SUSCEPTIBILITY OF *TOXORHYNCHITES AMBOINENSIS* AND *AEDES AEGYPTI* TO SEVERAL 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 amboinensis* and *Aedes aegypti. Aedes aegypti* was not substantially more susceptible than *Tx. amboinensis* to the compounds tested. Except for resmethrin, *Ae. aegypti* was on the average 1.60 times more susceptible to the OP insecticides than *Tx. amboinensis; Tx. amboinensis* was actually 2.74 times more susceptible to resmethrin than *Ae. aegypti.* The results suggest that the female *Toxorhychites* may be less susceptible than the males to all of the compounds tested.

For the past 4 years, the New Orleans Mosquito Control organization and the Insects Affecting Man and Animals Research Laboratory, ARS, USDA, have been evaluating various species of *Toxorhynchites* (Theobald) as biocontrol agents of mosquitoes breeding in artificial containers such as *Aedes aegypti* (L.) and *Culex quinquefasciatus* Say. *Toxorhynchites rutilus rutilus* (Coquillett) was too strictly oriented to trees and other vertical objects when searching for oviposition sites to be of much value in the control of mosquitoes breeding in artificial containers at ground level (Focks et al. 1983a). Subsequently, it was demonstrated that *Toxorhynchites amboinensis* (Doleschall) would oviposit in virtually all of the various types of artificial containers commonly found in substandard urban areas of New Orleans (Focks et al. 1983b). Computer simulations (Focks et al. 1978) suggested that in certain situations it may be possible to employ regular releases of *Toxorhynchites* adults integrated with insecticidal control measures to significantly reduce populations of artificial container-breeding mosquitoes. Toward this end, we have determined the comparative susceptibilities of *Tx. amboinensis* and *Ae. aegypti* adults to several commonly used mosquito adulticides.

MATERIALS AND METHODS

The *Tx. amboinensis* used in this study came from a colony maintained by Robert Copeland, Department of Tropical Medicine, Louisiana State University Medical Center, New Orleans, Louisiana. This laboratory colony was established from stocks obtained from the National Institutes of Health Pacific Research Center (NIHPRC) in Honolulu, Hawaii. The NIHPRC colony was derived from a field population of *Tx. amboinensis* that had become established on the island of Oahu, Hawaii, following the 1953 introduction from the Philippines (Hu 1955). The *Ae. aegypti* were reared from eggs collected from oviposition traps in New Orleans. Both species were maintained by methods described earlier (Focks et al. 1977, Focks and Boston 1979). The *Tx. amboinensis* adults were ca. 12 days old when tested and equal numbers of both sexes were used; this age was used because laboratory-reared predators are normally held in the insectary for 6 to 8 days prior to release. *Aedes aegypti* adults were ca. 5 days old when tested and only females were used. The *Tx. amboinensis* data were analyzed to determine if there was a sex related difference in susceptibility.

The one synthetic pyrethroid tested was resmethrin [5(phenylmethyl)-3-furanyl) methyl 2,2-dimethyl-3-(2-methyl-1-prophenyl)cyclopropanecarboxylate; approximately 70% *trans* and 30% *cis*-isomers]. Four organophosphates were tested: fenthion (0,0-dimethyl 0-(4-(methylthio)-m-tolyl)phosphorodithioate), chlorpyrifos(0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl)phosphorothioate), naled (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate), and malathion (0,0-dimethyl phosphorothioate of diethyl mercaptosuccinate). The sixth adulticide was a mixture (19:1) of malathion and resmethrin. Dilutions were made with acetone on a weight AI/volume of diluent basis.

All compounds were tested as aerosol sprays in a wind tunnel described by Mount et al. (1976). This device consisted of a cylindrical tube 15.5 cm diam through which a column of air (ca. 23°C and 50% RH) was blown at a rate of 1.8 m/sec. Adult mosquitoes were confined in cardboard exposure cages (8.6 cm diam 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 0.25 ml solution of the desired con-

[1] This paper reflects the results of research only. Mention of a pesticide in this paper does not constitute a recommendation of this product by the U.S. Department of Agriculture and/or the University of Florida.

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centration of insecticide was atomized at a pressure of 10.3 kPa.

Immediately following exposure, the insects were anesthetized with carbon dioxide and transferred to new cardboard holding cages covered with aluminum screen tops, provided with a cotton ball soaked with a 10% sucrose solution, and held at ca. 23°C and 50% RH. Mortality was observed 24 hr after treatment. Controls were exposed to an aerosol of acetone alone and handled in the same manner.

