

# PRELIMINARY NOTES ON THE DEVELOPMENT OF DDT RESISTANCE IN ANOPHELES CULICIFACIES, GILES IN BALUCHESTAN PROVINCE, SOUTHERN IRAN\*

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**ABSTRACT** *Anopheles culicifacies* is the vector of malaria in southeastern part of Iran, India, West Pakistan and Ceylon. In 1959 the LC50 of DDT in the Panchmahal district of Gujarat State (India) had increased. DDT-resistant population of *A. culicifacies* have been reported from West Pakistan, Burma and Iran. After application of DDT in 1959, the density of *A. culicifacies* decreased sharply. The susceptibility test carried out in 1963 showed that the LC50 was 0.5%.

After DDT spraying, followed by Dieldrin, for about 10 years the density of *A. culicifacies* was so negligible that it was not possible to perform susceptibility tests. By April and May of 1973, the density of *A. culicifacies* in Saidabad, Khairabad and Hit in Baluchestan Province, Southeast of Iran, increased to about 500 per shelter. The susceptibility tests carried out showed that *A. culicifacies* is resistant to DDT and susceptible to Dieldrin and Malathion.

**INTRODUCTION** *Anopheles culicifacies* is the vector of malaria in India, West Pakistan and Ceylon. It is also a vector in southeast of Iran (Manou-

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\* 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.

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chehri and Ghiasseddin, 1959). It is distributed throughout Burma, Thailand, Indo-China, Mainland China and Bangladesh (Stone *et al.*, 1959). In Iran, *A. culicifacies* is distributed mainly in the southeastern part of the country. It is found in the southern area of Fars Province, Kerman, Baluchestan and Sistan, goes north up to the southern regions of Khorassan as far as Birjand. During certain years the density of *A. culicifacies* rises and its distribution extends, thus it practically becomes predominant over *A. stephensi* (Shahgudian, 1969).

In 1959, the LC50 of DDT in the Panchmahal district of Gujrat State in India had increased to 2.2%, compared with 0.5% observed there in 1957 (Rahman, Roy and Singh, 1959). By 1961, the LC50 of DDT had increased to 4.0% in this area (Luan and Shalaby, 1961). Subsequently, DDT resistance was found in Mysore, Maharashtra (Bhatia *et al.*, 1962), Gujrat (Shalaby, 1962, 1963) and Madhya Pradesh (Krishnamurthy and Singh, 1962; Shalaby, 1968).

In West Pakistan, DDT-resistant populations of *A. culicifacies* have been recorded at Gujrat, Campbelpur, Sialkot, Jhang and Multan (Brown and Pal, 1970). In Burma, DDT resistance at the intermediate level was found at Kyankse and Myingyan and full DDT resistance at Mandalay.

*A. culicifacies* is characteristically more irritable than all other Anophelines except the *maculipennis* group (Bhatia and Deobhankar, 1962).

## MATERIAL AND METHOD

The method used in testing is that developed by the World Health Organization for evaluating resistance in a field population of mosquitoes (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 papers at concentrations of 0.05, 0.1, 0.2, 0.4, 0.8, 1.6, and 4.0% were provided by WHO. For the control, paper impregnated with Risella oil alone was used.

The mosquitoes were placed in tubes with untreated paper and allowed to remain there for one hour. Those which were not active were removed from the tube. After one hour the mosquitoes were gently blown into a tube with treated paper. Exposure to the treated paper lasted one hour, after which the mosquitoes were blown back into the holding tubes with untreated paper. The mosquitoes were held in these tubes for 24 hours; then a final mortality count was made. During the holding period a pad of wet cotton wool was placed on top of the tube. The temperature

and relative humidity during the test period were recorded. All mortality percents were corrected by Abott's formula (Abott, 1925). LC50's were estimated by plotting the dosage-mortality lines.

The mosquitoes were collected from unsprayed human and animal shelters in Said Abad, Kheirabad, 25 km west of Iranshahr, and Hit, about 200 km north of Chahbahar, southeast Iran. This area has been under DDT (75% wp) for about 10 years, Dieldrin for 3 years and Malathion for the last 5 years.

## RESULTS AND DISCUSSION

After the application of DDT in 1959, the density of *A. culicifacies* decreased sharply. Susceptibility tests carried out in 1963 showed that the LC50 of this anopheles for DDT was 0.5%.

In 1964 and 1965, Baluchestan was sprayed with Dieldrin, and from 1967 to 1973, with DDT and Malathion, 2 cycles per year with each insecticide. During this period of 10 years, the density of *A. culicifacies* was so negligible that it was not possible to perform susceptibility tests. By April and May of 1973, the density of *A. culicifacies* in Hit village increased to about 500 and 5 per shelter in unsprayed and sprayed dwellings respectively. Susceptibility tests carried out at Hit, Said Abad and Kheirabad showed that *A. culicifacies* is resistant to DDT. The mortality rate after one hour exposure and 24 hours recovery was between 39 and 43 percent. When the time of exposure was increased to 4 hours, the percentage of mortality after 24 hours recovery was 70. Susceptibility tests carried out with Dieldrin and Malathion showed that *A. culicifacies* is susceptible to both insecticides and the LC50's were 0.055 and 0.55 respectively (Table 1 & 2).

