Iranian J. Publ. Hlth. February 1974, Vol. 2, No. 4.

RESISTANCE OF ANOPHELES SACHAROVI FAVRE TO DDT IN IRAN, 1973 ✿

A. V. Manouchehri
A. Zaini
E. Javadian
E. Saebi

ABSTRACT **A. sacharovi, which is one of the main malaria vectors of the Palearchic region, is resistant to DDT in Greece (1949), Lebanon (1954), Turkey (1959), Syria and the U.S.S.R. (1972).**

The first record of A. sacharovi resistance to DDT in Iran was given in 1959 from the Kazeroon area, followed by Izeh (1969) and Meshkin-Shahr (1970).

This paper urgently advises speedy measures to eliminate the present foci of DDT-resistant A. sacharovi, to distinguish the areas of spread around the foci and to proceed with the systematic checking of the susceptibility level of A. sacharovi in other areas of its distribution in Iran.

INTRODUCTION

Anopheles sacharovi was the first anopheline to develop resistance to DDT. Failure in the effect of DDT on *A. sacharovi* was first observed in southern Greece in 1949, when it was observed that adults of this species were resting in large numbers under road bridges, but were absent from sprayed houses and stables. In 1950, adults were observed remaining in houses and resting on sprayed

* This study was supported in part by the funds of the School of Public Health and Institute of Public Health Research, University of Teheran, and partly by the Public Health Research Project of the Ministry of Health and Plan Organization.

** Vector Control Unit, Department of Environmental Health, School of Public Health and Institute of Public Health Research, University of Teheran, P.O. Box 1310, Teheran, Iran.

walls (Georgopoulos, 1951). In 1952, control failure was observed within 4 weeks after spraying and the indoor population of *A. sacharovi* had returnd to the unsprayed level (Livadas and Georgopoulos, 1953). Definite DDT resistance as well as Dieldrin resistance was observed (De Zulueta, 1959) in areas that had been sprayed 10 times with DDT and 5 rounds with Cholordane or HCH.

DDT-resistant populations of *A. sacharovi* have been reported from Lebanon (Garrett-Jones and Gramiccia, 1954), Turkey (De Zulueta, 1959), Syria (Orioni, 1972) and the U.S.S.R (Drobozian *et al.*, 1972). In Yugoslavia, *A. sacharovi* has shown tolerance to DDT and there is no report of DDT resistance from Rumania, northern Iraq, Italy or Albania (Brown and Pal, 1971). *A. sacharovi* is distributed throughout the U.S.S.R., Italy, Sardinia, Corsica, Syria, Iraq, Austria, Cyrus, Turkey, Greece, Kazakestan, Lebanon and Jordan (stone *et al.*, 1959). In Iran, *A. sacharovi* is partly scattered throughout Azerbaijan, the central area, the west and southwest and Fars Province. It is found in the northern area of Kerman Province, but not in Khorassan, Baluchestan and the Caspian Sea area.

As the emergence of insecticide resistance has great impact on the Malaria Eradication Campaign, evaluation of the susceptibility level of the anopheline vectors has been checked regularly by members of the Vector Control Unit, Department of Environmental Health, School of Public Health and Institute of Public Health Research.

In this paper, the history of *A. sacharovi* resistance in Iran as well as the results of susceptibility tests performed in Izeh (southwest) and Meshkin-Shahr (northwest) from 1969 to date are discussed.

MATERIALS AND METHODS

The method used in testing is that developed by the World Health Organization for evaluating the susceptibility of a field population of adult Anophelines (WHO, 1970). Paper impregnated with DDT in Risella oil at concentrations of 0.5, 1.0, 2.0 and 4.0%, Malathion-impregnated paper at concentrations of 0.5, 3.2 and 5.0%, and Dieldrin-impregnated paper at concentrations of 0.2, 0.4, 0.8 and 1.6% were provided by WHO. For the controls, paper impregnated with Risella oil alone was used.

The *A. sacharovi* were placed in tubes with untreated paper and allowed to remain there for one hour. Those insects which were not active were removed from the tubes. The mosquitoes were gently blown into the tubes with treated paper. Exposure

to the impregnated papers lasted one hour, two hours or fou hours as necessary, after which time the mosquitoes were blow back into the tubes with untreated paper. The mosquitoes wer held in these for 24 hours; then a final mortality count was mad During the holding period a pad of wet cotton wool was place on top of the tubes. The temperature and relative humidit during the test period were recorded. All observed mortalit percentages were corrected by Abott's formula when necessar (Abott, 1925). LC50's were estimated by plotting the dosage mortality lines. The mosquitoes were collected from human an animal shelters in Izeh, northern Khuzestan, in southern Iran, an from Meshkin-Shahr in the northwest of the country.

