

WHO/Mal/350 ✓
17 July 1962

ORIGINAL: FRENCH

STUDY OF SUSCEPTIBILITY OF A. LABRANCHIAE TO DDT
AND DIELDRIN IN SOME PARTS OF ALGERIA

by

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Studies of the susceptibility of A. labranchiae to insecticides have been made since 1959 in some parts of the Algiers and Oran regions.

The first results obtained in 1959 had to be rejected owing to excessive mortality among the controls, caused by summer heat and difficulties of transporting the anopheles from the place of capture to the laboratory. These difficulties having been overcome, we were able in 1960 to make a certain number of tests which demonstrated that A. labranchiae was normally susceptible to DDT and to some extent resistant to dieldrin. In 1961, the resistance tests were undertaken on a much larger scale, and in accordance with WHO's instructions - which were strictly followed.

All our tests were made at temperatures ranging from 21°C to 28°C and at satisfactory degrees of humidity.

The females tested were all engorged. They were handled with care: the captures were made by lots of 10, the specimens being then very carefully transferred into the observation tubes. A preliminary waiting period of at least one hour was allowed.

The areas in which the studies were made were:

- (a) in the Algiers region: the rice-field zone of Saint Charles (Kolea);
- (b) in the Oran region: the rice fields of Saint Aime and of Ouled-Addi.

These localities were chosen for reasons of security and because there is a dense anopheline population. In this report we shall deal with:

- I. Tests for susceptibility to dieldrin
- II. Tests for susceptibility to DDT
- III. Tests for irritability in the presence of DDT

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I. SUSCEPTIBILITY TO DIELDRIN

3519 specimens were tested:

- 519 at Saint Charles (Kolea)
- 1500 at Saint Aime, and
- 1500 at Ouled-Addi

1. Saint Charles (Kolea) - region of Algiers

Saint Charles is situated in the Mitidja plain in the area of the rice fields - which from 1954 to 1956 were given regular antilarval treatment, using dieldrin pellets. Since 1957, when the antilarval treatment ceased, the dwellings on the edges of these rice fields have been sprayed with 75% DDT.

TABLE 1. A. LABRANCHIAE MORTALITY REGISTERED IN
DIELDRIN-SUSCEPTIBILITY TESTS CARRIED OUT
AT ST CHARLES (KOLEA)

(Period of contact: one hour)

| Date | Dieldrin concentrations | | | | | |
|--------|-------------------------|----------|---------|---------|----------|--------|
| | 0 | 0.2 | 0.4 | 0.8 | 1.6 | 4 |
| 4.6.61 | 8 (63) | 9 (55) | 21 (48) | 11 (56) | 10 (54) | 0 (16) |
| 5.7.61 | 12 (42) | 3.4 (46) | 17 (41) | 7 (51) | 5.6 (71) | " |

(Figures in brackets indicate the number of mosquitos in the test)

2. Saint Aime - region of Oran

From 1954 to 1956 the St Aime rice fields were treated with dieldrin in pellets; in 1960, the dwellings were sprayed with 75% DDT; in 1961, the owners of the rice fields treated them with Pacol.

TABLE 2. A. LABRANCHIAE MORTALITY REGISTERED IN
DIELDRIN-SUSCEPTIBILITY TESTS CARRIED OUT AT ST AIME (ORAN)

(Period of contact: one hour)

| Date | Dieldrin concentrations | | | | | |
|----------|-------------------------|-----|-----------|-----------|-----------|---------|
| | 0 | 0.2 | 0.4 | 0.8 | 1.6 | 4 |
| 25. 8.61 | 15 (20) | " | 11.7 (20) | 29.5 (20) | 47 (20) | 65 (20) |
| 9. 9.61 | 15 (20) | " | 23.5 (20) | 35 (20) | 41 (20) | 35 (20) |
| 21. 9.61 | 5 (40) | " | 20 (40) | 42 (40) | 42.5 (40) | 65 (40) |
| 5.10.61 | 7.5 (40) | " | 8 (40) | 40 (40) | 38 (40) | 68 (40) |
| 5.10.61 | 5 (80) | " | 14 (80) | 26 (80) | 42.5 (80) | 49 (80) |

