原　著

DDT-Resistance Hazard in the Indian Houseflies, *Musca domestica nebulo* and *Musca domestica vicina*. Nawab H. Khan and Jamil A. Ansari (Department of Zoology, Muslim University, Aligarh, India) Received April 30, 1964. *Botyu-Kagaku*, 29. 15, 1964.

3. イエバエの2亜種 *Musca domestica neblo, M. d. vicina* における DDT 抵抗性

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野外で採集したイエバエ *Musca domestica nebulo* を 0.1% DDT で処理すると 91.5% 致死率であった．その生存虫を飼育し次世代で再び同処理を行なった．同じ方法で37世代繰返し，DDT に対する抵抗性の検定を行なった．また *M. d. vicina* でも DDT で12世代選抜し，抵抗性の発達を検討した．選抜の結果両亜種共に DDT 抵抗性が発達した．しかし *vicina* は *nebulo* より抵抗性になり易かった．

Perhaps no single problem in applied entomology has so thoroughly been investigated as the development of DDT-resistance in houseflies. Since the appearance of the first report of DDT tolerance in *M. d. domestica* from northern Sweden in 1946, entomologists in nearly all parts of the world have confirmed the inefficiency of DDT in controlling the flies, so much so, that at present the common housefly, *M. d. domestica*, is known to have become practically immune to DDT in several parts of the world. Different, however, is the case with Indian forms of houseflies, *M. d. nebulo* and *M. d. vicina* which have hitherto not been found to have attained any significant degree of DDT-resistance in India.

Pal[6] (1951) tried to develop a DDT-resistance strain of *M. d. nebulo* by submitting flies collected from a Delhi Village to DDT pressure for 45 generations, but could obtain an increase of only 1.6—2.0 times and that too, only in the first two generations. Abedi[1] (1958) succeeded in inducing some resistance in the larvae but could not find any correlation between the larval tolerance and the development of DDT-resistance in adult flies. In 1960, Karani and Menon[4] compared the DDT-susceptibility of flies collected from Poona contonment with a non-resistant laboratory stock. It was found that while 100% flies from the susceptible stock died on exposure to 0.5% DDT-Risella oil papers for 1 hour, only 6 to 61% mortality occurred with 2% DDT papers in the case of flies collected from the contonment.

The situation is somewhat different with *M. d. vicina* which is known to have developed insecticide resistance in several regions of its occurrence. In Cairo, Madawar and Zahar[5](1951) found DDT and Chlordane to be ineffective against *vicina* in 1948, a year after it had effectively controlled fly population in the city and by 1952, it developed resistance to DDT and other chlorinated insecticides in all the Levantine countries (West[9], 1953). Suzuki[8] (1958) confirmed the existence of DDT-resistant strains in Japan, while reports from Central America Gillette[2](1955)stated the existence of DDT-resistant *vicina* in that region also.

Sen[7] in 1959 tested the susceptibility of *M. d. vicina* collected from Calcutta to several insecticides and found them to be resistant to DDT, but highly susceptible to dieldrin, diazinon and malathion. He exposed the flies to impregnated test papers and obtained 50% mortality with 4% DDT after 4 hours of exposure as compared to 92% mortality obtained with 1% dieldrin and 100% kill with 0.5% diazinon and malathion after only an hour's exposure to impregnated papers.

During the present studies a total of 56,112 flies belonging to the form *nebulo* collected from fields in and around Aligarh, India, was exposed to 0.1% DDT in glass cages and mortality counts were made after 24 hours of exposure to DDT. The survivals, 9.5% were bred at a temperature of 28°C±1° on cotton pads soaked in diluted

Table 1. Susceptibility of normal and resistant strains of *M. d. nebulo* to DDT solutions.