RESULTS AND DISCUSSION

1. A spraying operation with DDT, at the rate of 2 g/m^2 agains two important vectors, *A. stephensi* and *A. sacharovi,* commenced in Izeh area, Khuzestan, southwest Iran, in 1953. These insecticide applications decreased the indoor population of *A. sacharov* to almost zero and adults of this species were collected in earthenware wheat containers at a very low density. By 1957, *A stephensi,* the main malaria vector, acquired resistance to DDT (Mofidi *et al.,* 1958). In 1958, the area was sprayed with Dieldrin at the rate of 0.5 g/m^2 twice a year. In the following year *A. sacharovi* disappeared from the sprayed area. By 1960, *A. stephensi* acquired resistance to Dieldrin and the area was resprayed with DDT. In 1967, because of the double resistance of *A. stephensi* to DDT and Dieldrin, the area had gone under DDT and Malathion application, twice a year with each insecticide. However, *A. sacharovi* reappeared in houses in 1969, after 8 years of spraying with DDT, 3 times spraying with Dieldrin and 2 times with Malathion. In July 1969, susceptibility tests showed that the LC50 for DDT had increased from 0.7% to 1.1%. In 1970, 1971, 1972 and 1973 the LC50's for DDT were 1.4, 1.4, 3.6 and 4% respectively. In 1973 when *A. sacharovi* was tested against 4% DDT at one hour exposure, after 24 hours recovery the mortality obtained was about 53%. When the exposure time was increased to 2 hours, the mortality obtained was about 90%.

2. In Meshkin-Shahr, northwestern Iran, the area has been under DDT application at the rate of 2 g/m^2 once a year for 10-11 years. In August, 1970, *A. sacharovi* was found resistant to DDT in one village (Mohamad-Bagloo). When this species was tested again 4% DDT at one-hour exposure, after 24 hours recovery the mortality rate was zero. When the time of exposure was increased to 4 and 8 hours, the mortality rate remain

the same level. The average density of *A. sacharovi* was 36 per room. In July, 1971, out of 31 villages investigated, susceptibility tests were performed in four villages. *A. sacharovi* was tested against 4% DDT. The mortality rate after one and four hours exposure was zero. The average density of *A. sacharovi* was recorded at 5 to 22 females per room.

In 1973, 26 villages in the same area were checked. In all villages we were able to catch *A. sacharovi* in human and animal shelters. The average density was about 10 to 26 per room. When *A. sacharovi* was tested against 4% DDT, after one and four hours' exposure the mortality rate was zero.

3. In 1959 in the Kazeroun area of southern Iran, which had been treated with DDT for 5 years, the mortality rate on 4.0% DDT paper was 35-40% in Dadin Bala and Polabgineh respectively. The area was sprayed with Dieldrin at the rate of 0.5 g/m^2, twice a year, in 1960-1961, and from 1967 to 1973 with Malathion at the rate of 2 g/m^2. After Dieldrin application, *A. sacharovi* disappeared from the area and has not reappeared up to the present time.

Taking into account the problems created in Turkey and Syria, etc. (Zahar, 1973), by the resistance of *A. sacharovi*, we should be aware of the potential danger and technical difficulties which the resistance of this vector could cause in Iran.

All possible measures should be taken in order to prevent the spread of existing areas of resistant foci and to facilitate their elimination.

A careful systematic checking of the susceptibility level of *A. sacharovi* in other areas where resistance has not been detected is also recommended.

CONCLUSION

These investigations show that *A. sacharovi* is resistant to DDT in the northwest and southwest of Iran. The susceptibility tests carried out with Malathion and Dieldrin show that *A. sacharovi* is susceptible to both insecticides. In the northwest of Iran, the discriminating dosage that killed 100% of *A. sacharovi* tested for Malathion was 3.2% and for Dieldrin 1.6%. In the southwest, the discriminating dosage that killed 100% of *A. sacharovi* for Malathion was 3.2% and for Dieldrin 0.8%.

