

STATUS OF RESISTANCE OF ANOPHELINE MOSQUITOES IN IRAQ, 1978¹

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ABSTRACT. In order to up-date the status of the resistance of malaria vectors to insecticides, as well as to establish base-line data for the susceptibility level of *Anopheles sacharovi* and *An. pulcherrimus* to malathion a series of susceptibility tests were carried out during March, April and May, 1978 in the southern,

central and northern regions of Iraq. These studies showed that *An. stephensi* is resistant to malathion, *An. sacharovi* and *An. pulcherrimus* are susceptible to malathion, and their LT 95 to malathion 5.0% is estimated to be about 15 and 31 min. respectively. The last 2 species were found to be resistant to DDT.

INTRODUCTION

Of the almost 16 anopheline species so far recorded in Iraq (Christophers and Shortt 1921, Macam 1950, Pringle 1954, Pringle et al. 1960) only 3, *Anopheles*

stephensi Liston, *An. sacharovi* Favre and *An. superpictus* Grassi are proven to be vectors of malaria. *An. pulcherrimus* Theobald has been suspected of being a vector in Najaf Province. The susceptibility level of these mosquitoes has been studied by several workers (Gramiccia et al. 1958, Davidson and Jackson 1961, Rishikesh 1972, Zahar 1974, Iyengar 1978), and it has been reported that *An. stephensi* which is the main vector in the southern region of Iraq, is resistant to

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DDT and dieldrin, *An. sacharovi* which is the vector of malaria in the northern region is resistant to DDT, and *An. pulcherrimus*, a secondary vector, Najaf Province, is resistant to DDT.

However, the use of DDT in Iraq has been banned for malaria control as well as for agricultural purposes. It was planned to substitute malathion as a residual insecticide for malaria eradication programme beginning in August 1978. To determine the current status of the resistance of malaria vectors to insecticides, as well as to establish base-line data for the susceptibility level of *An. sacharovi* and *An. pulcherrimus* to malathion, a series of susceptibility tests was carried out during March, April and May, 1978 in the southern, central and northern regions of Iran.

MATERIALS AND METHODS

The method used in testing is that developed by the world Health Organization (WHO 1970) for evaluating the susceptibility level of a field population of adult anopheline mosquitoes to organophosphorus and chlorinated hydrocarbon insecticides. Papers impregnated with malathion and DDT were provided by the World Health Organization. For the controls, papers impregnated with olive oil or resella oil were used. The exposure times to 5.0% malathion impregnated papers were 5, 10, 15, 30, 60 and 120 min. and to 4.0% were 1 hr., 2 hrs. and 4 hrs. Following exposure the mosquitoes were held in holding tubes with a pad of wet cotton wool.

All observed mortalities were corrected by Abbott's formula when necessary (Abbott 1925). The mosquitoes were blood-fed in the following regions: *An. stephensi* from Moavyiah Village, Basrah Province, *An. pulcherrimus* from the same village as well as from OmalHawa Village, Missan Province and Ashegh Village, Salahuddin Province (see map). In the case of *An. sacharovi* the specimens used were mixed blood fed and half gravid, collected from unsprayed shelters from SayedSadegh

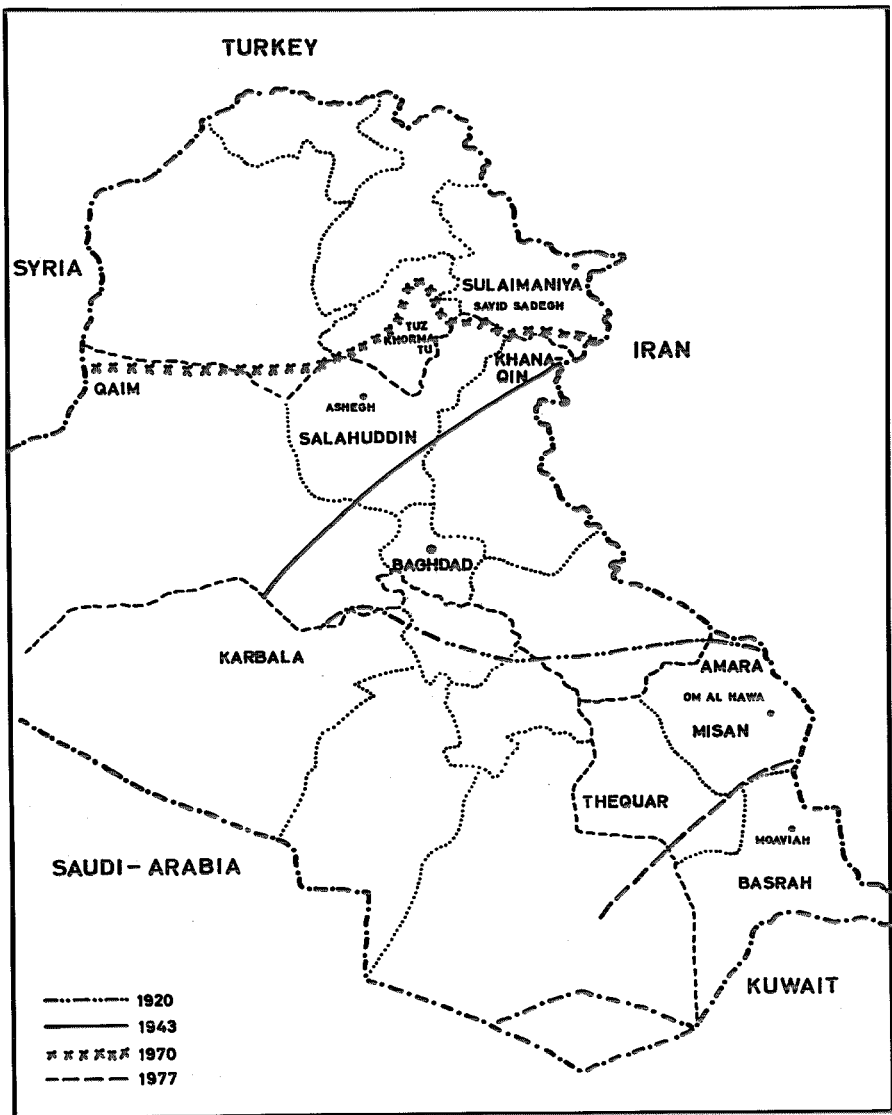
Village, Sulaimaniya Province. For each test as well as the control, 4 replicates were made, and for each replicate 20–25 mosquitoes were tested. LT95's were estimated by plotting the percentage mortality against time.

