

RESISTANCE OF *ANOPHELES CULICIFACIES* GILES TO DDT IN BALUCHESTAN PROVINCE, SOUTHERN IRAN, 1974¹

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ABSTRACT. *A. culicifacies* is the vector of malaria on the Indian subcontinent, in Sri Lanka, Burma, southern Arabia, Afghanistan and southeastern Iran. After the application of DDT in Baluchestan, southeastern Iran, the population of this species decreased sharply, and for about a decade remained so low that it was not possible

Anopheles culicifacies is a vector of malaria on the Indian subcontinent, in Sri Lanka (Ceylon), Burma, southern Arabia, the United Arab Emirates and Afghanistan (Christophers, 1933). It is also a vector of malaria in southeastern Iran. The susceptibility status of *A. culicifacies* has been very fully summarized by Brown and Pal (1970) and Pal (1974). At the present time this species is resistant to DDT in India (Shalaby, 1968; Samson et al. 1974), West Pakistan, Burma (Brown and Pal, 1971), and other countries.

MATERIAL AND METHOD. The areas under study were Iran Shahr and Chahbahar Shahrestans (counties), Baluchestan, southeastern Iran. The tests were carried out in 4 localities in Iran Shahr and one locality in Chahbahar. The method used in testing was that developed by the World Health Organization for evaluating resistance in a field population of mosquitoes (WHO, 1970). Papers impregnated with

to collect adults of this species for susceptibility tests. However, by April 1973, the density of this species in unsprayed houses had increased to up to 500 per room. Susceptibility tests carried out in 1973-1974, in Iran Shahr county, showed that this species was resistant to DDT.

DDT in Risella oil at concentrations of 1, 2 and 4%, malathion at concentrations of 0.5, 3.2 and 5% and dieldrin at concentrations of 0.8, 1.6 and 4% were provided by WHO.

Blood-fed mosquitoes were collected from unsprayed human and animal shelters in Said-Abad, Kheirabad, 25 km west of Iran Shahr; Sarbaz, 150 km south of Iran Shahr; and Hit and Nikshahr, about 200 km north of Chahbahar. The area was sprayed with DDT in March 1974, at the rate of 2 g/m². The mosquitoes were exposed for 1 hour, 2 hours and 4 hours. All observed mortalities were corrected by Abbott's formula (Abbott, 1925) when necessary. LC₅₀'s were estimated by plotting the dosage-mortality lines.

RESULTS AND DISCUSSION. After DDT application in 1959 for malaria control, the density of *A. culicifacies* decreased sharply. Susceptibility tests carried out in 1959 showed that the DDT concentration that killed 100% of *A. culicifacies* was 1.0%. Susceptibility tests carried out in 1963 showed that the LC₅₀ of DDT was 0.55%. In 1964 and 1965, Baluchestan was sprayed with dieldrin because of the resistance of *A. stephensi*, the other ma-

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alaria vector in this area, to DDT. Subsequently, in 1967-1973, 2 cycles per year each of malathion and DDT at the rate of 2 g/m² were applied. During this period of 10 years, the density of *A. culicifacies* was so negligible that it was not possible to perform susceptibility tests (Zaini and Manouchehri, 1973). By April and May 1973, the density of *A. culicifacies* in Hit had increased to about 5 and 500 per shelter in sprayed and unsprayed dwellings respectively. Susceptibility tests carried out in Hit, Said-Abad and Kheirabad showed that the mortality rate for 4% DDT after 1 hour exposure and 24 hours recovery was between 39 and 43%. When the time of exposure was increased to 4 hours, the percentage mortality was 70% (Zaini and Manouchehri, 1973). By April and May 1974, susceptibility tests in 5 localities in Iranshahr and Chahbahar

showed that the mortality with 4% for 1 hour exposure was 16-42% (Table 1.) When the time of exposure increased to 2 and 4 hours, the mortality rate was between 30-41 and 46-58% respectively.

It should be mentioned that the mosquitoes tested were collected from unsprayed shelters. The density of *A. culicifacies* in sprayed shelters was very low (5-12 per room), whereas in unsprayed shelters it was 100-200 per room. This study showed that *A. culicifacies* is resistant to DDT in the areas investigated. Parasitological investigation showed that, during 1971, the annual parasite incidence (API) in Iran Shahr and Chahbahar Shahr-restans was 10 and 6.6 per thousand. During 1972 and 1973, the API increased to 38-31.8 and 18.5-9.9 per thousand respectively. Susceptibility tests carried out with dieldrin and malathion showed that *A.*

Table 1. Results of DDT susceptibility tests on *A. culicifacies* adults in Baluchestan, April-May 1973.

Village and area	Date	Exposure time in hrs.	% Mortality after 24 h			
			Cont.	1.0%	2.0%	4.0%
Kheirabad, Iran Shahr	4/73	1	0 (20)	0 (18)	9.5 (21)	42 (19)
Hit, Iran Shahr	5/73	1	0 (84)	1 (74)	3.7 (81)	16.4 (79)
Hit, Iran Shahr	5/73	2	0 (82)	10.5 (76)	27 (78)	44 (84)
Hit, Iran Shahr	5/73	4	0 (79)	15 (81)	33 (78)	58 (81)
Said-Abad, Iran Shahr	5/73	1	0 (87)	3 (90)	9 (94)	36 (89)
Said-Abad, Iran Shahr	5/73	2	1 (83)	7 (85)	18 (84)	41 (82)
Said-Abad, Iran Shahr	5/73	4	0 (86)	10 (81)	23 (90)	53 (86)
Sarbaz, Iran Shahr	5/73	1	0 (37)	5 (41)	12 (43)	31.8 (38)
Nikshahr, Chahbahar	5/73	1	0 (83)	0 (82)	0 (84)	18 (76)
Nikshahr, Chahbahar	5/73	2	0 (81)	2 (85)	15 (84)	31 (88)
Nikshahr, Chahbahar	5/73	4	1 (82)	13 (84)	28 (78)	47 (75)

Remarks: 1. The area has been treated 24-25, 6 and 10 rounds with DDT, dieldrin and malathion respectively. 2. Figures in parentheses represent the number of mosquitoes tested at each concentration.

culicifacies is susceptible to both insecticides; the LC₅₀'s were 0.055 and 0.55 respectively.

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