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Insecticide Susceptibilities of Phlebotomus papatasi (Scopoli) from Egypt and the Sudan

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INSECTICIDE SUSCEPTIBILITIES OF *PHLEBOTOMUS PAPATASI* (SCOPOLI) FROM EGYPT AND THE SUDAN[1]

By M. L. Schmidt and J. R. Schmidt[2]

Abstract: Susceptibility levels for Egyptian and Sudanese strains of *Phlebotomus papatasi* were determined through the use of the W.H.O. Standard Test Kit for Adult Sandflies. Mean LC_{50} values for DDT ranged from 0.80–1.93% and for dieldrin from 0.63–1.07%. Laboratory-colony sandflies were found to be slightly more tolerant to both insecticides than were wild-caught specimens, possibly a manifestation of vigor tolerance.

Recognizing the importance of maintaining a continuous surveillance of the insecticide susceptibility status of medically important insects, the World Health Organization has developed standard tests for assessing tolerance levels and has encouraged their use in areas where disease vectors are prevalent (W.H.O. 1960). By periodically comparing the susceptibility levels of natural field populations with previously established baseline values, it is possible to detect increased tolerances and to recommend appropriate modifications in control measures.

The status of the susceptibility of *Phlebotomus* sandflies to various insecticides has been reviewed by Brown (1958) and Pal & Kalra (1965). Members of the genus are characterized by marked susceptibility to DDT, dieldrin and BHC under laboratory and field conditions and no evidence of resistance has been uncovered. Unfortunately, information based on the use of standard quantitative methods is limited for this genus, and the need for more extensive testing has been stressed (W.H.O. 1960). The present report sets forth baseline data for Egyptian and Sudanese populations of *Phlebotomus papatasi* and compares the tolerance levels of wild and colonized material.

MATERIALS AND METHODS

Susceptibility tests were performed with: wild-caught specimens collected during 1960 and 1961 from human dwellings in 3 Nile Delta villages, Qaranfil and Barrada in Qalubiya Province, and El Amiriya, a suburb in northern metropolitan Cairo; flies from a laboratory colony established in 1959 with specimens collected in El Amiriya; flies from a laboratory colony established in 1961 with specimens collected in Tir village, 8 km north of Paloich, Upper Nile Province, Republic of the Sudan.

Wild-caught specimens were collected between May and October, the period of greatest sandfly prevalence in lower Egypt. They were aspirated from walls and ceilings, transferred to a small holding cage and transported to the laboratory where they were held at 21°C and 90% RH until tested on the following day. Only females which had fed within the previous 60 hr, judged by the extent of blood-meal digestion, were used in the tests.

Laboratory-reared flies from various generations were fed on a guinea pig and held at 21°C and 90% RH for 1 to 2 days until tested. All colony flies were 1 to 4 days old when exposed to insecticide.

The standard W.H.O. Test Kit for Adult Sandflies was used throughout the study. The methods are described in detail in a W.H.O. Technical Report (1960). In general, flies were exposed to papers impregnated with 2-fold dilutions of DDT (ranging from 0.25 to 4.0%) or dieldrin (ranging from 0.2 to 1.6%) for 1 hr, using 15 to 20 flies per dilution. Two-hour exposure periods were also used in testing colony flies for dieldrin susceptibility because 1-hr exposures frequently resulted in incomplete mortality at the highest test concentration. During the exposure period, room temperature ranged from 24° to 28°C, relative humidity from 30 to 75% and light intensity from 6 to 7 foot-candles. Following exposure, flies were transferred to insecticide-free containers and held in total darkness for 24 hr at 20° to 22°C and 90% RH. For each valid test, i.e., in which the control mortality was less than 20%, the corrected percent mortalities (Abbott's formula) were calculated for each insecticide dilution and plotted on logarithmic probability paper. LC_{50}s and dosage-mortality regression line slopes were determin-

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ed according to the method described by Litchfield & Wilcoxon (1949).