TABLE 3. A. LABRANCHIAE MORTALITY REGISTERED IN
DIELDRIN-SUSCEPTIBILITY TESTS CARRIED OUT AT ST AIME (ORAN)

(Period of contact: three hours)

| Date | Dieldrin concentrations | | | | | |
|---------|-------------------------|-----|---------|---------|---------|---------|
| | 0 | 0.2 | 0.4 | 0.8 | 1.6 | 4 |
| 7.10.61 | 0 (60) | " | 17 (60) | 43 (60) | 35 (60) | 58 (60) |

3. Ouled-Addi - region of Oran

From 1954 to 1956 the rice fields were treated with dieldrin: no DDT treatment has been applied in the region.

TABLE 4. A. LABRANCHIAE MORTALITY REGISTERED IN
DIELDRIN-SUSCEPTIBILITY TESTS CARRIED OUT AT OULED-ADDI (ORAN)

(Period of contact: one hour)

| Date | Concentration of dieldrin | | | | | |
|----------|---------------------------|-----|------------|------------|-----------|-----------|
| | 0 | 0.2 | 0.4 | 0.8 | 1.6 | 4 |
| 31. 8.61 | 5 (40) | " | 5 (40) | 17.5 (40) | 25.2 (40) | 42.5 (40) |
| 6. 9.61 | 7.5 (40) | " | 11 (40) | 11 (40) | 30 (40) | 57 (40) |
| 7. 9.61 | 5 (40) | " | 17.5 (40) | 35 (40) | 65 (40) | 70 (40) |
| 20. 9.61 | 5 (40) | " | 5 (40) | 7.5 (40) | 12.5 (40) | 63 (40) |
| 22. 9.61 | 2.5 (40) | " | 5 (40) | 17.5 (40) | 40 (40) | 37.5 (40) |
| 28. 9.61 | 5 (80) | " | 11.25 (80) | 16.25 (80) | 41 (80) | 47.5 (80) |
| 7.10.61 | 0 (20) | " | 10 (20) | 5 (20) | 20 (20) | 60 (20) |

TABLE 5. A. LABRANCHIAE MORTALITY REGISTERED IN
DIELDRIN-SUSCEPTIBILITY TESTS CARRIED OUT AT OULED-ADDI (ORAN)

(Period of contact: two hours)

| Date | Concentration of dieldrin | | | | | |
|---------|---------------------------|-----|---------|---------|---------|---------|
| | 0 | 0.2 | 0.4 | 0.8 | 1.6 | 4 |
| 7.10.61 | 0 (20) | " | 30 (20) | 30 (20) | 75 (20) | 60 (20) |

TABLE 6. A. LABRANCHIAE MORTALITY REGISTERED IN
DIELDRIN-SUSCEPTIBILITY TESTS CARRIED OUT AT OULED-ADDI (ORAN)

(Period of contact: four hours)

| Date | Concentration of dieldrin | | | | | |
|---------|---------------------------|-----|---------|---------|---------|---------|
| | 0 | 0.2 | 0.4 | 0.8 | 1.6 | 4 |
| 7.10.61 | 7.5 (40) | " | 11 (40) | 57 (40) | 60 (40) | 73 (40) |

Discussion and conclusions

The tests whose results are summarized above show that there was definite resistance to dieldrin in the three localities studied. The resistance reached its peak in the region of Kolea where none of the concentrations used caused 50% mortality after one hour's contact.

Resistance seemed less evident at Saint Aime and Ouled-Addi than at Kolea. The various concentrations gave different results from one test to another: with a 4% concentration, for example, mortality ranged from 35% to 70%. It should be noted that longer exposure made very little difference to the mortality rates:

- 60% with two hours' contact (Ouled-Addi)
- 58% with three hours' contact (St Aime)
- 73% with four hours' contact (Ouled-Addi)

II. SUSCEPTIBILITY TO DDT

2627 adult mosquitos were tested with DDT including:

- 469 at Kolea (rice-field area)
- 630 at St Aime (rice-field area)
- 1528 at Ouled-Addi (rice-field area)