	Strain	Sex	Percentage mortality with different concentrations of DDT												
			0.03125	0.0625	0.1	0.125	0.2	0.25	0.4	0.5	1.0	2.0	3.0	4.0	5.0	6.0
in Acetone	Normal	♂	16.6	26.6	—	43.7	—	49.1	—	73.3	81.6	91.5	99.6	100.0	—	—
		♀	7.1	14.06	—	24.5	—	33.9	—	51.7	81.3	89.6	92.9	96.8	—	—
	Resistant (F_{15})	♂	—	—	17.2	—	21.05	—	40.9	—	53.06	71.2	—	90.0	92.6	81.08
		♀	—	—	7.6	—	8.6	—	16.6	—	14.4	36.6	—	44.4	64.8	82.4
	Resistant (F_{26})	♂	—	—	—	—	—	—	—	10.6	12.6	18.1	—	37.1	—	44.1
		♀	—	—	—	—	—	—	—	5.2	7.4	10.1	—	17.5	—	27.2
	Resistant (F_{37})	♂	—	—	—	—	—	—	—	4.1	8.6	16.0	—	17.6	21.05	22.4
		♀	—	—	—	—	—	—	—	0.0	0.0	6.4	—	10.2	13.04	16.7
in Risela oil	Normal[1]	♂	15.0	19.1		39.02		47.6		68.7	77.0	86.6	96.1	96.6		—
		♀	6.1	8.4		20.4		25.0		49.1	66.1	75.0	87.3	95.1		—
	Normal[2]	♂	68.7	73.6		80.0		88.8		94.7	100.0	100.0	—	—		—
		♀	44.4	52.9		52.9		73.3		81.2	95.5	100.0	—	—		—
	Resistant[1] (F_{37})	♂	—	—		—		—		4.0	6.3	12.0	—	12.5		20.4
		♀	—	—		—		—		0.0	3.7	5.3	—	8.9		11.1
	Resistant[2] (F_{37})	♂	—	4.3		12.5		23.8		26.08	40.9	42.3	—	56.0		70.7
		♀	—	3.5		3.8		7.6		11.1	23.3	31.2	—	30.4		51.6

1. DDT solutions applied per fly : 0.0009 cc ; 2. DDT solutions applied per fly : 0.0018 cc

Table 2. Susceptibility of normal and resistant strains of *M. d. vicina* to DDT solutions.

	Strain	Sex	Percentage mortality with different concentrations of DDT								
			0.03125	0.0625	0.125	0.25	0.5	1.0	2.0	4.0	6.0
in Acetone	Normal	♂	18.6	32.6	40.2	53.7	71.4	89.07	94.4	100.0	—
		♀	6.2	17.6	27.3	36.5	57.6	70.0	81.4	96.07	—
	Resistant (F_{12})	♂	—	—	6.1	10.0	14.2	20.4	22.9	30.0	40.8
		♀	—	—	1.8	5.3	5.5	14.5	14.8	20.3	27.4
in Risella oil	Normal	♂	30.4	32.6	34.2	43.2	64.4	73.6	83.3	98.9	—
		♀	9.6	9.3	11.4	17.6	36.9	54.4	67.5	95.7	—
	Resistant (F_{12})	♂	—	—	2.2	4.5	6.2	8.1	15.2	22.4	31.8
		♀	—	—	1.7	1.8	3.6	5.5	9.6	14.8	20.9

milk and sugar when 4 days old, the flies were topically treated with DDT at an LC level of 75% or more. This process of selection and the breeding of the surviving individuals was continued up to 37th generation. The selected stock when in 15th, 26th, 30th and 37th generation was compared with the normal laboratory strain and LC_{50} values determined. The size of the drop of the