RESULTS AND CONCLUSIONS

The results of susceptibility tests with DDT are given in TABLE 1. Mean LC_{50}s for wild-caught Egyptian sandflies ranged from 0.80 to 1.03%, for colonized Egyptian material from 0.97 to 1.50%, and for colonized Sudanese specimens from 1.40 to 1.93%. The dosage-mortality regression lines reveal the natural and colony populations to be quite homogeneous in their response to DDT. No evidence of pronounced heterogeneity indicating a potential shift in tolerance levels was obtained.

The responses of sandflies following 1- and 2-hr exposures to various concentrations of dieldrin are summarized in TABLE 2. Mean LC_{50}s following 1-hr exposure ranged from 0.63 to 0.80% for wild-caught Egyptian sandflies, 1.03 to 1.07% for colonized Egyptian material, and 0.90 to 0.95% for colonized Sudanese flies. Slopes of the regression lines for dieldrin were generally steep indicating a consistent homogeneity in both the wild and colonized populations. In comparing the results of tests using 1- and 2-hr exposure times, an approximate 1:1 inverse relationship was found between exposure time and LC_{50}. Regression line slopes were not influenced by variations in exposure times.

Colonization appears to have conferred a degree of "vigor tolerance" (Hoskins & Gordon 1956) to the sandflies, since the highest LC_{50}s for both DDT and dieldrin were obtained with laboratory-reared material. Sandflies from early laboratory generations were consistently more tolerant to both insecticides than were wild-caught flies. On continued colonization, the flies tended to revert to their natural state of susceptibility to DDT but retained their enhanced tolerance to dieldrin. The mechanisms responsible for their greater tolerance are unknown, but it is possible that the improved nutritional state and larger size of the colony flies (Lewis & Minter 1960, Schmidt 1964) are contributing factors.

The Egyptian strains of *P. papatasi* used in the present study resemble those from other countries in regard to their susceptibilities to DDT and dieldrin (TABLE 3). Total experience with natural populations of this species reveals an LC_{50} range of 0.28 to 1.2% for DDT and 0.15 to 0.80% for dieldrin when tests were conducted according to W.H.O. standards. The levels observed for DDT to date are similar to those obtained with naturally susceptible populations of mosquitoes prior to the development of resistance, i.e., 0.5 to 2.0%. Values for

TABLE 1. Results of DDT susceptibility tests with wild and colonized *Phlebotomus papatasi*.

Sandfly Source	No. of Tests	Corrected percentage mortalities after 1-hr exposure to: 0.25% DDT Mean	0.25% DDT Range	0.5% DDT Mean	0.5% DDT Range	1.0% DDT Mean	1.0% DDT Range	2.0% DDT Mean	2.0% DDT Range	4.0% DDT Mean	4.0% DDT Range	LC_{50} (%) Mean	LC_{50} (%) Range	Regression Line Slope Mean	Regression Line Slope Range
El Amirya, Egypt (wild-caught)	9	6	0–24	13	0–25	46	26–67	87	72–100	–	–	1.03	0.77–1.40	1.8	1.2–2.4
Barrada, Egypt (wild-caught)	2	0	0	0.5	0–1	75	65–85	97	94–100	–	–	0.80	0.80–0.80	1.5	1.2–1.8
Qaranfil, Egypt (wild-caught)	4	0	0	16	0–33	50	22–80	85	75–93	–	–	0.96	0.64–1.25	1.9	1.4–2.3
Egypt; 2nd–3rd lab. generations	9	–	–	1	0–5	16	0–35	72	45–91	97	90–100	1.50	1.12–1.82	1.6	1.4–1.9
Egypt; 13–14th lab. generations	4	–	–	8	0–20	51	35–69	90	84–100	100	100	1.01	0.88–1.15	1.6	1.4–1.8
Egypt; 19th lab. generation	2	–	–	0	0	55	47–63	97	93–100	100	100	0.97	0.92–1.03	1.4	1.3–1.5
Sudan; 6th lab. generation	3	–	–	4	0–13	13	7–20	49	40–67	91	80–100	1.93	1.50–2.20	1.9	1.5–2.3
Sudan; 10th lab. generation	1	–	–	7	–	27	–	67	–	100	–	1.40	–	1.3	–

TABLE 2. Results of dieldrin susceptibility tests with wild and colonized *Phlebotomus papatasi*.

