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SUSCEPTIBILITY OF ADULT ANOPHELINES TO DDT AND OF CULEX FATIGANS
AND AEDES AEGYPTI LARVAE TO DDT AND DIELDRIN

by

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The data given hereunder refer to preliminary results obtained in susceptibility tests carried out by the Insecticide Toxicology Service of the Malariology Division of the Ministry of Health and Social Welfare, Venezuela.

1. Tests with adult Anophelines

For these tests, female anophelines with blood in their stomachs were used, obtained in the following manner:

(a) Direct night catches made on human bait, outside houses sprayed with DDT at La Cabrera near Maracay, between 6 and 8 p.m. on the day before the test. These anophelines were placed in tulle cages and fed on pigeon for 12 to 20 hours before the test.

(b) Captures made on animal bait (donkey), between 6.30 and 8 a.m. in a stable trap at El Limón near San Carlos (Cojedes), the tests being carried out underneath the trap immediately afterwards.

The exposure of the mosquitos to the insecticide-sprayed surfaces was carried out according to the method of Busvine and Nash as recommended by the Expert Committee on Malaria of WHO,¹ with some technical modifications to adapt it to field work.

Filter papers, 11 cm in diameter, were impregnated with 1 ml of a mixture of Risolla oil and ether and left to dry for 24 hours in a horizontal position on pins. The dilutions used were as follows:

Series	Mixture used		% DDT in solution
	Solution of DDT in "Risella"	Commercial ether	
A	3 ml at 2%	3 ml	1.00
B	2 ml at 2%	4 ml	0.66
C	2 ml at 1%	4 ml	0.33
Controls	2 ml -	4 ml	-

Detachable 5" lengths of 0.5" glass tube were used with rubber tubing as an aspirator, and 6-8 mosquitos were caught direct in each. The tubes were each inserted into a 3" x 1" glass shell vial with the glass bottom removed, and the top closed with tulle, and lined with impregnated paper. After the mosquitos had been transferred, the bottom was closed with tulle. The vials were placed in an upright position for 60 minutes. After this exposure period the mosquitos were transferred to holding cages made of paper with a glass front and kept, with glucose solution, in a damp chamber. The percentage mortalities were recorded 24 hours later.

These operations may be easily carried out in the field on the spot where the catches are made and no special laboratory is necessary. All the equipment is transportable in a small kit-box of light-weight wood, which can be transformed into a moist chamber. Its contents are as follows:

- (a) wooden stand for six exposure vials, with movable stoppers for the introduction of the mosquitos;
- (b) simple catchment device with coupled glass tubes enabling 6-8 mosquitos to be collected rapidly and without injury;
- (c) paper traps with glass fronts to facilitate observation of the mosquitos; these can be thrown away after each test.

In each test, 6 replicates were prepared at each concentration. In tabulating the results, the percentage mortalities were corrected on the basis of the control mortalities in accordance with the equation used by Fay, Simmons & Clapp.³

The results obtained are given in Tables 1 and 2. They indicate the LC_{50} for the adult Anopheles to be as follows:

<u>A. albimanus</u>	0.24% DDT
<u>A. aquasalis</u>	0.33% DDT
<u>A. albitarsis</u>	0.39% DDT.

2. Tests with Culex and Aedes larvae

Tests were performed with larvae in the 3rd and 4th instar. Aedes aegypti larvae were collected direct from the natural breeding-places on the outskirts of Carúpano (Sucre) and at Caracas; Culex fatigans larvae were collected from natural breeding-places in Caracas and Puerto Cabello, and also from a DDT-susceptible colony maintained in our laboratory since 1947. The tests with field-collected larvae were carried out in a local building 1-5 hours after capture.

About 20 larvae (3rd and 4th instar) were placed in cardboard cups with 99 ml of water and 1 ml of the appropriate ethanolic solution of p,p'-DDT or technical dieldrin. After 24 hours the dead specimens were counted, moribund larvae being considered as dead.

The results are summarized in the tables given hereunder; in most cases 2-6 replicates were prepared for each concentration used.

The results in Table 3 show that the LC_{50} for Culex fatigans larvae at Caracas was 0.7 p.p.m. DDT, and at Puerto Cabello was 5.0 p.p.m. DDT. When compared to 0.04 p.p.m. for the normal laboratory strain, a considerable degree of developed resistance is indicated for the Caracas sample and very high DDT-resistance for C. fatigans at Puerto Cabello.

The results in Table 4 show that the LC_{50} for Aedes aegypti larvae at Carúpano was 0.3 p.p.m. DDT, and at Caracas was between 1 and 5 p.p.m. DDT. Normal LC_{50} levels for this species range between 0.004 and 0.05 p.p.m. DDT.²⁾ The data obtained therefore indicates that DDT-tolerance has developed at Carúpano, and evidently even more so in the sample from Caracas. The LC_{50} levels for dieldrin of less than 0.05 p.p.m. for Carúpano and less than 0.01 p.p.m. for Caracas indicate normal susceptibility to dieldrin.