REFERENCES

Abbott, W.W. (1925). A method of computing the effectiveness of an insecticide. J. Econ. Ent. *18* :265-267.

Brawn, A.W.A. and Pal, R. (1971). Insecticide resistance in arthropods Wld. Hlth. Org. Monograph Series No. 38, pp. 95-104.

Drobozian, V.P., Anufriev, V.N., Sergiev, V.P. and Kondrashi, A.V. (1972). Detection of resistance to DDT in *Anopheles maculipennis sacharovi* Favre in Azerbaijan S.S.R. Med. Parazitiy-Parazit. Bolenzi *41*(4) :460-464.

Garrett-Jones, C. and Gramiccia, G. (1954). Evidence of the development of resistance to DDT by *Anopheles sacharovi* in the Levant. Bull. Wld. Hlth. Org. *11* :865-883.

Georgopoules, C.D. (1954). Extension to Chlordane of the resistance to DDT observed in *Anopheles sacharovi.* Bull. Wld. Hlth. Org. *11* :855-864.

Hadjinicolaou, J. (1954). Cited in : Brawn, A.W.A. and Pal, R. (1971). Insecticide resistance in arthropods. Wld. Hlth. Org. Monograph Series No. 38, pp 95-104.

Livadas, G.A. and Georgopoulos, G. (1953). Development of resistance to DDT by *Anopheles sacharovi* in Greece. Bull. Wld. Hlth. Org. *8* :497-511.

Mofidi, Ch., Samimi, B., Eshghy, N. and Ghiasseddin, M. (1958). Further studies of Anopheline susceptibility to insecticides in Iran; results of Busvine and Nash method. Report of the Institute of Parasitology and Malariology, Teheran, Iran.

Onori, E. (1972). Experience with mass drug administration as a supplementary attack measure in areas of vivax malaria. Bull. Wld. Hlth. Org. *47* :543-584.

Ramsdale, C.D. (1973). Insecticide resistance in the Anophelines of Turkey. In : Proceedings of the 9th International Congress on Tropical Medicine and Malaria, Athens, Oct. 1973, pp 260-261.

Shahgudian, E. (1969). Biological and bionomic features of malaria vectors in Iran and their role and importance. I.P.H.R. No. 1667, Teheran, Iran.

Ston, A., Knight, K.L. and Stracker, H. (1959). A synoptic catalog of the momsquitoes of the world. Tomas Say Foundation, 6 Washington.

