# THE MODE OF INHERITANCE OF DIELDRIN-RESISTANCE IN *ANOPHELES (A.) PSEUDOPUNCTIPENNIS* AND THE CROSSING OF POPULATIONS OF THIS SPECIES—FROM VARIOUS PARTS OF MEXICO[1]

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The first indication of resistance to the insecticide dieldrin in the malaria vector *Anopheles pseudopunctipennis* was given in the town of Temixco, State of Morelos, Mexico, in the year 1958, only 16 weeks after the houses had been sprayed for the first time with this insecticide. Only 2.5 percent mortality resulted when the adult mosquitoes were exposed to 0.4 percent dieldrin for one hour and only 10 percent when exposed to 1.6 percent for one hour (Martínez-Palacios, 1958). Field studies in 1959 (Martínez-Palacios, 1959) further showed that dieldrin-resistance was present in this species in 27 localities representing 9 foci, all on the Pacific slope of the country. Records of dieldrin-resistance in the same species have now been made in Peru, Nicaragua, Guatemala and Ecuador.

A study of the exact mode of inheritance of resistance in *A. pseudopunctipennis* has been delayed by the reluctance of mosquitoes of this species to mate under cage conditions. Now with the aid of an artificial mating technique based on that of Baker *et al.*, (1962) it has been possible for one of us (G. D.) to make this study with material sent by the other (A.M.P.) from Mexico to London.

In October, 1964, eggs of *A. pseudopunctipennis* from Acatlipa, Morelos, were sent to London and an adult population reared showing a 35 percent mortality (24 tested) on 0.4 percent dieldrin for one hour, and 79 percent mortality (187 tested) on 4 percent dieldrin for 2 hours. The survivors of the latter dosage and exposure time were mated and the offspring shown to be homozygous for dieldrin-resistance by virtue of the fact that no mortality resulted when 43 mosquitoes were exposed to 4 percent dieldrin for 2 hours. This homozygous resistant strain was then crossed with a susceptible strain from Santa Maria, Zacazonapan, showing 100 percent mortality when exposed to 0.4 percent dieldrin for one hour (70 tested). The cross made was resistant male by susceptible female and the resulting hybrid adults showed virtually no mortality (3 of 97 tested) on 0.4 percent dieldrin for one hour and 100 percent mortality (119 tested) on 4 percent dieldrin for 2 hours. The $F_2$ generation from this cross showed a 30 percent mortality (162 tested) on the lower dosage and 80 percent mortality (212 tested) on the higher one, while the offspring of a backcross between the hybrid male and the susceptible female showed a mortality of 51 percent (41 tested), when exposed to 0.4 percent dieldrin for one hour. Expected mortalities assuming monofactorial inheritance of a partially-dominant gene are 25 percent and 75 percent in the $F_2$ generation and 50 percent in the offspring of the backcross. A single autosomal genetic factor for dieldrin-resistance showing incomplete dominance has already been found in *A. gambiae, A. albimanus, A. quadrimaculatus, A. stephensi, A. sundaicus* and *A. pharoensis* (Davidson, 1965) and in *A. funestus* (Davidson, unpublished).

The persistence of malaria transmission in some parts of Mexico where house-spraying with DDT has been carried out over a number of years, and where no detectable resistance to the insecticide has developed in the mosquito, has led to the

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suspicion that populations with differing behaviour patterns in the presence of DDT have been selected out (Martínez-Palacios and de Zulueta, 1964; de Zulueta and Garrett-Jones, 1965). Combined with taxonomic evidence of the existence of "varieties" of this species in some areas (Aitken, 1945), this evidence might indicate the existence of a species complex such as that recently discovered in *A. gambiae* (Davidson and Jackson, 1962; Paterson, 1963; Davidson, 1964). With this possibility in mind, material from the following localities in Mexico was sent to London:

A. Acatlipa, Temixco, Morelos. Pacific slope, 1400 meters altitude above the sea level. House-spraying with DDT from 1957 up to date, except in 1958 when was sprayed once with dieldrin.

B. Agostadero, Pihuamo, Jalisco. Pacific slope, 120 meters altitude above the sea level. House-spraying with DDT twice a year from 1957 up to date.

C. La Manigua, Ayotoxco, Puebla. Atlantic slope, 300 meters altitude above the sea level. House-spraying with dieldrin in 1957 and 1958; from 1959 up to date with DDT.

D. Buena Vista, Chilpancingo, Guerrero. Pacific slope, 1000 meters altitude above the sea level. House-spraying wtih DDT from 1957 to now.

E. Santa Maria, Zacazonapan, Mexico. Pacific slope, 1380 meters altitude above the sea level. House-spraying with DDT from 1957 up to date.

Colonies were set up and the following crosses were then made:

D male x C female
A male x C female
A male x D female
C male x A female
A male x B female
B male x A female
C male x B female
A male x E female

Crosses between member species of the *A. gambiae* complex always produce hybrid male sterility and in some cases distorted sex ratios (Davidson, 1964). In all 8 crosses performed between the *A. pseudopunctipennis* populations no evidence of hybrid sterility could be found. All gave vigorous $F_1$ generations showing normal sex ratios and the male reproductive system appeared normal on dissection. Artificially mating the $F_1$ males and females produced viable $F_2$ generations and so fertility was confirmed. On this evidence, then, all five populations would appear to belong to the same species.

SUMMARY. Dieldrin-resistance in *A. (A.) pseudopunctipennis* is dependent on a single, partially-dominant, genetic factor. The results of crossing five populations of this species from different malaria areas of Mexico indicate that all the populations of this area belong to the same species.

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