Carúpano has been subjected to 17 cycles of residual house-spraying with DDT between 1947 and 1955; in addition, DDT larvicide has been applied once in 1954. Deposits remaining on walls in Carúpano in 1956 ranged from 0.8 up to 10.0 g/m². In Caracas, house-spraying with DDT was commenced in 1954 together with DDT larvicide application and in 1956 dieldrin replaced DDT in house-spraying. In Puerto Cabello, DDT house-spraying has been applied since 1947 until 1954, followed by one dieldrin application.

TABLE 1. CORRECTED PERCENTAGE MORTALITIES OF FEMALE ANOPHELINES CAPTURED AT LA CABRERA, MARACAY

Series	% DDT in solution	<u>A. albimanus</u>			<u>A. aquasalis</u>			<u>Others</u> *		
		L	D	%	L	D	%	L	D	%
A	1.00	6	192	96.6	16	179	89.5	0	69	100
B	0.66	17	188	90.0	23	177	85.6	18	48	58.1
C	0.33	67	182	67.6	82	123	50.0	22	68	62.7
Controls	-	99	21	-	163	43	-	38	20	-

* A. triannulatus, A. punctimacula, A. pseudopunctipennis and Anopheles sp.

TABLE 2. CORRECTED PERCENTAGE MORTALITIES OF FEMALE ANOPHELINES CAPTURED AT EL LIMÓN, SAN CARLOS

Series	g/m ² DDT	<u>A. albitarsis</u>			<u>Other Species*</u>		
		L	D	%	L	D	%
A	1.00	3	52	93.5	2	90	97.4
B	0.66	9	27	70.3	4	73	94.0
C	0.33	17	20	45.5	19	46	63.3
Controls	-	32	6	-	52	8	-

* A. strodei, A. argyritarsis, A. neomaculipalpus, A. triannulatus, A. pepsoai, A. rangeli, A. oswaldoi, A. punctimacula, and Anopheles sp.

TABLE 3. PERCENTAGE MORTALITIES OF CULEX FATIGANS LARVAE CAPTURED FROM BREEDING-PLACES IN CARACAS AND PUERTO CABELLO AND FROM THE LABORATORY

Series	DDT p.p.m.	Deaths after 24 hours								
		<u>Caracas</u>			<u>Pto. Cabello</u>			<u>Laboratory</u>		
		L	D	%	L	D	%	L	D	%
A	10	0	20	100	12	78	86.6	0	156	100
B	5	1	19	95.0	45	46	50.5	0	178	100
C	1	9	11	55.0	75	13	14.8	0	176	100
D	0.5	11	10	47.6	68	18	20.9	0	177	100
E	0.1	18	4	18.2	84	5	5.6	15	161	91.5
F	0.05	16	6	27.2	83	3	3.5	50	116	69.6
G	0.01	18	5	21.7	84	4	4.5	167	10	5.6
Controls	-	18	3	14.3	65	3	4.5	87	1	1.1

TABLE 4. PERCENTAGE MORTALITIES OF Aedes aegypti LARVAE, CAPTURED IN NATURAL BREEDING-PLACES IN CARACAS AND CARÚPANO, TO CONCENTRATIONS OF DDT

Series	DDT p.p.m.	Deaths after 24 hours					
		<u>Caracas</u>			<u>Carúpano</u>		
		L	D	%	L	D	%
A	10	0	21	100	3	111	97.4
B	5	3	18	85.6	9	117	92.8
C	1	17	5	22.4	33	103	75.6
D	0.5	16	4	17.4	24	90	78.6
E	0.1	13	11	45.8	122	10	7.6
F	0.05	19	2	9.5	113	10	8.1
G	0.01	21	1	4.5	114	6	5
Controls	-	20	1	4.8	90	4	4.3

TABLE 5. PERCENTAGE MORTALITIES OF Aedes aegypti LARVAE, CAPTURED IN NATURAL BREEDING-PLACES IN CARACAS AND CARÚPANO, TO CONCENTRATIONS OF DIELDRIN

Series	Dieldrin p.p.m.	Deaths after 24 hours					
		<u>Caracas</u>			<u>Carúpano</u>		
		L	D	%	L	D	%
A	10	0	41	100	0	76	100
B	5	0	40	100	0	78	100
C	1	0	39	100	3	97	97.0
D	0.5	0	40	100	5	89	95.6
E	0.1	0	41	100	11	84	88.3
F	0.05	1	41	97.6	23	74	76.3
G	0.01	0	43	100	84	4	4.8
Controls	-	34	9	20.9	81	2	2.4

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1. World Health Organization, Fifth Report of the Expert Committee on Malaria (Annex 3). Wld Hlth Org. techn. Rep. Ser. 80
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3. Fay, R. W., Simmons, S. W. & Clapp, J. M. (1947). Extended laboratory investigation on the toxicity of DDT-residues to adults of Anopheles quadrimaculatus. Publ. Hlth Rep. (Wash.), 62, 149-158