Epidemiological investigation showed that, during 1971, the Annual Parasite Incidence (API) in Iranshahr and Chahbahar was 10 and 0.4 per thousand, and during 1972, the Annual Parasite Incidence in Iranshahr and Chahbahar increased to 38 and 4 per thousand respectively. It is possible that the appearance of DDT resistance had an effect on the increase of positive cases in these areas.

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TABLE 1: Results of DDT susceptibility tests on A. culicifacies adults in Baluchestan Province, SE Iran, 1959-1973

| Area & Location                | Date  | Spraying Cycles               | Exposure Period (hrs.) | % Mortality after 24 hours recovery |         |         |           |           |           | LC50 |
|--------------------------------|-------|-------------------------------|------------------------|-------------------------------------|---------|---------|-----------|-----------|-----------|------|
|                                |       |                               |                        | Cont.                               | 0.25    | 0.5     | 1.0       | 2.0       | 4.0       |      |
| Dadin, Zabol                   | 10/59 | not sprayed                   | 1                      | 7 (13)                              | --      | 94 (24) | 100 (26)  | 100 (45)  | --        |      |
| Daman & Piratch, Iranshahr     | 7/63  |                               | 1                      | 2.7 (74)                            | 30 (53) | 42 (64) | --        | 96 (71)   | 100 (30)  | 0.55 |
| Khayrabad & Kootitch Iranshahr | "     |                               | 1                      | 0 (12)                              | --      | --      | --        | 100 (3)   | 100 (19)  | --   |
| Khayrabad, Iranshahr           | 4/73  | 22 X DDT<br>6 X DL<br>8 X Mal | 1                      | 0 (33)                              | --      | 0 (14)  | 0 (13)    | 8.8 (34)  | 38.7 (31) | > 4  |
| Said Abad, Iranshahr           | "     | "                             | 1                      | 0 (26)                              | --      | 0 (16)  | 0 (14)    | 4.7 (21)  | 46.1 (26) | > 4  |
| Hit, Nick-Shahr                | 5/73  | 23 X DDT<br>6 X DL<br>8 X Mal | 1                      | 2.1 (93)                            | --      | --      | 13.6 (95) | 25.2 (91) | 43.3 (90) | > 4  |
| Hit, Nick-Shahr                | "     | "                             | 4                      | 0 (91)                              | --      | --      | --        | --        | 70.1 (87) |      |

Figures in parentheses represent the numbers of mosquitoes tested at each concentration.

Mal = Malathion

DL = Dieldrin

TABLE 2: Results of Dieldrin susceptibility tests on A. culicifacies adults in Baluchestan Province, SE Iran, 1963-1973

| Area & Location            | Date | Spraying Cycles               | Exposure Period (hrs.) | % Mortality after 24 hours recovery |            |            |             |              |             |             |     | LC50 |
|----------------------------|------|-------------------------------|------------------------|-------------------------------------|------------|------------|-------------|--------------|-------------|-------------|-----|------|
|                            |      |                               |                        | Cont.                               | 0.05       | 0.1        | 0.2         | 0.4          | 0.8         | 1.6         | 4.0 |      |
| Daman & Piratch, Iranshahr | 7/63 | 4 X DIT                       | 1                      | 2<br>(47)                           | 39<br>(36) | 98<br>(44) | 100<br>(42) | 100<br>(9)   | 100<br>(9)  | --          | --  | 0.05 |
| Hit, Nick-Shahr            | 5/73 | 23 X DDT<br>6 X DL<br>8 X Mal | 1                      | 0<br>(85)                           | --         | --         | --          | 91.2<br>(91) | 100<br>(86) | 100<br>(88) |     |      |

TABLE 3: Results of Malathion susceptibility tests on A. culicifacies adults in Baluchestan Province, SE Iran, 1973

| Area & Location | Date | Spraying Cycles               | Exposure Period (hrs.) | % Mort. after 24 hrs. |              |             |             |      | LC50 |
|-----------------|------|-------------------------------|------------------------|-----------------------|--------------|-------------|-------------|------|------|
|                 |      |                               |                        | Cont.                 | 0.5          | 3.2         | 5.0         |      |      |
| Hit, Nick-Shahr | 5/73 | 23 X DDT<br>6 X DL<br>8 X Mal | 1                      | 0<br>(86)             | 46.9<br>(83) | 100<br>(88) | 100<br>(84) | 0.55 |      |

Figures in parentheses represent the numbers of mosquitoes tested at each concentration.

Mal = Malathion

DL = Dieldrin

# THE MAP SHOWING SURVEYED ARIA IN BALUCHESTAN

