

A. sacharovi have been carried out in addition to the above-mentioned studies. Thus Belios,ⁱ in summarizing the problem of *A. sacharovi* in Greece, gives a map showing the places where investigations of resistance of this kind were conducted. It should be noted that such investigations were carried out in Evsoni, which is only 10 km distant from the Yugoslav villages of Stojakovo and Bogorodica. Belios also concludes that in more recent times *A. sacharovi* are being encountered deep inland, whereas this vector was earlier found near coastal dwellings.

It is certainly difficult to postulate that the migration of *A. sacharovi*, which has been established, has been exclusively due to the application of insecticides. Even if the insecticide is taken as the influencing factor, it is hard to see how essential is its effect on a migration of this type.

Two questions arise:

(a) Has the decrease in the *A. maculipennis* group, which is susceptible to insecticides, left more living space for other species such as *A. sacharovi*?

(b) Is the irritability of *A. sacharovi* to insecticides the factor which has caused the species to migrate?

ⁱ Belios, G. D. (1960) *Riv. Malar.*, 39, 1.

Considering that *A. sacharovi* have been found in great numbers in the settlements investigated and that their relative numbers have been as high as those of varieties of the *A. maculipennis* group, such findings cannot be considered accidental. It must be considered that *A. sacharovi* is migrating into these areas. Differences in the proportions of *A. sacharovi* found in the various settlements could be attributed to the degree of salinity of the water in the anopheline breeding places, high salinity being a favourable factor for their maintenance. On the other hand, the proof that *A. sacharovi* is migrating from the south is that its appearance has been confined to the Greek border and that its presence has been established only in four out of the seven settlements investigated in Yugoslavia.

Bearing in mind the importance of *A. sacharovi* in the transmission of malaria and especially its capacity to develop resistance to insecticides, it is considered that special attention should be devoted to the presence of *A. sacharovi* in Macedonia and that investigations should be continued on its distribution and its susceptibility to insecticides. Only thus can undesirable consequences to the successful malaria eradication programme in Yugoslavia be prevented.

Preliminary Note on the Development of DDT-Resistance in *Anopheles culicifacies* Giles in Panchmahals District, Gujarat State, India *

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Susceptibility tests

Intensive susceptibility testing of *Anopheles culicifacies* Giles against DDT has been carried out in Panchmahals district, Gujarat State, since September 1959.

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Panchmahals district, which is situated about 350 miles (about 560 km) north of Bombay city has been exposed to residual DDT spraying since 1950, as follows:

1950-52: 3 cycles per year, each of 56 mg/square foot; ^b
 1953-55: 2 cycles per year, each of 112 mg/square foot;
 1956-57: 1 cycle per year, of 112 mg/square foot;
 1958-60: 2 cycles per year, each of 112 mg/square foot.

^b A convenient conversion rate is 100 mg per square foot = 1 g per m².

In 1958 and 1959 an additional (third) cycle of DDT at 112 mg/square foot was applied in Baria and Limkheda talukas, which make up about one-fifth of the area of the district.

The malaria vectors encountered in the district are *A. culicifacies*, *A. fluviatilis* and *A. stephensi*. The most important is considered to be *A. culicifacies*, which is prevalent throughout the year and has been found by us in the highest densities during the months of November, December and January.

The malaria transmission season lasts from July to November generally throughout the district and probably until February in Baria and Limkheda talukas.

The first tests carried out in September 1959 showed an appreciable reduction in the normal susceptibility of *A. culicifacies* to DDT. These tests, performed in the villages of Motipura in Baria taluka and Sindbhai Mehta in Halol taluka which are 30 miles (or nearly 50 km) apart, gave LC₅₀ values of between 2.3% and 2.5% DDT.

Unfortunately no DDT susceptibility tests on *A. culicifacies* had been carried out previously in these areas. However, at two other locations in Panchmahals district previous tests on *A. culicifacies* had demonstrated an LC₅₀ of 0.5% DDT at Khojwa village^c and of 0.5% at Popatpura.^d Prior to our tests the highest LC₅₀ of DDT recorded for *A. culicifacies* was 0.84% at Potgoan village in the Thana district of Bombay State about 300 miles (about 500 km) south of Panchmahals.^e Previously published information on the DDT susceptibility status of *A. culicifacies* at various places in India is summarized in Table 1. From this it will be seen that until August 1959 the recorded LC₅₀ of DDT varied from 0.4% to 0.84% in DDT-sprayed areas and from 0.16% to 0.43% in unsprayed areas. The tests at Motipura and Sindbhai Mehta, showing an appreciable increase in the LC₅₀ of DDT of *A. culicifacies* coupled with the fact that 100% mortality was not produced at the highest impregnated paper concentration (4.0% DDT), gave the impression that we were dealing with a heterogeneous *A. culicifacies* population developing DDT-resistance.

