1979. Biological transmission of Western encephalomyelitis virus by *Culex tarsalis* Coquillett. Mosquito News 39:385–390.
McKay, J., W. Stackiw and R. A. Brust. 1968. Western encephalitis in Manitoba in 1966. Manitoba Med. Rev. 48:56–57.
McLintock, J. 1976. The arbovirus problem in Canada. Can. J. Public Health 67, Suppl 1:8–12.
McLintock, J. and J. Iversen. 1975. Mosquitoes and human diseases in Canada. Can. Ent. 107:695–704.
Medovy, H. 1976. The history of Western encephalomyelitis in Manitoba. Can. J. Public Health 67, Suppl 1:13–14.
Sekla, L. H. and W. Stackiw. 1976. Laboratory diagnosis of Western encephalomyelitis. Can. J. Public Health 67, Suppl 1:33–40.

SUSCEPTIBILITY OF *AEDES AEGYPTI* TO SYNTHETIC PYRETHROIDS COMPARED WITH A NEW INSECT GROWTH REGULATOR[1]

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ABSTRACT. Three synthetic pyrethroids and a new insect growth regulator (IGR) were evaluated in the laboratory against early 3rd instar *Aedes aegypti* (Linnaeus). Of all compounds tested the Atroban® permethrin formulation was the most effective. *Ae. aegypti* were more susceptible at the LC_{90} level to the synthetic pyrethroids than to the IGR Bay Sir 8514(2-Chloro-N-[[[4-(trifluoromethoxy) phenyl]amino]carbonyl]benzamide). LC_{90} values for Atroban, Ectiban®, fenvalerate, and Bay Sir 8514 were 0.44, 3.84, 38.17, and 51.42 ppb, respectively.

INTRODUCTION

The increasing threat of mosquito resistance to chlorinated hydrocarbons and organophospate larvicides has initiated research in alternative chemicals for mosquito control. The potential control value of insect growth regulators (IGR) and synthetic pyrethroids has been extensively tested in both laboratory tests and field trials (Jakob and Schoof 1971 and 1972, Jakob 1972, Hsieh and Steelman 1974, Lowe et al. 1975, Mulla et al. 1975, Dame et al. 1976, Mulla and Darwazeh 1976, Rogers et al. 1976, Mulla et al. 1978, Yap and Jamaludin 1979). Recently, one of the newer, IGRs, Bay Sir 8514 (2-chloro-N-[[[4-(trifluoromethoxy)phenyl]amino]carbonyl]benzamide), was tested against the house fly, *Musca domestica*, L. (Chang 1979). Reported here is an evaluation of the comparative laboratory susceptibilities of Bay Sir 8514 and 3 synthetic pyrethroids to *Aedes aegypti* (Linnaeus) larvae.

MATERIALS AND METHODS

The compounds tested against *Ae. aegypti* were:

Bay Sir 8514: tested as the technical formulation (95% pure) provided by Chemagro Agricultural Division, Mobay Chemical Corporation.

fenvalerate (SD 43775): tested as the technical formulation (95% pure) provided by Shell Development Company.

Atroban® (BW 21Z permethrin): tested as the technical formulation (96.3% pure) provided by Burroughs Wellcome Company.

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Ectiban® (permethrin): tested as the technical formulation (93.7% pure) provided by ICI Americas Incorporated.

The bioassay techniques were similar to those used by Mulla et al. (1961) in studies with *Culex* spp. Early 3rd instars from a susceptible laboratory colony of *Ae. aegypti* were used for all tests. To standardize the tests, all larvae used were approximately the same age. This was accomplished by placing an egg paper in water until hatch began, removing it and placing it in another container of water for a period of 1 hr, then moving it again to still another container of water. At the time the egg papers were removed a measured amount of liver powder was added to the water as a source of food for the larvae. When the larvae reached the 3rd instar, their food was removed by transferring them through 3 containers of distilled water. Larvae were then used in the tests without encountering difficulty from molting.

The test procedures consisted of dissolving technical formulations of the various insecticides in glass-distilled acetone and making serial dilutions to obtain the desired dosage. The final dilution was made by adding 1 ml of the acetone solution to 99 ml of distilled water which was contained in 6-ounce waxed paper cups. Twenty-five 3rd instars were added to each cup. Each treatment and the untreated check were replicated 4 times. The untreated check consisted of 1 ml of acetone plus 99 ml of distilled water. Mortality counts were taken 24 hr after treatment, with the criterion for mortality being the inability of the larvae to surface. Temperatures were approximately 24°C during the tests.

Probit analysis was performed on the data by using an IBM 370 computer according to the program of Barr et al. 1976.

