RESPONSE REACTIONS OF URBAN POPULATIONS OF HOUSE FLIES AGAINST ANTHROPOGENIC INFLUENCE

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Abstract - In 1996-97 response reactions of urban populations of houseflies *(Musca domestica* L.*)* collected in Moscow and Moscow were studied against long-term influence of industrial pollutants and insecticide press. Reaction on the industrial influence evaluated for fecundity and on the insecticide press for resistance against pyrethroid insecticides. The study showed decrease of fecundity of houseflies while approaching industrial areas. The obtained results matched previous data for houseflies from different regions of Russia and evidenced negative effect of long-term industrial influence on fecundity in houseflies. House flies from industrial center of Moscow were high resistant to pyrethroid insecticides compared to susceptible reference strain Cooper (Great Britain). Populations from relatively clean area were not so high resistance to it. It is assumed between mechanisms through which some components of the main industrial pollutant range and pyrethroid insecticides affect houseflies. This results in growing resistance, possibly through the cross-resistance.
Key words - Fecundity, resistance, pyrethroids

INTRODUCTION

Pollution of the environment as a result of industrial activity and often misuse of pesticides result in changes in organisms. The changes occur at various levels: at the level of cells, at the level of the whole organism, at population level, at biocoenosis level and at ecosystem level. As known, industrial pollutants and pesticides may produce either inhibiting or stimulating effect on insect populations. By the progress of time, in population selection of individuals occur, which possess mechanisms to survive in the changing environment. For example, numbers of insects may change as a result of changes in their vital capacity and fecundity (Golutvin *et al.*, 1981; Führer, 1985; Heliövaara and Väizänen, 1994). Populations of insects, resistant to insecticides appear (Lauridsen and Jespersen, 1997). House fly, *Musca domestica* L. (Diptera: Muscidae), which suffers systematic insecticide pressure is one of the first develop resistance against insecticides (Keiding and Jespersen, 1991).

This paper evaluates population resistance to pyrethroids and fecundity of houseflies collected at food processing facilities' sites, located at various distances from industrial facilities. Therefore we observed populations of house flies which suffered two kinds influence: long-term insecticide pressure and industrial pollution.

MATERIALS AND METHODS

House flies were caught at food processing facilities in urban areas with different levels of industrial pollution in Moscow. Sites for sampling flies were selected according to distance from sources of pollution. Sampled populations were assigned names according the geographic names of the sites. A regular entomological dipper was used for sampling the insects. One sample included not less than 50 individuals.

To adapt flies to laboratory conditions and to achieve their numbers sufficient for testing (not less than 500 individuals per one population) flies were bred over two generations, using the method commonly accepted in practical work of toxicology entomologists (Roslavtseva, 1978).

Analyzing biological parameters among individuals, obtained in laboratory conditions enabled discovering their response specifically to factors of long-term influence of industrial pollutants and pesticides.

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A simple and original method to determine fecundity of flies was used in the research. Fecundity was determined as the average number of mature ovarioles in ovaries of young females before the first egg-laying per one female. Abdomen of no less than 50 females were dissected and the number of eggs in both ovaries was counted under a binocular microscope.

To evaluate sensitivity of house flies to pyrethroids, topical application test was used. Hose flies were preliminarily anesthetized with diethyl ether, then acetone solutions of insecticides, obtained through sequential dilution, were applied on insects. Deaths of flies were counted in 24 hours after the test. The degree of toxicity of an insecticide for the tested individuals was determined according to average lethal doses LD_{50} and LD_{95} using the method of probe-it analysis and than the resistant factor (RF) was determined. Each concentration was tested with 20 individuals. Tests were repeated twice.

Fly populations Zvenigorod and Yasenevo were used as reference. The populations were caught at two sites, relatively clear from industrial pollution. For evaluation resistance to insecticides, the standard susceptible to pyrethroids reference strain Cooper was used. The strain was received in 1993 from Central Research Laboratory for Synantropic Insects (Slough, Great Britain).

RESULTS AND DISCUSSION

Before discussing the results, brief description of areas were flies were caught, should be given (Shishkov and Rybalskii, 1996). In 1996 population parameters of houseflies Kapotnia-1, Mariino-2 and Zvenigorod-3 were studied.

Kapotnia was collected near a large oil refinery in the most ecologically unfavorable district of Moscow. Compared to other industries in the city, the refinery makes the largest contribution into contamination of the city air.

Mariino was caught 3 km to the west from the refinery in another industrial zone, where smaller machine-building factories, a rubber factory and a field of aeration are located. Ground waters in this area are the most contaminated with household and industrial wastes.

Zvenigorod was caught in a relatively clean rural area in Moscow. The area is remote from any industries and therefore was used as a reference in comparing industrial contamination.

Therefore population Kapotnia comes from the most contaminated area, Mariino comes from a less contaminated area, and population Zvenigorod comes from a relatively clean non-industrial area.

In 1997 resistance to pyrethroids and fecundity was studied in populations AZLK, ZIL-1, Kolomenskoe-2 and Yasenevo-3.

AZLK and ZIL were caught near major automotive plants AZLK and ZIL, in the area of abnormal contamination of soils due to activity of the above plants as well as some other instrument-building, construction, chemical, wood-processing and transport plants and a heating power station. The AZLK automotive plant is the city's second rated source of air contamination, which follows the Kapotnia refinery.