^c Rao, T. R. & Bhatia, S. C. (1957) *Indian J. Malar.*, 11, 261.

^d Bhatia, S. C., Deobhankar, R. B. & Vittal, M. (1958) *Indian J. Malar.*, 12, 371.

^e Patel, T. B., Rao, T. R., Halgeri, A. V. & Deobhankar, R. B. (1958) *Indian J. Malar.*, 12, 367.

Susceptibility tests were continued at intervals until February 1960, when the work was interrupted by the shortage of DDT-impregnated papers. Until that time there had been no further increase in the LC₅₀. In fact the LC₅₀ of *A. culicifacies* at Motipura village dropped to 1.4% during the month of January 1960, but it showed an increase to 1.8%-2.1% DDT during the month of February, as indicated in Table 2.

With the arrival of fresh DDT-impregnated papers in May 1960, susceptibility tests were continued at monthly intervals. Tests carried out in June 1960 indicated more definitely the development of DDT-resistance in this species. In Motipura village (Baria taluka), for example, the highest LC₅₀ recorded up to February 1960 was 2.1% DDT. In the series of tests performed in June, July and August 1960 the LC₅₀ had risen to a figure greater than 4% (Table 2). In 1959 the lowest mortality recorded to 4.0% DDT was 65.0%. In the June, July and August 1960 tests it had fallen to 34%-38%. In Rampura village (Godhra taluka) a similar situation is developing. The LC₅₀ DDT was 2.8% in June 1960, 3.7% in July 1960 and 4.0% in August 1960 compared with the previous highest figure of 1.6% in November 1959 (Table 3).

Susceptibility testing with lengthened exposure periods of 2, 3, 4 and 8 hours was carried out. Eight hours' exposure to 4.0% DDT gave mortalities of 90%, 79.0% and 75.0% in July, August and September 1960 compared with 99.0% in November 1959 (Table 4).

Tests on the progeny of the *Anopheles* survivors of 4.0% DDT exposed for one hour and 4% DDT exposed for eight hours have been attempted. Owing to difficulties in breeding *A. culicifacies* in the laboratory, no conclusive results were obtained.

Susceptibility tests of *A. culicifacies* on dieldrin have been performed. At Motipura village the LC₅₀ was 0.12% in December 1959 and 0.065% in March 1960 (Table 5).

Larval tests with DDT were carried out in February and October 1959 and in April and October 1960 (Table 6). At Godhra in October 1959 the LC₅₀ DDT was 0.03 p.p.m. At Motipura during the period from February 1959 to October 1960, the LC₅₀ of DDT has risen from less than 0.02 p.p.m. to a figure between 0.13 p.p.m. and 0.16 p.p.m., indicating a significant decrease in susceptibility.

At Motipura village in May 1960, the LC₅₀ for dieldrin was less than 0.0008 p.p.m. (Table 7).