RESULTS AND DISCUSSION

Of the 4 compounds tested, early 3rd instar *Ae. aegypti* was more susceptible to the synthetic pyrethroid, Atroban, with LC_{50} and LC_{90} values of 0.10 and 0.44, respectively (Table 1). Even though Atroban and Ectiban are essentially the same permethrin compound, the Atroban permethrin formulation showed more biological activity at both LC_{50} and LC_{90} concentration levels. Fenvalerate was the least toxic of the synthetic pyrethroids with a LC_{90} value of 38.2 ppb, ca. 100 times less active than Atroban. Mulla et al. (1978) also found fenvalerate to be less effective against larvae of *Cx. quinquefasciatus* Say than was permethrin.

Table 1. Susceptibility of 3rd instar *Aedes* synthetic pyrethroids and Bay Sir 8514.

Material	Lethal Concentration (ppb)		
	LC_{50}	LC_{90}	Slope
Bay Sir 8514	5.17	51.42	0.56
Fenvalerate	9.19	38.17	0.90
Ectiban®	0.41	3.84	0.57
Atroban®	0.10	0.44	0.85

As evaluated by their LC_{90} values, all the synthetic pyrethroids were more active than the IGR Bay Sir 8514. However, this compound was more active at the LC_{50} level than was fenvalerate.

When compared with the lethal concentrations of the 2 most commonly used IGR larvicides, diflubenzuron and methoprene, Bay Sir 8514 appears to be a promising new candidate as a larvicidal compound. In these tests, Bay Sir 8514 had a LC_{90} against *Ae. aegytpi* of 51.4 ppb whereas Hsieh and Steelman (1974) reported a LC_{90} value of 779 ppb for methoprene against other mosquito species. However, our results did show Bay Sir 8514 to be ca. 70 times less active against *Ae. aegypti* larvae than diflubenzuron which was reported by Hsieh and Steelman (1974).

Literature Cited

Barr, A. J., J. H. Goodnight, J. P. Sall and J. T. Helwig. 1976. The probit procedure. *In*: "A User's Guide to SAS 76" pp. 206–210. SAS Institute Inc. Raleigh, N.C.

Chang, S. C. 1979. Laboratory evaluation of

diflubenzuron, penfluron, and Bay Sir 8514 as female sterilants against the house fly. J. Econ. Entomol. 72:479–81.

Dame, D. A., R. E. Lowe, G. J. Wichtermen, A. L. Camron, K. F. Baldwin and T. W. Miller. 1976. Laboratory and field assessment of insect growth regulators for mosquito control. Mosquito News 36:462–72.

Hsieh, M. Y. G. and C. D. Steelman. 1974. Susceptibility of selected mosquito species to five chemicals which inhibit insect development. Mosquito News 34:278–282.

Jakob, W. L. 1972. Additional studies with juvenile hormone-type compounds against mosquito larvae. Mosquito News 32:592–95.

Jakob, W. L. and H. F. Schoof. 1971. Studies with juvenile hormone-type compounds against mosquito larvae. Mosquito News 31:540–43.

Jakob, W. L. and H. F. Schoof. 1972. Mosquito larvicide studies with MON-0585, a juvenile hormone mimic. Mosquito News 32:6–10.

Lowe, R. E., M. Schwarz, A. L. Cameron and D. A. Dame. 1975. Evaluation of newly synthesized insect growth regulators against *Anopheles quadrimaculatus, Anopheles albimanus*, and *Aedes taeniorhynchus*. Mosquito News 35:561–63.

Mulla, M. S. and H. A. Darwazeh. 1976. Field evaluation of new mosquito larvicides and their impact on some non target insects. Mosquito News 36:251–56.

Mulla, M. S., H. Axelrod and L. W. Isaak. 1961. Effectiveness of new insecticides against mosquito larvae. Mosquito News 21:216–24.

Mulla, M. S., H. A. Darwazeh and G. Majori. 1975. Field efficacy of some promising mosquito larvicides and their effects on non-target organisms. Mosquito News 35:179–85.

Mulla, M. S., H. A. Narrab-Gojrati and H. A. Darwazeh. 1978. Biological activity and longevity of new synthetic pyrethroids against mosquitoes and some non-target insects. Mosquito News 38:90–96.

Rogers, A. J., C. B. Rathburn, Jr., E. J. Beidler, G. Dodd and A. Lafferty. 1976. Tests of two insect growth regulators formulated on sand against larvae of salt-marsh mosquitoes. Mosquito News 36:273–77.

Yap, H. H., and S. Jamaludin. 1979. Laboratory susceptibility tests of an arylterpenoid insect growth regulator, MV-678, against six species of mosquitoes. Mosquito News 39:81–84.