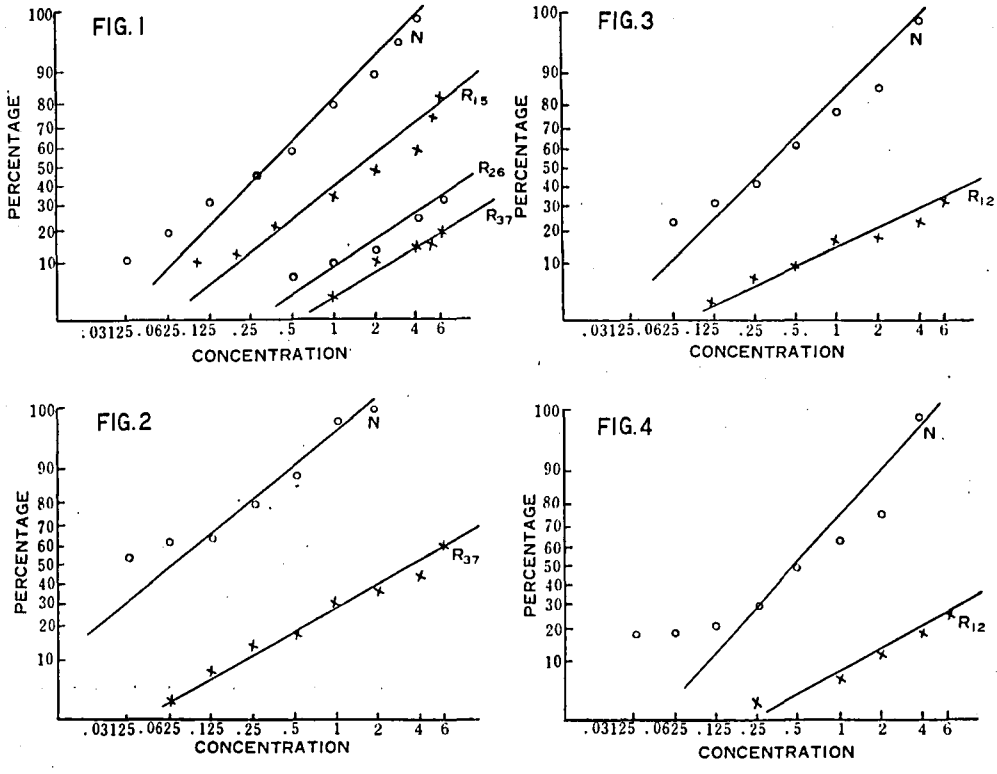

Fig. 1. Susceptibility of normal and resistant strains of *M. d. nebulo* to DDT solutions in acetone.

Fig. 2. Susceptibility of normal and resistant strains of *M. d. nebulo* to DDT solutions in Risella oil.

Fig. 3. Susceptibility of normal and resistant strains of *M. d. vicina* to DDT solutions in acetone.

Fig. 4. Susceptibility of normal and resistant strains of *M. d. vicina* to DDT solutions in Risella oil.

Table 3. Susceptibility levels of normal and DDT resistant strains of *M. d. nebulo* and *M. d. vicina*.

Species	Strain	Solvent	LC_{50}	Slope
M. d. nebulo	Normal	Acetone	0.32	1.91
	Resistant (F_{15})	Acetone	1.47	1.5
	Resistant (F_{26})	Acetone	11.7	1.25
	Resistant (F_{37})	Acetone	32.0	1.18
	Normal	Risella oil	0.062	1.55
	Resistant (F_{37})	Risella oil	3.4	1.05
M. d. vicina	Normal	Acetone	0.29	1.83
	Resistant (F_{12})	Acetone	14.5	0.89
	Normal	Risella oil	0.458	2.09
	Resistant (F_{12})	Risella oil	26.0	0.98

various concentrations of DDT solutions applied per fly was 0.0018 cc, but as the mortality of the normal strain with Risella oil itself was 50% or more when 0.0018 cc of the oil was applied per fly, another series of tests was performed with Risella oil solutions in which only 0.0009 cc of the solution was applied per fly.

The normal and resistant strains of *M. d. vicina* studied herein came from 70 adults originally collected from Chakrata, a hill town in the district of Dehra Dun, India.

Results

The results obtained (Tables 1 and 2) prove that both *M. d. nebulo* and *M. d. vicina* can develop DDT-resistance when put to insecticide pressure in succeeding generations in the laboratory. The development of resistance in *M. d. nebulo* through successive generations of selection (Fig. 1) and the increase in LC_{50} values with corresponding fall in slopes (Table 3) suggest that the species has acquired a specific resistance to DDT (Hoskins and Gordon[3], 1956). The degree of resistance developed in *vicina* in 12 generations of selection (Figs. 3 and 4) is far greater than the tolerance of *nebulo* acquired in 15 generations, and it seems reasonable to conclude that *vicina* is liable to become far more resistant to DDT than *nebulo*.

The differences in the percentage mortality of normal and resistant strains in tests performed with Risella oil solutions further prove the liability of both the species to develop DDT-resistance under laboratory pressure (Figs. 2 and 4).

The degree of DDT-resistance acquired by *M. d. nebulo* is not as great as has been reported in the case of *M. d. domestica* and it can safely be concluded that this is due to some inherent differences of the two species with respect to their liability of developing insecticide-resistance.

Summary

A DDT-resistant strain of *M. d. nebulo* was developed by exposing field collected flies to 0.1% DDT giving a mortality of 91.5%. The survivals were bred to produce the next generation which was again submitted to DDT pressure. In this way the flies were selected for 37 generations and their DDT resistance determined. The development of resistance was also studied in *M. d. vicina* by rearing the flies under DDT selection pressure for 12 generations.

It was found that both the subspecies can develop DDT resistance but *vicina* is liable to become far more resistant than *nebulo*.

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