TABLE 1
PREVIOUSLY PUBLISHED RESULTS OF DDT SUSCEPTIBILITY TESTS OF *A. CULICIFACIES* IN INDIA

Location	LC ₅₀ (%)	Spraying history	Investigators
BOMBAY STATE			
Panchmahals			
Khojwa	0.501	7 years DDT	Rao & Bhatia ^a
Popatpura	0.5	7 years DDT	Bhatia et al. ^b
Sindbhai Mehta	2.6	10 years DDT	Rahman et al. ^c
Poona			
Manjari	0.453	4 years DDT	Rao & Bhatia ^a
	0.536		
Manjari	0.2	2 years DDT and 2 years dieldrin	Bhatia et al. ^b
Dhond	0.598	1 year DDT	Rao & Bhatia ^a
Dhond	0.24	Unsprayed	Rao & Bhatia ^a
Kolwadi	0.6	2 years DDT and 2 years dieldrin	Bhatia et al. ^b
Baramati	0.535	4 years DDT	Rao & Bhatia ^a
Kolaba			
Dasagaon	0.365	Unsprayed	Rao & Bhatia ^a
Ladapur	0.41	4 years DDT	Rao & Bhatia ^a
Thana			
Revti	0.412	7 years DDT	Rao & Bhatia ^a
	0.571		Rao & Bhatia ^a
Potgaon	0.84	9 years DDT	Patel et al. ^d
Nagpur			
Chorbarvli	0.2	Unsprayed	Bhatia et al. ^b
Bhir			
Kada	0.3	Unsprayed	Bhatia et al. ^b
Dharwar			
Bellary	0.379	Unsprayed	Rao & Bhatia ^a
Bijapur			
Haldur	0.472	7 years DDT	Rao & Bhatia ^a
MYSORE STATE			
Mandya			
Nelligeri	0.158	Unsprayed	MII Team (M. L. Mamman)
Mandya District	0.25	Unsprayed	Sundar Rao et al. ^f
RAJASTHAN STATE			
Udaipur			
Kailashpuri	0.78	DDT twice	MII Team (J. S. Khamre) ^j
Kailashpuri	0.19	Unsprayed	Sharma et al. ^g
	0.22		
MADHYA PRADESH			
Morena			
Palad Pur	0.35	Unsprayed	MII Team (Babu Ram) ^e
	0.34		
UTTAR PRADESH			
Meerut			
Arthala	0.43	Unsprayed	Sharma et al. ^h
PUNJAB			
Marnal			
Uchana	0.31	Unsprayed	MII Team (M.I.D. Sharma) ^e

^a Rao, T. R. & Bhatia, S. C. (1957) *Indian J. Malar.*, 11, 261.

^b Bhatia, S. C., Deobhankar, R. B. & Vittal, M. (1958) *Indian J. Malar.*, 12, 371.

^c Rahman, J., Roy, M. L. & Kuldip Singh (1959) *Indian J. Malar.*, 13, 125.

^d Patel, T. B., Rao, T. R., Halgeri, A. V. & Deobhankar, R. B. (1958) *Indian J. Malar.*, 12, 367.

^e The findings of the Malaria Institute of India (MII) team were quoted by Pal, R. (1958) *Indian J. Malar.*, 12, 383.

^f Sundar Rao, A. R., Krishnamurthy, B. S. & Singh, N. N. (1958) *Bull. nat. Soc. India Malar.*, 6, 83.

^g Sharma, M. I. D., Krishnamurthy, B. S., Khamre, J. S. & Singh, N. N. (1957) *Bull. nat. Soc. India Malar.*, 5, 198.

^h Sharma, M. I. D., Krishnamurthy, B. S. & Singh, N. N. (1957) *Indian J. Malar.*, 11, 401.

TABLE 2. ADULT SUSCEPTIBILITY TESTS WITH DDT ON *A. CULICIFACIES* FROM MOPITURA VILLAGE, BARIA TALUKA ^a (WHO METHOD)

Date	Temperature during exposure (°C)	Relative humidity during exposure (%)	Temperature during following 24 hrs (°C)		Percentage mortality at DDT concentrations shown ^b					Control	LC ₅₀ (%)
			Max.	Min.	0.25 %	0.5 %	1 %	2 %	4 %		
3-16 Sept. 1959	27.5	94	32	26	9 (55)	20 (45)	24 (55)	30 (40)	65 (55)	2 (55)	2.0-2.5
22 Sept. to 6 Oct. 1959	27	80-90	27.5	24	—	—	21.5 ^c (78)	44.5 ^c (74)	81 ^c (77)	5.3 (78)	2.1
1-5 Dec. 1959	23	50-70	25	21	5 (100)	9 (80)	14 (80)	55 (80)	88 (76)	0 (80)	1.9
19-21 Jan. 1960	18	63-67	19	17	1.7 (60)	5 (80)	37.5 (80)	64 (78)	96 (72)	0 (80)	1.4
18-28 Feb. 1960	22-26	40-52	26	21	1.2 (78)	6.5 (78)	20 (80)	48 (71)	91 (67)	0 (76)	1.8-2.1
15-22 June 1960	31	80	35	30	5 (80)	11 (81)	15 (80)	24 (79)	34 (79)	0 (79)	> 4
12-19 July 1960	29-31	84-88	31	29	4 (125)	3 (101)	2 (102)	5 (104)	35 (105)	3 (105)	> 4
8-10 Aug. 1960	27-28	82-85	28.5	27	—	—	4 (185)	13 (184)	37 (183)	0.5 (188)	> 4
2-6 Sept. 1960	28	75-83	29	27	—	—	3 (77)	22 (81)	45 (79)	0 (79)	> 4

^a Spraying history: 1950-52: 3 cycles DDT at 56 mg/square foot; 1953-55: 2 cycles DDT at 112 mg/square foot; 1956-57: 1 cycle at 112 mg/square foot; 1958-59: 3 cycles at 112 mg/square foot; 1960: 1 cycle in July.

