EVALUATION OF CYPERMETHRIN AS AN ULV COLD AEROSOL AGAINST CAGED MOSQUITOES[1, 2]

R. H. ROBERTS[3]

ABSTRACT. Cypermethrin was evaluated against caged mosquitoes using a truck-mounted Leco HD model ULV cold aerosol generator and the results were compared to malathion. Calculated effective dosages (ED) for 90% and 95% control with cypermethrin against *Aedes taeniorhynchus* were 1.8 and 4.5 g/ha, and against *Anopheles quadrimaculatus* were 0.3 and 0.5 g/ha, respectively. Cypermethrin was 30× more effective than malathion against *An. quadrimaculatus* and 5× more effective than malathion against *Ae. taeniorhynchus.*

Our laboratory testing program evaluates aerosols of candidate chemicals by a wind-tunnel procedure (Mount et al. 1976) against a laboratory strain of the salt marsh mosquito, *Aedes taeniorhynchus* (Wiedemann). In comparative studies using malathion as the standard, cypermethrin was 35× more effective at the LC50 level and 15× at the LC90 level. This was sufficiently effective to warrant further evaluation as a ULV ground cold aerosol against caged mosquitoes under field conditions. The present paper reports the results obtained in this evaluation.

MATERIALS AND METHODS

The candidate adulticide, cypermethrin (=FMC−45806)[4], a synthetic pyrethroid, was supplied as an emulsifiable concentrate formulation containing 0.297 kg AI/liter with a cis-trans isomer ratio of 52:48. The malathion[5] used as the standard was a ULV formulation containing 1.1 kg AI/liter.

The tests were conducted in a fairly level open field near Gainesville, Florida, during April and May, 1981. Applications were made in the evening between 1900 and 2000 hr. Temperatures ranged from 19–26°C (mean 23°C) and wind velocities ranged from 5–13 km/hr (2–10 mph) (mean 9 km/hr) during these tests.

A Leco model HD cold aerosol generator[6] with a blower pressure of 27.6 KPa was used to disperse the adulticide, which was delivered to the nozzle by a positive displacement pump at 60 ml/min. The adulticides were diluted in Klearol®[7] or Solv G[8] to obtain the concentrations necessary for treatment at the desired rate of AI/ha based on a 91 m (300 ft) swath and a truck speed of 16 km/hr (10mph).

Laboratory insecticide susceptible strains of *Aedes taeniorhynchus* and *Anopheles quadrimaculatus* Say were used. Adult female mosquitoes (4–6 days old) were immobilized on a cold table for handling and counting. Groups of 25 were placed in 16-mesh screen wire cages (4.5 cm diam × 15 cm long) for exposure to the aerosol. The screen cage replaced one of the plastic tubes of a World Health Organization test assembly. The screen wire cage and companion plastic holding tube lined with paper were mounted on opposite sides of a divider containing a slide unit with a 20 mm opening that could be positioned between the cage and tube. Thus, a rapid transfer of the exposed mosquitoes could be made from the cage into the clean holding tubes without the necessity of additional immobilization stress. This also eliminated exposure to residues left on the treatment cage wire from the aerosol that would occur if the screen cages had been used to retain the mosquitoes until the time for mortality counts.

Cages of each species were suspended 1.2 m above ground on stakes, two at 46 m (150 ft) and two at 91 m (300 ft) downwind in two rows 30.5 m (100 ft) apart perpendicular to the line of travel of the truck-mounted ULV aerosol

---

[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. Also, mention of a commercial or proprietary product does not constitute an endorsement of this product by the USDA.

[2] This research was conducted as a cooperative effort between the Agricultural Research Service, USDA, and the State Agricultural Experiment Stations of Arkansas, California, Louisiana, Mississippi, and Texas as part of a USDA/CSRS Southern Regional Project (S-122) on the Biology, Ecology and Management of Riceland Mosquitoes in the Southern Region.

[3] Insects Affecting Man and Animals Research Laboratory, Agricultural Research Service, USDA, Gainesville, FL 32604.

[4] Supplied by FMC Corporation, Agricultural Chemical Group, Middleport, NY 14105.

[5] Supplied by American Cyanamid Company, Agricultural Division, Princeton, NJ 08540.

[6] Lowndes Engineering Company, Inc., 125 Blanchard Street, Valdosta, GA 31601.

[7] Witco Chemical Corp., Sonneborn Division, 277 Park Avenue, New York, NY 10017.

