

STUDIES ON THE IRRITABILITY OF  
A FIELD POPULATION OF *ANOPHELES MACULIPENNIS*  
AND *ANOPHELES SUPERPICTUS* TO DDT  
IN THE PROVINCE OF ISFAHAN, IRAN\*

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ABSTRACT

A series of DDT-irritability tests with adult *A. maculipennis typicus* and *A. superpictus* were carried out in the Isfahan area in August-September, 1970. The observations on irritability were measured in accordance with the WHO method and the natural populations of anopheline mosquitoes were used. The tests were carried out in a light intensity of approximately 8 foot-candles. The engorged mosquitoes were captured in various villages that had not been treated with DDT since 1964. Note was taken of the number of take-offs by anopheline mosquitoes from the impregnated filter paper during a period of 15 minutes. The temperature of the testing room was approximately 25°C.-27°C. and the tests were carried out between 9 a.m. and 2 p.m.

It was noted that there was a great difference in the average number of take-offs between the control mosquitoes and the mosquitoes exposed to DDT. The average number of take-offs for *A. maculipennis* exposed to 2% DDT was observed to be between 17.1 and 21, and for 4% DDT, between 25.95 and 26.8; for *A. superpictus* exposed to 2% DDT, it was between 17.8 and 21. The average number of take-offs for the control group was between zero and one.

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The levels of irritability for the strains of *A. maculipennis* and *A. superpictus* were about the same, with no statistically significant difference in irritability for 2% DDT. However, a significant difference in irritability was observed with *A. maculipennis* exposed to 2% and 4% DDT.

## INTRODUCTION

The irritability of mosquitoes with regard to several insecticides, DDT in particular, is probably one of the main factors in bringing about a change in the behavioristic patterns of anopheline vectors of malaria in a wide program of residual house treatment with DDT, which may result in the failure of control (Bhatia & Deobhankar, 1963).<sup>1</sup>

It seems that the avoidance of mosquitoes of treated surfaces is a general phenomenon. The variation in the number of take-offs in response to treated surfaces is considerable. Some species are hyper-irritable, e.g. *A. gambiae*, with 40-50 take-offs in 15 minutes on DDT-impregnated paper, while *A. albimanus*, a hypo-irritable species, had only 2-3 take-offs in the same period of time (M. Coluzzi, 1963).<sup>2</sup>

Observations have shown that mosquitoes settling on surfaces with deposits of residual insecticide may have an irritation effect and thus escape, while on non-treated surfaces they would have a normal reaction. Different species naturally have different reactions to residual insecticides. Some mosquitoes take more time to become irritated, while others will become irritated immediately after contact with a sprayed surface. It is also possible that different populations or strains of the same species have different characters. The importance of irritability tests has been emphasized by Brown (1958),<sup>3</sup> de Zulueta (1959)<sup>4</sup> and Muirhead-Thomson (1960).<sup>5</sup>

## OBJECTIVE

The objective of the present study was to determine the threshold of irritation for the two species of anopheline mosquitoes against DDT-treated surfaces. The test consisted of determining the number of flights during 15 minutes of exposure in a conical plastic chamber after pre-conditioning for 30 minutes. Only one mosquito was released for exposure to 2% or 4% DDT and one was used as a control. Natural populations were used in the experiments. It will be noted that the area has been under DDT residual house spraying before 1963.

## MATERIAL AND METHODS

1. The WHO standard method was used for this irritability test, as stated in the Seventeenth Report of the WHO Expert Committee on Insecti-

cides (WHO, 1970).<sup>6</sup>

2. The mosquitoes (natural population) were caught by spirator from indoor resting places, such as bedrooms and cow-sheds; they were blood-fed and released into the holding tube.
3. The mosquitoes were then transferred to the laboratory and released into a cage with 30×30×30 cm dimensions. Each cage contained not more than 30 mosquitoes.
4. The mosquitoes were caught directly by pre-exposure tubes, one in each tube.
5. The mosquitoes were pre-conditioned for 30 minutes in a light intensity of approximately 8 foot-candles in order to reach the mosquitoes through the paper.
6. Each mosquito was tested individually after being released into the exposure chamber. The number of take-offs was recorded for 15 minutes after an initial 3 minutes period of first settling down.
7. WHO impregnated papers were used in concentrations of 2% and 4% DDT.
8. The susceptibility test was performed on the mosquito population before the irritability test.
9. The room temperature was between approximately 25° and 27°C. and the relative humidity was between 45% and 50%. The tests were made between 9 a.m. and 2 p.m.
10. Observations were made on samples of natural populations of the following species: *A. (A.) maculipennis typicus*, Meigen, 1818; and *A. (M.) superpictus*, Grassi, 1819.
11. The susceptibility of *A. maculipennis* and *A. superpictus* to DDT was as follows:

a. *A. maculipennis*

Strain	Lc50	Lc90
Falavarjan (Isfahan)	2.8% DDT	6.5% DDT
Ahmadabad (Istahan)	3.5% DDT	8.0% DDT
Mobarakeh (Isfahan)	3.7% DDT	9.5% DDT

b. *A. superpictus*

Junaghan (Shar-Kord)	1.15% DDT	1.9% DDT
Broojen	1.1 % DDT	1.8% DDT

## DISCUSSION

In order to study the behavior of anopheline mosquitoes after contact with DDT, a series of investigations were carried out on *A. maculipennis typicus* and *A. superpictus* by the W.H.O. method. The results of these tests

indicate irritability in *Anopheles* when placed in contact with DDT, as compared with the control.

The mean number of take-offs per mosquito over a period of 15 minutes in three series of experiments with *A. maculipennis* with 2% DDT was observed to be between 17.1 and 21, and with 4% DDT, between 25.95 and 26.8. The same experiments with *A. superpictus* with 2% DDT showed a mean number of between 17.8 and 21 take-offs. The mean number of take-offs for the control in the whole series of experiments over the same period of time was observed to be between zero and one. The individual mosquito's range of take-offs with *A. maculipennis* and 2% DDT was observed to be between 2 and 48 and with 4% DDT between 6 and 54. With *A. superpictus* it was between 6 and 39.

These studies show that DDT affects the behavior of mosquitoes, and changes in behavior arise from irritability, which induces flight and some times enables mosquitoes to escape from surfaces with DDT.

Reaction to DDT has been reported and investigated in about 14 species of mosquitoes (Kaschef, 1969).<sup>7</sup>

The mean time-lapse before first take-off (after an initial 3 minutes) was found to be between 2.75 and 3.1 minutes for 2% and 4% DDT, with the control between 11½ and 15 minutes with *A. maculipennis*. Experiments with *A. superpictus* and 2% DDT showed between 1.25 and 1.5 minutes and with the control between 12.75 and 14.2 minutes.

Concerning irritability to DDT, it should be noted that some of the mosquitoes under test conditions walked on DDT-impregnated filter paper in the plastic conical chamber. The irritant effect of DDT on mosquitoes appears by the reaction of moving on DDT-impregnated paper. The results are indicated in Tables 1-4.

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Individual Records of Take-offs of Mosquitoes in Irritability Tests  
in Different Localities, August - 10 September, 1970

TABLE 1

Locality	Species	Treatment	Number Exposed	Individual Take-off Totals (15 minutes)	Total Take-offs (15 min.)
Ahmad-Abad (Isfahan)	<u>A. maculipennis</u> DDT-tolerance	DDT 2%	20	2, 14, 14, 4, 4, 14, 25, 18, 23, 7, 17, 47, 32, 10, 5, 34, 14, 13, 16, 30, 10.	349
		Control	4	0, 0, 0, 1.	1
		DDT 4%	20	8, 23, 52, 53, 26, 42, 19, 22, 7, 41, 28, 34, 29, 12, 26, 25, 24, 20, 19, 10.	520
Palavarjan (Isfahan)	<u>A. maculipennis</u> DDT-tolerance	Control	4	0, 0, 0, 0.	0
		DDT 2%	20	23, 37, 12, 24, 12, 20, 12, 6, 4, 8, 26, 6, 4, 5, 22, 25, 44, 7, 22, 23.	342
		Control	4	0, 0, 0, 3.	3
Palavarjan (Isfahan)	<u>A. maculipennis</u> DDT-tolerance	DDT 4%	20	26, 23, 15, 6, 49, 23, 41, 41, 34, 26, 26, 28, 23, 24, 12, 18, 29, 25, 36, 14	519
		Control	4	0, 0, 0, 0.	0

TABLE 1 (Continued)