^b Figures in parentheses represent the numbers of mosquitos tested at each concentration.

^c Corrected for control mortality.

TABLE 3. ADULT SUSCEPTIBILITY TESTS WITH DDT ON *A. CULICIFACIES* FROM RAMPURA VILLAGE, GODHRA TALUKA ^a (WHO METHOD)

Date	Temperature during exposure (°C)	Relative humidity during exposure (%)	Temperature during following 24 hrs (°C)		Percentage mortality at DDT concentrations shown ^b					Control	LC ₅₀ (%)
			Max.	Min.	0.25 %	0.5 %	1 %	2 %	4 %		
28 Sept. to 10 Oct. 1959	28	85-95	29	26	—	—	7.5 ^c (69)	85.5 ^c (68)	96.5 ^c (65)	8.8 (68)	1.5
19-28 Nov. 1959	25	60	25	23	—	1.8 (56)	30.5 (76)	55 (69)	93.7 (80)	0 (76)	1.6
29-30 Jan. 1960	18	41	21	19	1.2 (80)	5 (80)	37 (78)	78 (79)	97.5 (80)	1.2 (80)	1.2
21-27 Feb. 1960	21-28	30-55	28	20	5 (80)	11 (82)	48 (77)	73 (74)	97.4 (76)	0 (78)	1.2
29-30 Jun. 1960	30	92-94	31	30	5.4 (56)	10 (71)	16.5 (73)	33 (72)	65 (74)	1.4 (72)	2.8
26-28 July 1960	30-32	78-89	32	29.5	1.7 (60)	5.3 (75)	2.2 (92)	30 (91)	53 (90)	2.2 (92)	3.7
24-25 Aug. 1960	27-28	84-87	28.5	27	—	3.5 (56)	7.5 (80)	40 (80)	49 (80)	2.5 (80)	4.0

^a Spraying history: 1950-52: 3 cycles DDT at 56 mg/square foot; 1953-55: 2 cycles DDT at 112 mg/square foot; 1956-57: 1 cycle DDT at 112 mg/square foot; 1958-59: 2 cycles at 112 mg/square foot; 1960: 1 cycle at 112 mg/square foot.

^b Figures in parentheses represent the numbers of mosquitos tested at each concentration.

^c Corrected for control mortality.

TABLE 4
ADULT SUSCEPTIBILITY TESTS WITH 4% DDT ON *A. CULICIFACIES* FROM MOTIPURA,
USING LENGTHENED EXPOSURE TIMES

Date	Percentage mortalities ^a							
	2 hours		3 hours		4 hours		8 hours	
	4% DDT	Control	4% DDT	Control	4% DDT	Control	4% DDT	Control
11-26 Nov. 1959	92.5 (40)	0 (20)	—	—	—	—	98.6 (220)	0 (120)
1-8 Dec. 1959	—	—	—	—	—	—	98.9 (275)	0 (120)
18-27 Feb. 1960	—	—	96.2 (53)	4 (56)	—	—	—	—
2-5 July 1960	—	—	—	—	—	—	91 ^b (259)	6.5 (77)
11-18 Aug. 1960	50 (79)	0 (20)	—	—	59 (101)	2.5 (40)	79 (118)	2.5 (39)
1-5 Sept. 1960	50 (80)	0 (40)	—	—	72.5 (80)	2.5 (40)	75 (161)	2.5 (41)

^a Figures in parentheses represent the numbers of mosquitos tested at each concentration.

^b Corrected mortality figure.

Field observations

Parallel with the series of adult susceptibility tests, careful observations have been made on variations in density and on the resting habits of *A. culicifacies*, in order to detect any sign indicating the failure of DDT residual spraying to control the vector effectively.