[8] Union Chemical Division, Union Oil Company of California, 1345 N. Meacham Road, Schaumberg, IL 60196.

generator. After each aerosol had drifted through the test plot (ca. 5–10 minutes), the insects were transferred to the plastic holding tubes lined with clean paper. The cages containing the test insects were held in chilled, insulated chests containing moist cotton for transportation between the laboratory and the test site. During the 12-hr holding period prior to mortality counts, the test insects were held at room temperature (24°C) and supplied with 10% sugar water on cotton pads. Cages of test insects not exposed to the insecticide but handled in the same manner were used as controls.

Effective dosages (ED) for 90 and 95% control were calculated with a probit analysis program written for a Hewlett-Packard Model 9810A programmable calculator following procedures given by Finney (1971).

RESULTS AND DISCUSSION

The results of the aerosol tests are presented in Table 1 and the calculated effective dosages for 90 and 95% control are presented in Table 2.

In our field evaluation of new materials, malathion has been used at the label recommended rate of 27 g/ha as a standard. Data accumulated over several seasons indicated that this rate was greater than needed against our laboratory insecticide susceptible strains. Therefore, in order to have a more comparable basis for the evaluation of new materials, a series of treatment rates was tested for ED 90 and ED 95 determinations. These data indicated the ED 90 and ED 95 control rates against *An. quadrimaculatus* were approximately 11 and 15 g/ha, respectively, and against *Ae. taeniorhynchus*, approximately 17 and 22 g/ha. Generally, these findings are consistent with label recommendations.

Cypermethrin was ca. 30× more effective against *An. quadrimaculatus* and ca. 5× more effective against *Ae. taeniorhynchus* at the ED 95 level than malathion. However, in wind tunnel tests against a field strain of *An. quadrimaculatus* in Arkansas that was ca. 18× more resistant to malathion than our laboratory strain, unsynergized cypermethrin was ca. 100× more effective, and when synergized with piperonyl butoxide at 1:1 ratio, was ca. 549× more effective than malathion (Roberts et al. 1980).

Cypermethrin is the fifth synthetic pyrethroid tested in our adulticide ULV evaluation program. Data on the other four pyrethroids have been reported previously (Roberts 1981, 1982). These five compounds, when placed in a decreasing rank order of effectiveness based on their ED 95 against *Ae. taeniorhynchus* are: NRDC-161 ((S)-[cyano(3-phenoxyphenyl) methyl]cis-(+)-3- (2,2-dibromoethenyl)-2,2-dimethylcyclopropane carboxylate)(0.7 g/ha); American Cyanamid 222705 (±-cyano(3-phenoxyphenyl) methyl (+)-4-α-(1methylethyl)benzeneacetate)(4.0 g/ha); cypermethrin (4.5 g/ha); fenvalerate (9.3 g/ha; and phenothrin (44 g/ha).

The presently registered pyrethroid, resmethrin, has a label for a treatment rate of 7.8 g/ha and natural pyrethrin has a label for a treatment rate of 2.2–8.9 g/ha. Based on the data presented in this paper, practical field treatment rates for cypermethrin would probably be at comparable levels. Actual recommended rates, however, will have to be deter-

Table 1. Efficacy of ULV ground cold aerosols discharged at 60 ml/min. at a dispersal speed of 16 km/hr against caged adult female mosquitoes[a] (number of replicates in parentheses).

Treatment rate (g/ha)	Mean 12 hr % mortality	
	Aedes taeniorhynchus	*Anopheles quadrimaculatus*
	Cypermethrin	
0.8	80 (4)	96 (3)
0.4	79 (5)	93 (4)
0.2	61 (5)	87 (5)
0.1	48 (5)	83 (3)
0.05	48 (3)	83 (3)
0.025	—	50 (2)
Control	7 (7)	8 (7)
	Malathion	
26.9	99 (5)	99 (3)
13.4	80 (6)	97 (6)
6.7	52 (6)	64 (6)
3.4	20 (3)	40 (3)
Control	7 (7)	8 (7)

[a] Caged mosquitoes at 1.2 m elevation 46 and 91 m downwind.

Table 2. Calculated effective dosage (ED) for 90 and 95% control of caged adult female mosquitoes with ULV ground cold aerosols. (Fiducial limits at 95% level of probability in parentheses.)