Sandfly Source	No. of Tests	Corrected % mortalities after 1-hr exposure to: 0.2% Dieldrin Mean	0.2% Dieldrin Range	0.4% Dieldrin Mean	0.4% Dieldrin Range	0.8% Dieldrin Mean	0.8% Dieldrin Range	1.6% Dieldrin Mean	1.6% Dieldrin Range	LC_{50} (%) Mean	LC_{50} (%) Range	Regression Line Slope Mean	Regression Line Slope Range
El Amiriya, Egypt (wild-caught)	8	5	0–13	19	5–36	68	53–86	99	94–100	0.63	0.49–0.80	1.7	1.4–2.1
Barrada, Egypt (wild-caught)	3	0	0	6	0–12	49	33–64	95	86–100	0.80	0.73–0.85	1.5	1.3–1.7
Qaraunfil, Egypt (wild-caught)	4	1	0–5	14	0–35	55	45–64	100	100	0.72	0.66–0.76	1.7	1.3–2.2
Egypt; 2nd–3rd lab. generations	8	1	0–5	2	0–5	23	15–45	85	70–100	1.07	0.84–1.27	1.6	1.5–1.7
Egypt; 13th lab. generation	1	0	–	0	–	27	–	87	–	1.03	–	1.5	–
Sudan; 6th lab. generation	3	0	0	9	7–13	47	27–87	80	67–100	0.95	0.61–1.14	1.8	1.4–2.2
Sudan; 10th lab. generation	1	0	–	7	–	33	–	100	–	0.90	–	1.6	–
		Corrected % mortalities after 2-hr exposure											
Egypt; 2nd–3rd lab. generations	8	4	0–10	35	5–60	87	55–100	100	100	0.48	0.35–0.75	1.6	1.4–1.7
Egypt; 13–14th lab. generations	5	9	0–27	46	13–91	99	94–100	100	100	0.42	0.28–0.59	1.4	1.3–1.5
Egypt; 19th lab. generation	2	5	0–10	29	16–42	100	100	100	100	0.47	0.40–0.55	1.5	1.4–1.6

TABLE 3. Summary of available information on the susceptibility of *P. papatasi* to DDT and dieldrin, using the W.H.O. Standard Test Kit.

Sandfly Source	Mean LC_{50} % DDT	Mean LC_{50} % Dieldrin	Reference
Chania, Crete	0.75	N.T.	Hadjinicolaou, 1958
El Amiriya, Egypt	1.03	0.63	Present study
Barrada, Egypt	0.80	0.80	Present study
Qaraunfil, Egypt	0.96	0.72	Present study
Athens, Greece	0.26	0.2	Hadjinicolaou, 1958
Euboea Is., Greece	N.T.	0.2	Hadjinicolaou, 1958
Karditsa Gula, Greece	1.2	0.5	Belios; cited in Pal & Kalra, 1965
Vrontamas, Greece	0.4	0.27	Belios; cited in Pal & Kalra, 1965
Karela, India	0.56	0.15	Pal & Kalra, 1965
Wad Medani, Sudan	0.9	0.32	Qutubuddin, 1964
Maarret Shamrine, Syria	0.8	0.52, 0.8	Hadjinicolaou; cited in Pal & Kalra, 1965

dieldrin are higher for *P. papatasi*, i.e., 0.15 to 0.80%, than for mosquitoes, i.e., 0.05 to 0.15% (Busvine 1956, W.H.O. 1957, Davidson 1958). This suggests that sandflies have a higher natural level of tolerance to this insecticide.

Lack of definitive information on the extent of insecticide use in many of the countries in which susceptibility tests have been conducted precludes an assessment of the influence of spraying on the reported LC_{50} values. The values for Greece, Crete (Hadjinicolaou 1958) and Egypt are based on tests using sandflies from areas where aerosol space sprays had been used extensively but where residual spray had not been applied. Thus, it is likely that the LC_{50} values obtained with sandflies from these areas represent "normal" susceptibility levels and that flies from other areas exhibiting similar tolerances have been unaffected by exposure to insecticides. The reported values, whether indicative of normalcy or not, reflect the susceptibility status of sandfly populations at a given point in time and as such constitute valuable baseline data for future comparisons.

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13. ABSTRACT
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