Until the end of 1959 field observations showed no indication of a possible breakdown in control. Densities of *A. culicifacies* in well-sprayed structures

were very low and no *A. culicifacies* could be found resting even on old DDT deposits. However, in early 1960 it was noticed that significant increases in densities of *A. culicifacies* were occurring in houses three to four weeks after they had been sprayed. At the same time it was noticed that a few *A. culicifacies* were found resting on old visible DDT deposits (at Motipura on a 7-month-old deposit; at Rameshra, Halol taluka, on 4-month-old deposits).

TABLE 5
ADULT SUSCEPTIBILITY TESTS WITH DIELDRIN ON *A. CULICIFACIES* FROM MOTIPURA (WHO METHOD)

Date	Temperature during exposure (°C)	Relative humidity during exposure (%)	Temperature during following 24 hrs (°C)		Percentage mortalities at dieldrin concentrations shown ^a						Control	LC ₅₀ (%)
			Max.	Min.	0.05 %	0.1 %	0.2 %	0.4 %	0.8 %	1.6 %		
14-16 Dec. 1959	23-24	50-60	24	20.5	6.5 (77)	32 (76)	83.5 (58)	98.6 (73)	98.6 (73)	100 (75)	1.3 (78)	0.12
9-18 May 1960	27	50	28	22	31 (99)	79 (100)	98 (103)	100 (101)	100 (101)	—	2 (100)	0.065

^a Figures shown in parentheses represent the numbers of mosquitos tested at each concentration.

TABLE 6
LARVAL SUSCEPTIBILITY TESTS^a WITH DDT ON *A. CULICIFACIES* IN PANCHMAHALS DISTRICT (WHO METHOD)

Locality	Date	Temperature at which test was performed (°C)	Percentage mortalities at DDT concentrations shown ^b						LC ₅₀ (p.p.m.)
			0.004 p.p.m.	0.02 p.p.m.	0.10 p.p.m.	0.50 p.p.m.	2.50 p.p.m.	Control	
Motipura (Baria taluka)	2-3 Feb. 1959	18-21	10 (20)	100 (20)	100 (20)	100 (20)	100 (20)	0 (20)	Between 0.004 and 0.02
	14-15 Oct. 1959	27-28	5.25 ^c (40)	10.5 ^c (40)	58 ^c (40)	100 (40)	100 (26)	5.25 (38)	0.08
	26 April 1960	22-23.5	20 (30)	32 (28)	45 (29)	89 (35)	100 (38)	0 (29)	0.06-0.07
	5 Oct. 1960	24-25	2.0 (49)	8.3 (48)	28.6 (49)	90.0 (50)	100 (50)	0 (49)	0.13-0.16
Godhra (Godhra taluka)	7-8 Oct. 1960	26-28	14 (78)	35 (89)	85 (92)	100 (91)	—	13.75 (80)	0.03

^a All larvae tested were in late III or early IV instar.

^b Figures in parentheses represent the numbers of larvae tested at each concentration.

^c Corrected mortality figures.

During July and August 1960 it was noticed at Motipura village that a round of DDT spraying had little effect on the day-time resting densities of *A. culicifacies*. Houses which were sprayed on 3 July were found to yield large numbers of mosquitos, equal to pre-spraying densities, on 12 July. These houses have continued to yield high catches of *A. culicifacies*, estimated at about 100 per man-hour. At the same time it was noticed that an occasional *A. culicifacies* could be observed resting on fresh deposits of DDT. It should be pointed out that the DDT spraying in these houses was of very poor quality.^f

Discussion

The results of the first tests carried out at Motipura and Sindbhai Mehta in September 1959 raised the question whether we were dealing with the first instance of physiological DDT-resistance in *A. culicifacies*. Although the dosage-mortality curve given by these tests showed no plateau effect at the higher dosages, it was felt likely that, since no 100% mortality could be obtained with 4% DDT and as the LC₅₀ had risen to at least five times that recorded in unsprayed areas, we were dealing with a heterogeneous *A. culicifacies* population developing DDT-resistance.

^f Active malaria surveillance, with house visits every fortnight, was started in Panchmahals in August 1960. Until my departure from the area in April 1961, no case of malaria had, to my knowledge, been discovered in any of the villages where DDT-resistance had been discovered.—S.C.L.

The series of tests carried out at approximately monthly intervals until February 1960 did not demonstrate any further increase in resistance levels in the population, nor was a plateau effect evident in the dosage mortality curve in any of the tests.