Insecticide	ED 90 (g/ha)	ED 95 (g/ha)
	Anopheles quadrimaculatus	
Cypermethrin	0.3 (0.2–0.4)	0.5 (0.4–0.9)
Malathion	11.4 (10.2–13.2)	14.8 (12.9–17.9)
	Aedes taeniorhynchus	
Cypermethrin	1.8 (1.1–4.3)	4.5 (2.3–14.0)
Malathion	17.0 (15.1–19.8)	22.3 (19.3–27.0)

mined by field evaluation against natural populations.

References Cited

Finney, D. J. 1971. Probit analysis, 3rd Ed. Cambridge University Press. 333 pp.
Mount, G. A., N. W. Pierce and K. F. Baldwin. 1976. A new wind-tunnel system for testing insecticide aerosols against mosquitoes and flies. Mosq. News 36:127–131.
Roberts, R. H. 1981. Effectiveness of ULV ground aerosols of phenothrin against mosquitoes, houseflies and stable flies. Mosq. News 41:251–253.
Roberts, R. H. 1982. Efficacy of ground ULV aerosols of three pyrethroids against two mosquito species. Mosq. News 42:109–112.
Roberts, R. H., K. F. Baldwin, J. L. Pinson, T. W. Walker and M. V. Meisch. 1980. Effectiveness of nine pyrethroids against *Anopheles quadrimaculatus* Say and *Psorophora columbiae* (Dyar and Knab) in Arkansas. Mosq. News 40:43–46.

INHERITANCE OF SHORT PALPI, A MORPHOLOGICAL MUTANT IN THE MALARIA VECTOR MOSQUITO *ANOPHELES STEPHENSI*

HAMAYUN R. RATHOR, GHAZALA TOQIR AND SHAHIDA RASHID
Pakistan Medical Research Center International Health Program, University of Maryland, School of Medicine 6, Birdwood Road, Lahore 3, Pakistan

ABSTRACT. Genetic studies suggest that the mutant phenotype "short palpi" (*st*) is determined by a single autosomal recessive gene. The gene is fully penetrant and its expressivity is constant. The *st* locus is linked with the diamond palpi locus at a distance of 38.55 ± 0.73 crossover units.

INTRODUCTION

Although *Anopheles stephensi* Liston is an important malaria vector of high genetic variability, the genetic information on the species is still very meagre. The genetics of 12 morphological and eight biochemical mutants have been published on this species (Davidson and Mason 1963; Mason and Davidson 1966; Bianchi 1968; Aslamkhan and Baker 1969; Bullini et al. 1971; Aslamkhan 1973; Iqbal et al. 1973a, b; Sakai et al. 1974, 1977, 1981; DiDeco et al. 1978; Sharma et al. 1977, 1979; Subbarao and Adak 1978; Rathor and Toqir 1981; Suguna 1981). This paper presents the genetic analysis of a new morphological mutant, short palpi (*st*).

MATERIALS AND METHODS

The following strains were used:

1. Wild type: Colonized in 1978 from the village of Khano-Harni, 12.4 kilometers southeast of Lahore.
2. Short palpi (*st*): Mutant strain obtained from KH stock colony. The palps in this mutant are shorter than proboscis, the mutant stock is homozygous for the character (Fig. 1).
3. White eye (*w*): The eyes are white in color, the mutant strain was obtained from the Karachi stock colony. The mutant is controlled by a recessive sex-linked gene (Aslamkhan 1973).
4. Diamond short palpi (*dp-st*): The distal end of each palpus is triangular-shaped and the palpi are shorter than the proboscis. (Fig. 2)

Both larvae and adults were reared in insectaries maintained at 28 ± 1°C and 75 ± 5% relative humidity. Insectaries were illuminated with fluorescent and incandescent lighting. An artificial dawn and dusk was produced at 0500 and 2100 hr for 80 min. Larvae were reared in 45 × 22 cm enameled pans filled to 1 cm depth of water and were fed on liver powder. Adult females and males were fed 3% sugar solution, and females were offered restrained mice for blood meals. Mass matings were made for all genetic crosses. After a blood meal females were isolated singly for oviposition in 35 ml glass vials lined with filter paper and flooded with 10 ml of water. The resulting progeny from these females were individually reared.

Scoring for short and normal palpi and sex was done on one day old adults under a binocular microscope. The families were subjected to heterogeneity chi-square test for sex-ratio and for expected phenotypic ratios. No family showed any significant deviation ($P > 0.05$) from the expected ratios. Therefore, the data from these individual families were pooled.