Kolomenskoe was caught 4-5 km away from the above areas. There are no large industries here.

Yasenevo was caught in a dwelling area with no industries. This part of Moscow is generally referred to as a clean zone. Therefore populations ZIL and AZLK come from the most contaminated areas, population Kolomenskoe comes from a less contaminated area and population Yasenevo comes from a relatively clean urban area.

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Table 1. Susceptibility of the field populations houseflies to pyrethroids.

Insecticide	Population, the susceptible reference strain	LD_{50}, μg/g	LD_{95} μg/g	RF
Permethrin	Mariino	41.50 (21.46-79.68)	1000	30
	Zvenigorod	0.26 (0.17-0.37)	1.65	0.2
	Cooper	1.40 (1.10-1.78)	4.35	
	ZIL	>1250	-	>4000
	Kolomenskoye	27.00 (10.59-68.85)	4250	87
	Yasenevo	18.50 (8.81-38.85)	950	60
	Cooper	0.31 (0.22-0.44)	1.65	-
	AZLK	58.00 (29.60-114.56)	1300	440
	Cooper	0.13 (0.09-0.19)	0.80	-
Tethramethrin	Mariino	105.00(63.64-173.25)	750	5
	Zvenigorod	4.41 (3.50-5.56)	13.00	0.2
	Cooper	21.50 (16.13-38.75)	165	-
	Kapotnia	325.00(262.10-403.6)	900	34
	Cooper	9.50 (5.97-15.11)	75.00	-
Cypermethrin	Kolomenskoye	2.00 (1.38-2.90)	10.00	2
	Yasenevo	35.4 (17.79-70.45)	2000	37
	Cooper	0.95 (0.75-1.20)	2.60	-
	AZLK	2.7 (1.22-5.97)	110	11
	Cooper	0.25 (0.15-0.43)	4.25	-

Let us now consider the results of the research. The surveyed house flies were resistant to pyrethroids**,** while the strongest resistance level was that to permethrin (see Table 1). For example, population AZLK featured 440-fold resistance, while the resistance of population ZIL exceeded 4000-fold and 100% mortality of test individuals could not be achieved even by using the highest concentration. In 1996 house flies showed tolerance to tetramethrin: 5-fold Mariino population and 34-fold Kapotnia population.

In 1997 resistance to cipermethrin was evaluated in flies sampled in various Moscow areas. The flies were tolerant or resistant to this insecticide. The highest level of resistance at 37-fold was found in Yasenevo population, while the lowest level at 2-fold was found in Kolomenskoe population. Population

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Zvenigorod collected in a relatively clean rural area was highly sensitive to permethrin and tetramethrin (0.2-fold).

Insecticides based on pyrethroids became common in Moscow in recent years, but without proper rotation. As a result, resistant populations of house flies evolve rapidly. Detoxication of pyrethroids in organisms of insects involves the same enzymes as detoxication of most xenobiotics, including monooxygenase and esterasa (Roslavtseva and Pereguda, 1988). Populations AZLK, ZIL, and Kapotnia that come from the most industrially contaminated areas were the most resistant to pyrethroids. Therefore, similarity can be presumed between industrial pollutants and pyrethroids in their effect of house flies, which facilitated development of high resistance.

The study showed decrease of fecundity while approaching industrial areas (see Table 2). For example, in 1996 fecundity of house flies from Kapotnia district, which is the main source of pollution in Moscow, was found to be reliably lower than that of house flies from less polluted Mariino district and much lower than that of flies from a relatively clean rural area of Zvenigorod. Fecundity of Kapotnia population was about half of that of Zvenigorod population. In 1997 fecundity of house flies from AZLK automotive plant was the lowest, while fecundity of flies from moderate polluted Kolomenskoe district was higher, while fecundity of flies from a relatively clean Yasenevo was the highest and reliably differed from that of AZLK population.

Table 2. Fecundity of houseflies from areas having different industrial pollution.

1996		1997	
Population	Fecundity, eggs/female	Population	Fecundity, eggs/female
Zvenigorod (reference)	113.75±14.00	Yasenevo (reference)	127.88±5.50
Mariino	95.31±8.09	Kolomenskoye	118.65±7.16
Kapotnia	66.04±6.18	ASLK	102.00±9.85

Survey of house fly populations from areas with different extent of industrial pollution showed dependence between fecundity and the level of pollution irrespective to the composition of pollutants. Populations from the most polluted areas showed the lowest fecundity, while populations from the least polluted areas showed the highest fecundity. It was also obtained, that fecundity of flies grew up along with distance from the sources of industrial pollution. The obtained results matched previous data obtained for houseflies from different regions of Russia and evidenced negative effect of long-term industrial influence on fecundity in houseflies (Polyakova and Roslavtseva, 1994a; Polyakova and Roslavtseva, 1994b).

In conclusion to the paper let us summarize the obtained results. Wide use of pyrethroids in Moscow in the recent years results in rapid development of houseflies population resistant to pyrethroids. Similarity is assumed between mechanisms of action of the basic range of industrial pollutants, found in discharges from most industries, and mechanisms of action of pyrethroids on houseflies, which possibly facilitate formation high cross-resistance. Surveys of populations of house flies caught in areas with different quality and different level of industrial pollution revealed dependence of houseflies fecundity from the level of pollution irrespective to the actual composition of pollutants. Therefore, fecundity of house flies can be used as biological indicator of the quality of environment in industrialized cities.

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