

## SUSCEPTIBILITY OF ANOPHELES FLUVIATILIS TO INSECTICIDES IN SOUTHERN IRAN, 1979\*

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quitoes to insecticides.*

### ABSTRACT

The first records of Anopheles fluviatilis resistance to DDT was reported in 1963 from India, and to dieldrin from eastern Saudi Arabia in 1959. In southern Iran, antimalaria measures began in 1950 and up to 1957 the area was under DDT residual house spraying at the rate of 2g/m<sup>2</sup> one round/year. During 1958-59 dieldrin was used at 0.5 g/m<sup>2</sup>, 2 rounds/year. Since 1967, malathion house spraying, 50%, 2g/m<sup>2</sup>, 1 or 2 rounds/year was applied in the lowland areas. In the highlands, where the malaria vectors are An.stephensi, An.dthali and An.fluviatilis, 1 or 2 rounds of malathion and 1 or 2 rounds of DDT were applied per year. In spite of repeated spraying, An.fluviatilis remained susceptible to these insecticides.

### INTRODUCTION

Anopheles fluviatilis James, one of the important ma-

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alaria vectors of the Indo-Persian zone, is present in southern China, Burma, Thailand, Bangladesh, India, Pakistan Afghanistan, Iran, Iraq, and Saudi Arabia.

In Iran, it is seen on the southern slopes of the Zagros chain from southwest of Kermanshah to Baluchistan in the south-eastern of the country. It is considered to be a secondary vector of malaria in southern parts of Iran and is found at the altitudes between 50 m (Borazjan and Minab) to 1100 m (Salbiz, Kazeroun) above the sea level. This species is found in both natural outdoor shelters and houses and stables (2).

During 1959 studies in eastern Saudi Arabia, where residual spraying had been carried out for 7 years with DDT and subsequently with dieldrin for 3 years, it was found that some dieldrin-resistance had developed in An. fluviatilis at Dharan. Further studies by Eshghi and co workers in 1967 An.fluviatilis in Al-Jarudiyah of the Al-Qatif oasis showed intermediate dieldrin resistance with the LC50 of 1.0-1.2%. However, this species remained susceptible to DDT at Al-Qatif in 1967, with an LC50 of 0.3% (1).

In India, DDT resistance developed by 1963 at Pandharpure, Maharashtra State; intermediate DDT resistance was also present by 1965 in Chickmagalur, Mysore state (1).

At the present, the evidence for DDT and dieldrin resistance of An. fluviatilis are limited to India and eastern Saudi Arabia, respectively (5).

## MATERIALS AND METHODS

The method used for testing is the one developed by the World Health Organization(4). Papers impregnated with DDT, dieldrin and malathion at a given concentrations were provided by WHO. For the controls, paper impregnated with Risella oil was used. The exposure time to the impregnated papers was one h, and the mortality count was made after a 24-hrs recovery period. All observed mortalities were corrected by Abbott's formula when necessary.

The mosquitoes tested were blood fed An.fluviatilis, which had been collected from human and animal shelters in rural areas between 06.00 and 08.00 hrs.

## RESULTS AND DISCUSSION

The base-line data collected prior to the application of DDT, dieldrin, and malathion in the unsprayed and isolated village of Salbiz in the Kazeroun area showed that the discriminating dosage which killed 100% of An.fluviatilis was 2.0% for DDT and 0.4% for dieldrin. The base-line values of LC50 for DDT and dieldrin were 0.36 and 0.14%, respectively, in October 1960 (3).

Susceptibility tests carried out on An. fluviatilis obtained 100% mortality for 1 h exposure to 3.2% malathion paper, in the village of Chelow in the Minab area before the application of malathion in October 1964.

Other susceptibility tests in the Chelow village, which is in a palm growing area and where DDT has been used for 17 rounds, dieldrin for 3 rounds, and since 1967, malathion for two rounds annually in March and August, revealed the LC50 values for DDT and dieldrin to be 1.1% and 0.15% respectively, in February 1971. The discriminating dose which could kill 100% of An.fluviatilis was 2.0% for DDT and 0.8% for dieldrin and 3.2% for malathion (Tables 1-3). The mortality rate to 5.0% malathion paper after 1/2 hr exposure followed by a 24 hr recovery period was found to be 100% in February 1971.

During 1972-79, the density of An.fluviatilis was not high enough to allow the performance of the adult susceptibility tests. These results indicate that in spite of almost 20 years of DDT, two years of dieldrin, and subsequent application of malathion, An.fluviatilis is still susceptible to all these insecticides.

Table 1. Results of DDT susceptibility tests on *An. fluviatilis* (1958-71) in Iran

Locality	Date	Spraying cycle	% Mortality after one-hr exposure, 24-hrs recovery					2.0 LC50
			Control	0.25	0.5	1.0	2.0	
Kooh-Malek (Zahedan)	December 1958	3-DDT	5* (20)	5.2 (20)	59 (18)	100 (20)	100 (90)	0.4
Guenz (Khash)	December 1958	3-DDT	4 (30)	10 (45)	55 (48)	88 (37)	100 (39)	0.45
Sistan (Jahrom)	November 1959	5-DDT	0 (29)	48 (85)	70 (70)	98 (90)	100 (96)	0.3
Salbiz (Kazeroun)	October 1960	Untreated	0 (155)	20 (121)	66 (121)	98 (154)	100 (128)	0.36
Hookerd (Jiroft)	May 1964	5-DDT 3-DL 2-MAL.	0 (80)	11 (65)	45 (51)	71 (72)	100 (133)	0.6
Siahoo (Bandar- Abbas)	October 1964	10-DDT 3-DL	2.8 (73)	44.2 (70)	80.8 (73)	97.2 (73)	100 (71)	0.3
Chelow (Minab)	February 1971	17-DDT 3-DL 17-MAL.	0 (39)	-	27.3 (43)	42.3 (34)	100 (48)	1.1

\* Figures in parentheses represent the number of mosquitoes tested.

DL=dieldrin MAL.=Malathion

Table 2. Results of dieldrin susceptibility tests on An. fluviatilis (1960-71) in Iran

Locality	Date	Spraying cycle	% Mortality after one-hr exposure							
			24-hrs recovery							
			Control	0.05	0.1	0.2	0.4	0.8	LC50	
Tazarj (Bandar-) Abbas	October 1960	6-DDT 3-DL	5* (48)	36 (33)	90 (49)	100 (55)	100 (66)	.	0.06	
Salbiz (Kazeroun)	October 1960	Untreated	0 (69)	6 (67)	25 (64)	75 (61)	100 (36)		0.14	
Chelow (Minab)	February 1971	17-DDT 3-DL 17-MAL.	0 (35)	-	11.7 (34)	81.4 (43)	97.2 (39)	100 (42)	0.15	

\* Figures in parentheses represent the number of mosquitoes tested.  
DL=dieldrin MAL.--malathion

Table 3. Results of malathion susceptibility tests on An.fluviatilis (1964-71) in Iran

Locality	Date	Spraying cycle	% Mortality after one-hr exposure, 24-hrs recovery				
			Control	0.	1.6	3.2	5.0
Chelow (Minab)	October 1964	10-DDT 3-DL	0 (42)	-	95.8 (48)	100 (47)	-
Chelow (Minab)	February 1971	17-DDT 3-DL 17-MAL.	0 (25)	0 (39)	-	100 (64)	100 (45)

\* Figures in Parentheses represent the number of mosquitoes tested.  
DL=dieldrin MAL. malathion

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