [5(phenylmethyl)-3-furanyl]methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclo propanecarboxylate (approx. 70% *trans*, 30% *cis*-isomers)) was ca. 1.4X more toxic to *C. quinquefasciatus* than to *Tx. r. rutilus*. *Aedes aegypti* (L.) was ca. 2X more susceptible than *Tx. r. rutilus* to 3 of the 4 OP's tested and ca. 16X more susceptible to resmethrin. Chlorpyrifos was equally toxic to *Ae. aegypti* and *Tx. r. rutilus*. Male and female *Tx. r. rutilus* did not differ significantly in their response to the insecticides tested.

Interest in the predaceous genus of mosquito *Toxorhynchites* (Theobald) has recently been renewed (Brown 1973, Furmizo et al. 1977, Focks et al. 1977, and Gerberg and Visser 1978), partly because of the existence of endemic dengue fever in the Caribbean and the role played by the container-breeding mosquito *Aedes aegypti* (L.) in transmission of the disease. Computer simulations of an integrated control strategy that would incorporate releases of adult *Toxorhynchites rutilus rutilus* (Coquillett) and the use of adulticides suggest that in certain situations it may be possible to use the strategy to eliminate populations of these vectors (Focks et al. 1978). Because of this potential of *Tx. r. rutilus* as a biocontrol agent and the need to integrate biological and chemical control techniques, we undertook studies to determine the relative effectiveness of 5 commonly used mosquito adulticides against adult male and female *Tx. r. rutilus*.

[1] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended.

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METHODS AND MATERIALS

The *Tx. r. rutilus* adults tested were taken from our laboratory colony; the original material came from Gainesville and Vero Beach, Florida. The rearing techniquies employed have been described previously (Focks et al. 1977). The mosquitoes were ca. 14 days old at the time of the test. Both sexes were used in approximately equal numbers. The data were analyzed to determine if there were any sex related differences in response to the insecticides.

Four organophosphates (OP) were tested: malathion (*0,0*-dimethyl phosphorodithioate of diethyl mercaptosuccinate), naled (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate), chlorpyrifos (*0,0*-diethyl *0*-(3,5,6-trichloro-2-pyridyl) phosphorothioate), and fenthion (*0,0*-dimethyl *0*-[4-(methylthio)-*m*-tolyl] phosphorothioate). The one synthetic pyrethroid tested was resmethrin [5(phenylmethyl)-3-furanyl] methyl 2,2-dimethyl-3-(2-methyl-1-propenyl(cyclopropanecarboxylate (approx. 70% *trans*, 30% *cis*-isomers).

All compounds were tested as contact sprays in a wind tunnel (Mount et al. 1976). This device consisted of a cylindrical tube 15.5 cm in diameter through which a column of air (ca. 23°C and ca. 50% RH) was blown at a rate of 1.8 m/sec (ca. 4 mph). Adult mosquitoes (10/cage) were confined in cardboard exposure cages, 8.6 cm in diameter and 5.0 cm high, with 16-mesh galvanized wire screen ends; the cages were held in the center of the wind tunnel tube for exposure. Upwind of the insects, a 0.1 ml solution of the desired concentration of insecticide in acetone (wt. AI/vol. diluent and expressed as % concentration) was atomized at a pressure of 105 g/cm^2.

Following exposure, the insects were anesthetized with carbon dioxide and transferred to new 8.6 X 5.0-cm cardboard holding cages covered with nylon screen tops. Insects in each cage were provided with a 10% sucrose solution on cotton. The holding cages were held at ca. 23°C and ca. 50% RH. Knockdown was checked 60 min after treatment, and mortality was recorded 24 hr after treatment. Controls were exposed to contact sprays containing acetone only and handled in the same manner.