TABLE 7. A. LABRANCHIAE MORTALITY REGISTERED IN DDT-SUSCEPTIBILITY TESTS AT ST CHARLES (KOLEA), ST AIME AND OULED-ADDI

(Period of contact: one hour)

| Date | DDT concentrations | | | | | | | | | | | |
|------------------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|
| | 0 | | 0.25 | | 0.50 | | 1 | | 2 | | 4 | |
| <u>Saint Charles (Kolea)</u> | | | | | | | | | | | | |
| 6. 7.61 | 6 | (18) | 0 | (20) | 36 | (20) | 55 | (24) | 91 | (26) | 100 | (24) |
| 24. 8.61 | 4.4 | (69) | 40 | (30) | 58 | (29) | 62 | (64) | 86 | (83) | 83 | (62) |
| <u>Saint Aime</u> | | | | | | | | | | | | |
| 25. 8.61 | 15 | (20) | " | | 17.5 | (20) | 35 | (20) | 41 | (20) | 76 | (20) |
| 30. 8.61 | 15 | (30) | " | | 18 | (30) | 50 | (30) | 61 | (30) | 81 | (30) |
| 9. 9.61 | 15 | (40) | " | | 38 | (40) | 30 | (40) | 53 | (40) | 88 | (40) |
| 16. 9.61 | 5 | (20) | " | | 10 | (20) | 25 | (20) | 50 | (20) | 85 | (85) |
| 21. 9.61 | 10 | (20) | " | | 0 | (20) | 22 | (20) | 50 | (20) | 94 | (20) |
| <u>Ouled-Addi</u> | | | | | | | | | | | | |
| 31. 8.61 | 5 | (40) | " | | 20 | (40) | 30 | (40) | 75 | (40) | 93 | (40) |
| 6. 9.61 | 7 | (40) | " | | 11 | (40) | 33 | (40) | 51 | (40) | 84 | (40) |
| 7. 9.61 | 5 | (40) | " | | 15 | (40) | 32.5 | (40) | 77.5 | (40) | 95 | (40) |
| 20. 9.61 | 2.5 | (40) | " | | 12.5 | (40) | 17.5 | (40) | 70 | (40) | 92.5 | (40) |
| 22. 9.61 | 5 | (80) | " | | 7.5 | (40) | 45 | (40) | 64 | (88) | 94 | (80) |
| 28. 9.61 | 5 | (80) | " | | 12.5 | (80) | 32.5 | (80) | 65 | (80) | 100 | (80) |

Discussion and conclusions

The susceptibility of A. labranchiae to DDT appeared to be almost normal in the three localities studied. However, a certain degree of resistance seems to be showing itself in Kolea where there was a plateau of 86 (2%) to 83 (4%). This resistance appeared to be greater at St Aime where, although the regression lines were more regular, the 4% concentrations gave mortality ranging from 76 to 88% in four tests; in one test only, the mortality rate was 94%.

At Ouled-Addi, the regression lines were more regular and the mortality rates at the 4% concentration higher than at St Aime - around 94% (once 84% and once 100%). If there is resistance at Ouled-Addi, it is less apparent than at St Aime.

III. IRRITABILITY TESTS

In addition to the resistance tests, we carried out tests to determine the irritability of adult A. labranchiae in the presence of DDT. These tests were made according to the WHO provisional method described in WHO Technical Report Series No. 191.

The purposes of the tests were to determine:

- (1) the number of flights per mosquito in 15 minutes;
- (2) the resting-time (interval in minutes before the first flight).

1. Number of flights per mosquito in 15 minutes

This factor was studied on 600 specimens of A. labranchiae including 200 controls; the observations took 150 hours.

The tests were made in a darkened room with just sufficient light to perceive the movements of the mosquitos, and in complete isolation. The tested mosquitos had been caught very early in the morning and placed in cages to rest in the dark for at least one hour before the test. The temperatures and relative degrees of humidity are given with respect to each test in the tables set out hereunder:

TABLE 8. IRRITABILITY TESTS (A. LABRANCHIAE)

| Locality | Date | No. of flights per mosquito in 15 mins. | | | Observations |
|------------|----------|---|------------|------------|-----------------|
| | | Controls | 2% DDT | 4% DDT | |
| Ouled-Addi | 6. 9.61 | 2.60 (20) | 18.75 (20) | 18.35 (20) | T = 27° H = 65% |
| | 20. 9.61 | 4.35 (20) | 14.45 (20) | 26.70 (20) | T = 25° H = 80% |
| | 4.10.61 | 3.05 (20) | 11.06 (20) | 18.70 (20) | T = 26° H = 79% |
| Saint Aime | 10. 8.61 | 5.9 (20) | 12.35 (20) | 17.75 (20) | T = 31° H = 72% |
| | 11. 8.61 | 5.7 (20) | 23.35 (20) | 19 (20) | T = 31° H = 72% |
| | 1. 9.61 | 5.9 (20) | 14.85 (20) | 17.35 (20) | T = 26° H = 75% |
| | 21. 9.61 | 7.55 (20) | 25.30 (20) | 29.95 (20) | T = 25° H = 85% |
| | 27. 9.61 | 4.74 (20) | 15.3 (20) | 23.6 (20) | T = 26° H = 80% |
| | 29. 9.61 | 4.85 (20) | 35 (20) | 17 (20) | T = 26° H = 81% |
| | 6.10.61 | 10.55 (20) | 17.70 (20) | 27.65 (20) | T = 23° H = 81% |

T = temperature

H = humidity

From the over-all data obtained the following conclusions may be drawn:

(a) if these figures are compared with those given by WHO (average number of flights 9 for a normal population, 18.3 for an irritable population exposed to paper impregnated with 4% DDT) it would appear that the populations studied at Ouled-Addi and St Aime are definitely irritable;

(b) the results are very similar to those obtained in 1959 by Sacca & Guy in Morocco, at Braila and Rommani.

2. Resting-time before first flight (in minutes)

This test was applied to 570 specimens including 190 controls. The tests were made in the same conditions as for the determination of the number of flights, and on the same populations.

TABLE 9. IRRITABILITY TESTS (A. LABRANCHIAE)

| Locality | Date | Resting time before the first flight (in minutes) | | | | | | Observations | |
|------------|----------|--|------|--------|------|--------|------|--------------|---------|
| | | Controls | | 2% DDT | | 4% DDT | | | |
| Ouled-Addi | 7. 9.61 | 48 | (20) | 4.43 | (20) | 2.12 | (20) | T = 28° | H = 75% |
| | 16. 9.61 | 51.25 | (20) | 2.43 | (20) | 2.28 | (20) | T = 26° | H = 84% |
| | 22. 9.61 | 37.25 | (20) | 3.46 | (20) | 5.07 | (20) | T = 25° | H = 85% |
| | 30. 9.61 | 7.19 | (20) | 1.22 | (20) | 1.46 | (20) | T = 25° | H = 75% |
| Saint Aime | 2. 8.61 | 12.24 | (10) | 3.14 | (10) | 2.42 | (10) | T = 31° | H = 70% |
| | 25. 8.61 | 35.46 | (20) | 3.16 | (20) | 2.46 | (20) | T = 27° | H = 75% |
| | 1. 9.61 | 15.38 | (20) | 3.17 | (20) | 1.35 | (20) | T = 26° | H = 75% |
| | 14. 9.61 | 43.15 | (10) | 4.44 | (10) | 5.12 | (10) | T = 27° | H = 70% |
| | 14. 9.61 | 29 | (10) | 7.25 | (10) | 4.34 | (10) | T = 27° | H = 70% |
| | 26. 9.61 | 17.45 | (20) | 2.13 | (20) | 2.09 | (20) | T = 27° | H = 78% |
| | 5.10.61 | 6.25 | (20) | 4.11 | (20) | 1.43 | (20) | T = 23° | H = 79% |

On the basis of the average duration of the resting-time before the first flight given by WHO (12.8 ± 2.0 minutes for a normal population, 7.8 ± 1.8 minutes for an irritable population exposed to paper impregnated with 4% DDT), the populations studied would appear to be definitely irritable, as already noted in the tests to determine the number of flights in 15 minutes.

Further research should show whether this irritability is the result of selective pressure or if it is pre-existent.

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SUMMARY

The results of the observations made in the three localities in Algeria indicate that:

- (1) there is definite resistance to dieldrin;
- (2) A. labranchiae is still susceptible to DDT but a certain degree of resistance was brought to light by the resistance tests;
- (3) appropriate irritability tests revealed marked irritability, the origin of which has not yet been determined.

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