An. stephensi. This species has been reported to be resistant to DDT (Gramiccia et al. 1958, De Zulueta et al. 1958) and dieldrin (Davidson and Jackson 1961). Insecticide spraying, as an adulticide, was withdrawn from the area in 1961–63. As a result of favorable climatic conditions, *An. stephensi* populations rapidly increased and an outbreak of malaria occurred in 1963. DDT was, therefore, reintroduced in certain foci in 1963. In 1964 the entire southern region was once again under DDT coverage and, with the renewal of transmission in the central region in 1965, the entire area of distribution of *An. stephensi* in Iraq was sprayed with DDT at the rate of 2 g/m² twice a year. However, in 1969 the outbreak of malaria in the southern region showed that DDT was no longer effective against *An. stephensi*. Malathion was, therefore, substituted for DDT in the Basrah area in 1970 and in the Thequar area in 1972. The entire area was then under malathion spraying 3 times per year at the rate of 2g/m². This spraying interrupted malaria transmission in the southern region and caused the disappearance of *An. stephensi* from Central and Euphrates regions (Iyengar 1978).

Susceptibility tests carried out on *An. stephensi* during 1973–75 showed that malathion 50% gave 100% mortality. Tests carried out in December 1976 showed some survivors with malathion 5.0% 1-hr exposure, 24-hr recovery.

Tests carried out in March 1978 at Moaviyah, Basrah Province, showed 50% survival against malathion 5.0% 1 hr exposure, 24 hr recovery period. When the exposure time was increased to 2 hr the mortality rate also increased to 100%. It is worthwhile to mention that the malation-impregnated papers used were 5 months old (expiry date April, 1978) but in the same village, at the same time

RECORDED DISTRIBUTION OF A. STEPHENSI IN IRAQ
1920-1977



and with the same concentration, *An. pulcherrimus* tested against malathion showed 100% mortality, showing that the papers were still effective.

Resistance of *An. stephensi* to malathion has been reported from southern Iran (Manouchehri et al. 1976) and resistance of *An. albimanus* to malathion as well as propoxur from Central America (Georghiou et al. 1972). Also resistance of *An. culicifacies*, *An. hyrcanus*, *An. messeae* and *An. sacharovi* has been reported from India, Turkey and Romania respectively (WHO 1976, Georghiou and Taylor 1976).

An. pulcherrimus. This species has a distribution which includes the great alluvial basins of the Tigris and Euphrates rivers, the Oxus River (in Turkmanistan, U.S.S.R.) and the Indus River (in Pakistan). Also it has been reported from southern Iran, Caucasus, Afghanistan, (Christophers 1933) Saudi Arabia and the Syrian Arab Republic (Zahar 1974).

The species has been infected with *Plasmodium vivax* to the sporozite stage and has been found infected in nature in Central Asia, U.S.S.R. and in Sind area, Pakistan (Christophers 1933). Gland infection among wild caught females of *An. pulcherrimus* was demonstrated in the northern part of Afghanistan (Zahar 1974).

Susceptibility tests carried out in Thequar Province, Southern Iran, using DDT 4.0% showed 83% mortality 1 hr exposure, in 1971. In tests carried out in 1977 in 3 localities in Wasit, Thequar and Najaf Provinces, the observed mortalities were between 72% and 90% after 1 hr. exposure, 24 hr recovery. When the exposure time was increased to 2 hr the observed mortality was between 82% and 98% (Iyengar 1978).