Each insecticide was initially tested once with 10 mosquitoes at each of 2 doses slightly above and 2 doses slightly below the average LC-90 for *Ae. aegypti* and *Cx. quinquefasciatus*. The estimated LC-10, -25, -50, -75, and -90's obtained from a log-transformed probit analysis of the resulting data were used as the 5 test dosages at which each compound was subsequently tested. In this manner, virtually all the doses used were discriminating and 3 replicates of 5 doses each (30 mosquitoes/dose) were conducted for each of the 5 compounds. The dose-response relationship was determined by probit analysis of the log-transformed mortality data. Abbott's formula was applied to correct for control mortality (the average control mortality was less than 0.2%).

RESULTS AND DISCUSSION

The 24 hr LC-50's and LC-90's and their respective 95% fiducial limits are presented in Table 1. The compounds are ranked in order of decreasing toxicity (LC-90) to *Tx. r. rutilus*. The LC-90's for the same compounds against *Ae. aegypti* and *Cx. quinquefasciatus* are included for comparison (Mount and Pierce 1973, 1975).

The results indicate that *Ae. aegypti* was nearly twice as susceptible to malathion, naled, and fenthion as *Tx. r. rutilus* and not significantly different (p=0.05) in susceptibility to chlorpyrifos. Resmethrin

Table 1. Toxicity of aerosols of insecticides (% concentration) to caged adult *Toxorhynchites rutilus rutilus* (Coquillett) of both sexes, of *Aedes aegypti* (L.) and *Culex quinquefasciatus* (Say) exposed in a wind tunnel.

	Tx. r. rutilus				*Ae. aegypti*	*Cx. quinquefasciatus*
Insecticide	24 hr LC-50	95% Fiducial limits	24 hr LC-90	95% Fiducial limits	24 hr LC-90	24 hr LC-90
Fenthion	0.0061	0.0056–0.0067	0.0142	0.0125–0.0169	0.008[b]	0.016[b]
Chlorpyrifos	.0070	.0065– .0076	.0152	.0135– .0179	.012[c]	.011[c]
Naled	.0139	.0129– .0148	.0212	.0192– .0248	.012[b]	.020[b]
Resmethrin	.0063	.0045– .0087	.0258	.0168– .0563	.001[c,d]	.019[c,d]
Malathion	.0166	.0135– .0199	.0525	.0407– .0767	.026[b]	.070[b]

[a] ca. 14 days old.
[b] Data from Mount and Pierce (1973).
[c] Data from Mount and Pierce (1975).
[d] Values reported are the average LC-90 for *d-cis-* and *d-trans*-resmethrin.

appeared to be ca. 16X more toxic to *Ae. aegypti* than to *Tx. r. rutilus*. None of the OP compounds tested revealed significant differences ($p=0.05$) between susceptibility of *Tx. r. rutilus* and *Cx. quinquefasciatus*. Resmethrin was ca. 1.4X more toxic to *Cx. quinquefasciatus* than to *Tx. r. rutilus*.

Resmethrin and naled produced relatively quick knockdown (within 1 hr) at concentrations near that required for 24-hr kill. Fenthion and chlorpyrifos demonstrated no knockdown within 1 hr, and malathion showed only moderate knockdown.

When 2 of the 4 replicates were analyzed for differences in response by sex, no difference was found ($n=919$ mosquitoes, χ^2 (corrected) $= 0.58$).

Except for the use of resmethrin, there seems to be little possibility of applying an insecticidal dose sufficient to control prey adults without affecting the predaceous adult population. The difference in susceptibility to resmethrin between *Ae. aegypti* and *Tx. r. rutilus* may be great enough that a discriminating dose could be applied in the field during a release program. Monitoring adult predator releases has indicated that laboratory-reared adults die at ca. 20% per day in the field (Focks et al. 1979). This would suggest the optimal times for adulticiding to be immediately prior to and several days after a predator release. The proportion of predator adults alive on any particular day subsequent to a release is given by the expression: S_a^t where S_a is the adult daily survival (ca. 80%) and t being the number of days after the release. Using this expression for field mortality, one would expect ca. 32% of the adults released to be alive 5 days after a release and only 10% alive 10 days after a release.

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