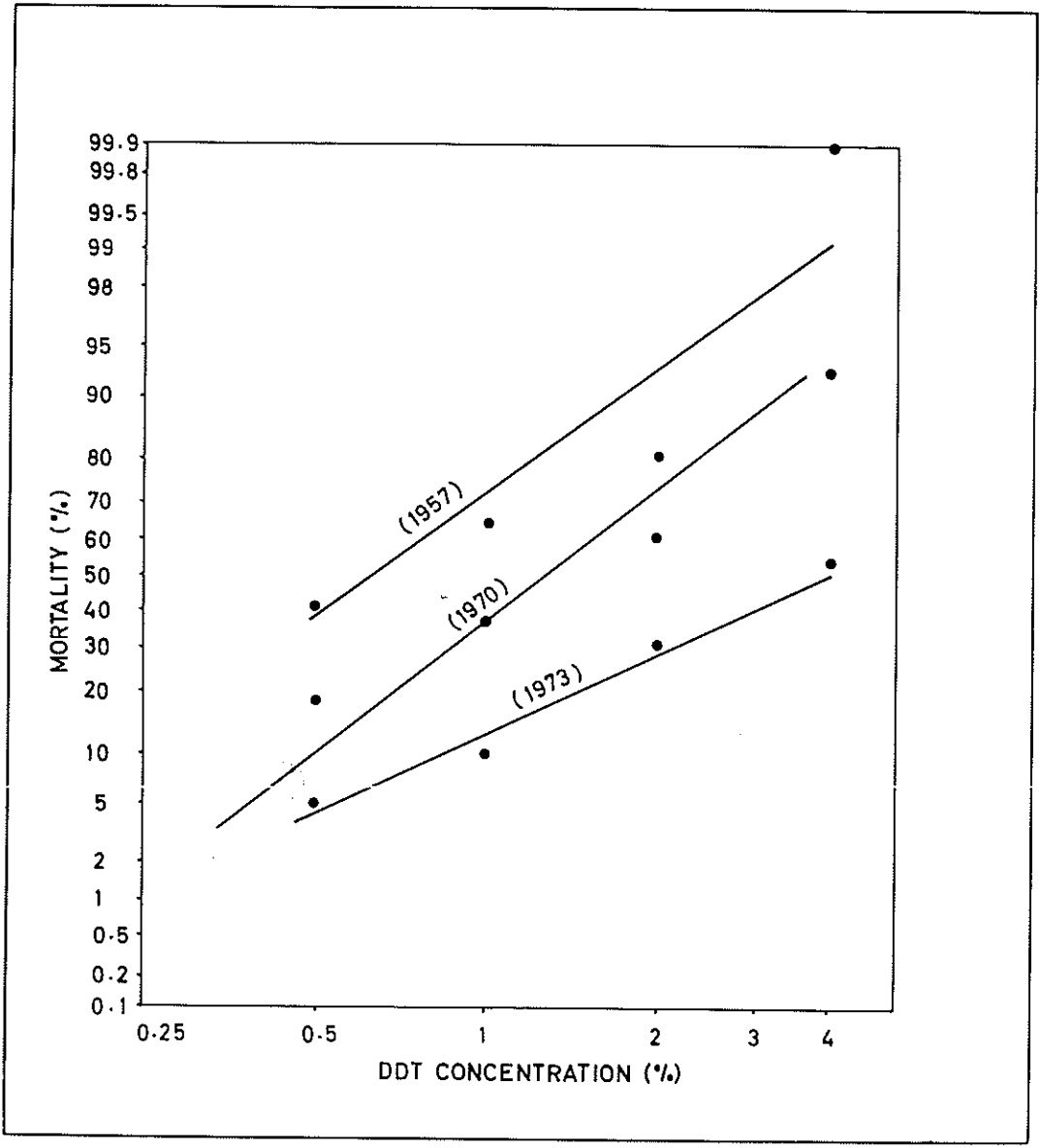
World Health Organization (1970). Insecticide resistance and vector control. 17th Report of the Expert Committee on Insecticides. Tech. Rep. Ser. No. 443.

Zahar, A.R. (1973). Review of ecology of malaria vectors in the WHO Eastern Mediterranean Region. WHO/Mal/808 (mimeographed document).

Results of DDT susceptibility tests on A. sacharovi adults in Khuzestan Province, S.W. Iran

Area & Location	Date	Spraying Cycles	Exposure Time-hrs	% Mortality after 24 hours						LC5
				Cont.	0.25	0.5	1.0	2.0	4.0	
Izeh	July 57	4 DDT	1	14 (108)	--	41 (108)	68 (108)	82 (108)	100 (36)	0.6
"	Aug. 57	"	1	9 (108)	--	50 (108)	72 (108)	82 (108)	--	0.5
"	Oct. 57	"	1	9 (147)	--	--	71 (159)	86 (165)	98 (194)	0.7
Takab-Bandan Izeh	July 69	4 DDT 2 Mal	1	0 (154)	8.4 (95)	22 (159)	43.5 (150)	68.5 (156)	90.6 (160)	1.1
"	June 70	9 DDT 2 Mal	1	0 (225)	5.5 (199)	17.1 (198)	36.6 (202)	61.9 (213)	93.2 (222)	1.4
Bardboran Izeh	June 71	10 DDT 3 Mal	2	0 (100)	--	34.3 (99)	42.2 (97)	72.5 (102)	97 (101)	--
Takab-Bandan Izeh	June 71	"	1	0 (201)	--	13.4 (146)	32.5 (200)	60.4 (197)	93.5 (203)	1.4
Bardboran Izeh	June 72	12 DDT 4 Mal	1	0 (100)	--	2 (100)	4 (100)	13 (100)	68 (100)	3.6
"	June 73	"	1	0 (199)	--	5.6 (198)	10.6 (198)	31 (202)	53.7 (199)	4
"	"	"	2	0 (173)	--	--	--	60 (173)	90 (176)	--

DOSAGE-MORTALITY REGRESSION LINES FOR ADULTS OF A. SACHAROVI, IZEH AREA, SOUTHERN IRAN, 1957-1973.



MAP SHOWING THE DDT RESISTANCE AREAS OF A. SACHAROVI AND IT'S DISTRIBUTION IN IRAN