Susceptibility tests using DDT as above were carried out in March and May 1978 in Missan and Salahuddin Provinces, and the observed mortality, after 1 hr exposure and 24 hr recovery, was 94% and 47% respectively. When the exposure time was increased to 2 hr in Ashegh village, Salahuddin Province, the mortality

increased to 78%. These studies show that *An. pulcherrimus* is resistant to DDT. (Table 1).

In order to establish base-line data for the susceptibility of *An. pulcherrimus* to malathion, a series of susceptibility tests was carried out in Basrah, Missan and Salahuddin. These tests showed that malathion 5.0% kills 100% of *An. pulcherrimus* tested after 1 hr exposure. In Ashegh village, Salahuddin Province, where malathion has not been used for malaria eradication as a residual insecticide, the observed LT 95 was ca. 15 min. This shows that this species is very susceptible to this insecticide. (Table 2).

An. sacharovi. This species is the main malaria vector in northern parts of Iraq. Since 1957, DDT has been used as a residual insecticide, and 37 rounds of spraying with this insecticide were carried out in April 1978. The first indication of DDT resistance in *An. sacharovi* was observed in 1970. The observed mortality after 4 hr exposure to DDT 4.0% was 93%. By 1973 the mortality with the same concentration, after 4 hr exposure was reported to be between 87-96%. The susceptibility test carried out in 1975, DDT 4.0%, 4 hr exposure, 24 hr recovery, showed 77 to 95% mortality (Iyengar 1978).

The susceptibility test carried out against DDT 4.0% in May, 1978 showed 72% mortality, 4 hr exposure, 24 hr recovery. It should be mentioned that in spite of spraying with DDT twice per year at the rate of 2 g/m², because of administrative operational, technical and political problems that exist, the interruption of transmission in the past years has not been achieved. By 1978, the government of Iraq had banned the use of DDT, so the northern part of Iraq would be sprayed with malathion at the rate of g/m².

In order to establish base-line data for the susceptibility of *An. sacharovi* to malathion which was to have been used for the next round (August 1978) in Seyed Sadegh village, Sulaimaniye Province, the mixed population (blood fed

Table 1. Susceptibility of female anopheline mosquitoes to DDT 4% in Iraq, March, May, 1978.

Province	Locality	Anopheline Species	Date	RH%	Temperature °C		Spraying Cycle	% Mortality, following hour exposure, 24 hour recovery			
					Max.	Min.		Control	1 hr	2 hr	4 hr
Barah	Moaviyeh	<i>An. stephensi</i>	March	53	31	13	22 DDT 7 DL	.5 (65)	26 (30)	—	—
Missan	Omalhawa	<i>An. pulcherrimus</i>	March	59	29	13.6	24 Mal 12 DDT 5 DL 18 Mal	8 (49)	94 (50)	—	—
Salahuddin	Ashgeh	<i>An. pulcherrimus</i>	May	25	31	22	16 DDT	4 (150)	47 (225)	78 (169)	—
Sulaimaniya	Sayedsadegh	<i>An. sacharovi</i>	May	22	34	16	37 DDT	0 (25)	—	—	(54)

Figures in parentheses represent the number of mosquitoes tested.

Table 2. Susceptibility of female anopheline mosquitoes to malathion 5.0% in Iraq, March, May, 1978.

Province	Locality	Anopheline Species	Date	RH%	Temperature °C		Spraying Cycle	% Mortality, following minutes exposure 24-hour recovery						
					Max.	Min.		Control	5	10	15	30	60	120
Barah	Moaviyah	<i>An. stephensi</i>	March	53	31	13	22 DDT 7 DL	1.5 (68)	—	—	—	—	50 (106)	100
Barah	Moaviyah	<i>An. pulcherrimus</i>	March	53	31	13	24 Mal "	5 (58)	—	—	—	—	100 (98)	—
Missan	Omalhawa	<i>An. pulcherrimus</i>	March	59	29	13.6	5 DL 12 DDT 18 Mal	4 (49)	—	—	—	—	100 (94)	—
Salahuddin	Ashgeh	<i>An. pulcherrimus</i>	May	22	34	16	16 DDT	12.6 (167)	62.3 (124)	95.2 (100)	94 (120)	98.3 (78)	100	—
Sulaimaniya	Sayedsadegh	<i>An. sacharovi</i>	May	22	34	16	37 DDT	0 (65)	53 (32)	75 (54)	82 (28)	92 (41)	100 (50)	—

Figures in parentheses represent the number of mosquitoes tested.

and half gravid) of *An. sacharovi* were tested against malathion 5.0%, and the following mortalities, 53, 85, 82, 92 and 100% were observed with 5, 10, 15, 20 and 60 minutes respectively. The LT 95 is about 31 min. Although at present different organophosphorus insecticides as well as malathion are used for agricultural pest control in the area. *An. sacharovi* shows normal susceptibility to malathion.

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