Each insecticide was initially tested once with 10 mosquitoes of each species at each of 2 doses slightly above and below the average ED-50 (Estimated Dose required to produce 50% kill) for *Ae. aegypti* and *Cx. quinquefasciatus* (Mount and Pierce 1973, 1975). The estimated ED-10, -25, -50, -75, and -90's obtained from probit analyses of the resulting data were used as the 5 test dosages at which each compound was subsequently tested. In this manner, virtually all of the doses were discriminating. After the initial screening test, 3 replicates (each on a different day) employing the 5 calculated concentrations of each compound were conducted; for *Tx. amboinensis,* a replicate consisted of 2 or 3 cages of 5 adults of each sex/concentration, and for *Ae. aegypti,* 3 cages of 25 females/cage/concentration. The dose-response relationship was determined by the probit analysis program of the Statistical Analysis System using mortality data that had been corrected for control mortality by Abbott's formula. Control mortality averaged 0.8 and 0% for *Ae. aegypti* and *Tx. amboinensis,* respectively, for all tests.

RESULTS AND DISCUSSION

The 24-hr ED-50's and -90's and their respective 95% fiducial limits are presented in Table 1. The compounds are listed in order of decreasing toxicity (ED-90's) to *Tx. amboinensis.* The results indicate that the New Orleans strain of *Ae. aegypti* was not substantially more susceptible than *Tx. amboinensis* to the compounds tested. On the average, and with the exception of resmethrin, the ED-90 values for *Ae. aegypti* were 1.6 times greater than *Tx. amboinensis;* these differences were significant only with naled and chlorpyrifos. In contrast to earlier work indicating that *Tx. r. rutilus* was ca. 16X less susceptible than *Ae. aegypti* to resmethrin (Focks et al. 1979), *Tx. amboinensis* was actually 2.7 times more susceptible to this insecticide than *Ae. aegypti.* Table 2 presents the results of probit analyses on the *Tx. amboinensis* data by sex and compound. As measured by the ED-90's, the females of this species were somewhat

Table 1. Toxicity of aerosols of insecticides (mg/ml) to caged adult *Toxorhynchites amboinensis* (both sexes) and *Aedes aegypti* (females only) exposed in a wind tunnel.

	Toxorhynchites amboinensis		*Aedes aegypti*	
Compounds	24-hr ED-90	95% fiducial limits	24-hr ED-90	95% fiducial limits
Resmethrin	0.019	0.012–0.227	0.052	0.018[1]
Fenthion	0.125	0.098–0.204	0.083	0.072–0.105
Malathion-Resmethrin (19:1)	0.171	0.155–0.194	0.143	0.085–0.832
Chlorpyrifos	0.171	0.153–0.199	0.101	0.084–0.147
Naled	0.441	0.368–0.592	0.266	0.237–0.315
Malathion	0.475	0.409–0.585	0.247	0.185–0.420

[1] Variation in the data associated with this compound was such that it was not possible to calculate an upper 95% fidicial limit for *Ae. aegypti.*

Table 2. Toxicity of aerosols of insecticides (mg/ml) to caged *Toxorhynchites amboinensis* exposed in a wind tunnel.

	Males		Females		
Compounds	24-hr ED-90	95% fiducial limits	24-hr ED-90	95% fiducial limits	Percentage difference
Resmethrin	0.018	[1]	0.022	0.018–0.031	18
Fenthion	0.111	0.081–0.250	0.135	0.118–0.162	18
Malathion-Resmethrin (19:1)	0.141	0.122–0.229	0.185	0.163–0.225	24
Chlorpyrifos	0.158	0.121–0.282	0.215	0.179–0.288	27
Naled	0.378	0.322–0.474	0.500	0.391–0.840	24
Malathion	0.440	0.365–0.604	0.536	0.424–0.844	18

[1] Variation in the data associated with this compound was such that is was not possible to calculate 95% fiducial limits.

less susceptible (average 22%) than the males to all of the compounds tested; however, no significant (t-test, P>0.05) differences were observed.

These results suggest that there is little possibility of applying a currently accepted insecticide at a level sufficient to control *Ae. aegypti* adults in New Orleans without affecting the *Tx. amboinensis* adult population. However, in a control effort based upon regularly repeated, inundative releases, the contribution that recycled predator adults make is limited (unpublished data). This fact, coupled with the relatively short lifespan of released predators, suggests that the optimal time for insecticide application would be just prior to releases. For example, if the daily survival of predator adults released on a weekly basis was 80%, only ca. 17% of the released insects would still be alive 7 days later. Thus, an adulticide application on day 6 or 7 of each release cycle, timed to just precede the subsequent release, would make optimum use of the released predators and also apply insecticidal stress to the prey population.

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