During November and December 1959 two series of tests on *A. culicifacies* were carried out using an 8-hour exposure to 4% DDT. The survival rate was just over 1% (6 out of 495 tested). De Zulueta^g in his work on *A. sacharovi* in Greece and Turkey, considered that the presence of survivors after 8 hours' exposure to 4% DDT indicated the presence of physiological resistance.

The tests in June, July and August 1960 indicated with much more certainty the appearance of DDT-resistance. At Motipura the mortalities with 4% DDT had fallen to 34%-37%, the LC₅₀ had risen to over ten times that of a normally susceptible population, and the dosage-mortality curve was much flattened although still not demonstrating the plateau effect expected in a mosquito population developing resistance. In addition, it was shown that the proportion of *A. culicifacies* surviving 8 hours' exposure to 4% DDT had increased from 1% in December 1959 to 9% in July, 21% in August and 25% in September 1960.

It is of interest to notice that DDT-resistance in *A. culicifacies* has taken the long period of ten years

^g Zulueta, J. de (1959) *Bull. Wld Hlth Org.*, 20, 797.

TABLE 7
LARVAL SUSCEPTIBILITY TEST ^a WITH DIELDRIN ON *A. CULICIFACIES* FROM MOTIPURA VILLAGE
(WHO METHOD)

Date	Temperature at which test was performed (°C)	Percentage mortalities at dieldrin concentrations shown ^b						LC ₅₀ (p.p.m.)
		0.0008 p.p.m.	0.004 p.p.m.	0.02 p.p.m.	0.1 p.p.m.	0.5 p.p.m.	Control	
11 May 1960	22-23	82.5 (40)	95 (40)	100 (40)	100 (40)	100 (40)	2.5 (40)	<0.0008

^a All larvae tested were in late III or early IV instar.

^b Figures in parentheses represent the numbers of larvae tested at each concentration.

to develop in the area. The tests reported by Bhatia et al.,^a in which at two places in Panchmahals the LC₅₀ of DDT for *A. culicifacies* was found to be 0.5%, indicate that there had been little decrease in the susceptibility during the eight years of DDT residual spraying from 1950 to 1957. However, since 1957, the LC₅₀ had risen from 0.5% to between 1.5% and 2.5% in about two years and to a figure greater than 4.0% nine months later.

This long delay in the development of resistance in *A. culicifacies* could be attributed to the reaction of excito-repellency exhibited by the mosquito on contact with DDT sprayed surfaces. Observations in two experimental huts at Motipura village demonstrate the highly irritant effect of DDT on *A. culicifacies*. Viswanathan et al.,^b as a result of their work on the nocturnal behaviour of *A. culicifacies* in Poona district, Bombay State, had suspected the excito-repellency of DDT on this species. This irritability, by causing the mosquito to leave a sprayed surface very quickly, may reduce the pressure exerted by the DDT deposits to a level below that which is necessary to select out the resistant individuals in the population. This has probably slowed down the appearance of physiological resistance.

The delayed appearance of resistance in *A. culicifacies* (only during the tenth year of continuous presence of residual DDT) might also be due to the fact that the period from 1958 to 1960, during which

the LC₅₀ of DDT had been rising, coincides with the intensified DDT spraying during the attack phase of the National Malaria Eradication Programme. From 1950 to 1955 inclusive, two cycles a year of DDT spraying were given to the area. In 1956 and 1957 only one cycle was given in each year. When the eradication programme commenced in 1958, the number of cycles per year was increased to two in some parts of the district and to three in others. This has increased the number of months per year in which the *A. culicifacies* population is exposed to DDT selection pressure and it has reduced the periods without selection pressure, during which a dilution of the resistant genes could occur.

* * *

Since the above was written in October 1960, tests carried out at three localities in Panchmahals district have demonstrated a higher degree of resistance to DDT than that previously recorded. These localities are Omidpura and Bania villages of Limkheda taluka and Mandhra village of Baria taluka. At Omidpura the mortality of *A. culicifacies* in 4% DDT exposed for 1 hour was 6.0%; at Bania, 3.7%; and at Mandhra, 17.8%.

Despite the increase in the levels of resistance and its persistence in the district, there has been no noticeable evidence of *A. culicifacies* invading the houses after thorough DDT spraying. Also there has been no increase in the tendency of *A. culicifacies* to rest on fresh DDT deposits.

^b Viswanathan, D. K., Rao, T. R. & Halgeri, A. V. (1955) *Indian J. Malar.*, 9, 371.