Locality	Species	Treatment	Number Exposed	Individual Take-off Totals (15 minutes)	Total Take-offs (15 min.)
Mobarakeh (Isfahan)	<u>A. maculipennis</u> DDT-tolerance	DDT 2%	20	20, 4, 8, 30, 48, 17, 31, 35, 16, 28, 25, 21, 12, 19, 28, 15, 24, 5, 7, 27.	420
		Control	4	2, 0, 0, 2.	4
Jounaghan (Shahr-kord)	<u>A. superpictus</u> DDT-susceptible	DDT 4%	20	20, 21, 48, 45, 6, 22, 33, 53, 27, 49, 36, 14, 26, 13, 10, 10, 45, 15, 6, 37.	536
		Control	4	0, 0, 0, 0.	
Jounaghan (Shahr-kord)	<u>A. superpictus</u> DDT-susceptible	DDT 2%	20	20, 15, 20, 19, 24, 32, 27, 24, 13, 23, 31, 24, 10, 33, 9, 23, 18, 20, 14, 21.	420
		Control	4	2, 0, 0, 1.	3
Hefshijan (Shahr-kord)	<u>A. superpictus</u> DDT-susceptible	DDT 2%	20	29, 11, 6, 24, 17, 21, 34, 14, 13, 9, 18, 19, 36, 27, 22, 16, 25, 22, 15, 23.	401
		Control	4	0, 0, 2, 0.	2
Broojen	<u>A. superpictus</u> DDT-susceptible	DDT 2%	20	8, 39, 24, 29, 28, 29, 9, 15, 10, 13, 11, 10, 7, 7, 17, 10, 36, 17, 25, 12.	356
		Control	4	0, 0, 4, 0.	4



TABLE 2 (Continued)

Locality	Species	Treatment	Number Exposed	No. of Take-offs per Minute															Total Take-offs
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Jounaghan (Shahr-kord)	A. superpicus DDT-susceptible	DDT 2%	20	39	34	42	45	41	34	36	29	31	18	18	18	12	13	10	420
	Control	Control	4								1					1	1		3
Hefshijan (Shahr-kord)	A. superpicus DDT-susceptible	DDT 2%	20	28	21	40	39	37	32	37	31	20	26	20	20	20	16	14	401
	Control	Control	4											1				1	2
Droojen	A. superpicus DDT-susceptible	DDT 2%	20	20	22	35	38	33	28	29	30	22	27	14	23	16	11	8	356
	Control	Control	4							2			2						4



TABLE 3

Results of Irritability Tests on DDT-tolerance strains of A. maculipennis with DDT in Different Localities, August - September, 1970

Locality	Treatment	Number Exposed	Mean Time-lapse before 1st Take-off (minutes)	No. of Take-offs (15 min.)	Mean No. of Take-offs (15 min.)	Variance	Standard Deviation	Standard Error
Ahmad-Abad (Isfahan)	DDT 2%	20	2.9	349	17.45	129.5	11.38	2.54
	Control	4	14	1	0.25	0.25	0.5	0.25
	DDT 4%	20	2.8	520	26.0	167.57	12.94	2.89
Falavarjan (Isfahan)	Control	4	15	0	0	0	0	0
	DDT 2%	20	3.1	342	17.1	128.09	11.32	2.53
	Control	4	12	3	0.75	2.25	1.5	0.75
Nobarakeh (Isfahan)	DDT 4%	20	2.8	519	25.95	111.21	10.54	2.35
	Control	4	15	0	0	0	0	0
	DDT 2%	20	2.75	420	21	123.05	11.09	2.48
Nobarakeh (Isfahan)	Control	4	11.5	4	1	1.33	1.15	0.57
	DDT 4%	20	3	536	26.8	233.22	15.46	3.45
	Control	4	15	0	0	0	0	0

TABLE 4

Results of Irritability Tests on DDT-susceptible strains of A. superpictus  
with DDT in Different Localities, August - September, 1970

Locality	Treatment	Number Exposed	Mean Time-lapse before 1st Take-off (minutes)	No. of Take-offs (15 min.)	Mean No. of Take-offs (15 min.)	Variance	Standard Deviation	Standard Error
Jounaghan (Shahr-kord)	DDT 2%	20	1.25	420	21	46.52	6.8	1.52
	Control	4	12.75	3	0.75	1	1	0.5
Hefshijan (Shahr-kord)	DDT 2%	20	1.4	401	20.05	62.05	7.88	1.76
	Control	4	14.2	2	0.5	0.91	0.96	0.48
Broojen	DDT 2%	20	1.5	356	17.8	101.33	10.06	2.25
	Control	4	13	4	1	4	2	1

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