PROLONGED STRESS INDUCES ADATATION OF DROSOPHILA POPULATION TO IONIZING RADIATION

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Introduction

Study on response of natural populations of living organisms to an increase in radiation background is a very important and complicated problem.

Earlier we studied genetic processes in natural populations of insects (drosophila, potatoes beetle and so on) living in areas radiocontaminated due to the Chernobyl disaster. We revealed some genetic and morphogenetic changes in these populations [1].

Since 14-15 years passed after this catastrophe, natural insect populations had to change their genetic structure because of chronic effect of radiation. It's well known that prolonged action of mutagenic factors results in adaptation of populations of living organisms to harmful agents [2-5]. Such adaptation is associated with death of more sensitive individuals and with selection and breeding of more resistant ones. It was important to investigate if natural insect populations from radiocontaminated regions became more adapted to irradiation than population from "clean" area.

Material and methods

We studied natural populations of Drosophila melanogaster from radiocontaminated area (Vetka district of Gomel region with 24 Ci/km^2 of ^{137}Cs and 0,5 Cu/km^2 of ^{90}Sr) and from Berezynski Natural Reserve as a control area. Population samples were caught in 2000-2001 years.

Males from these two populations were exposed to 40 Gy γ-rays on Laboratory Cs-machine. The dose rate was 29 Gy/min. We analyzed mutations of two kinds — dominant lethal and recessive lethal mutations after additional 40 Gy irradiation in populations from different areas. In order to estimate dominant lethal mutation frequency and viability of flies, we mated irradiated males (55 flies from each area) individually with virgin females and replaced them to bottles with fresh food daily for 3 days. We estimated the numbers of laid eggs, undeveloped eggs, alive larvae and the number of imago. Dominant lethal mutations (DLM) were estimated as a proportion of the number of undeveloped eggs to that of laid eggs.

DLM (%) = undeveloped egg number / laid egg number x 100%.

Viability was estimated as a proportion of the imago number to that of laid eggs.

Viability (%) = imago number / laid egg number x 100%.

Frequency of sex-linked recessive lethal mutations (RLM) was estimated by the standard method of Muller. According to this method wild-type males were mated to several virgin females of a special test line Muller-5 with mark genes “yellow” and “white apricot”. If recessive lethal mutation in X-chromosome arises, wild-type males are absent in the second generation of such mates.

Statistic processing of the experimental data was confirmed by the methods of Student and of Fisher.

Results and Discussion

The data, obtained after irradiation of samples from natural drosophila populations, were presented in the table. DLM frequency in the control population (Berezynski Reserve) is equal to 63,1±0,9% and such parameter in Vetka district is equal to 42,8±0,9%.

Table . Response of drosophila populations from control and radiocontaminated areas to 40 Gy exposure (viability, DLM and RLM)

Number	Berezynski Reserve	Vetka district
Laid eggs	2831	3192
Undeveloped eggs	1786	1365
DLM (%)	63,1±0,9	42,8±0,9*
Laid eggs	2831	3192
Imago	438	1349
Viability (%)	15,5±0,7	42,3±0,9 *
Analyzed chromosomes	831	1429
Mutations	105	95
RLM (%)	12,6±1,1	6,6±0,7*

* — p< 0,01

Irradiation death of flies from various populations at late ontogenetic stages differs even more sharply. The imago number of population sample from control area was twice less than the laid eggs number (438 in comparison with 2831 — viability is 15,5%), but 1349 imago flies arised from 3192 laid eggs as a result of irradiation of population sample from district with high radiation background (viability makes up 42,3%).

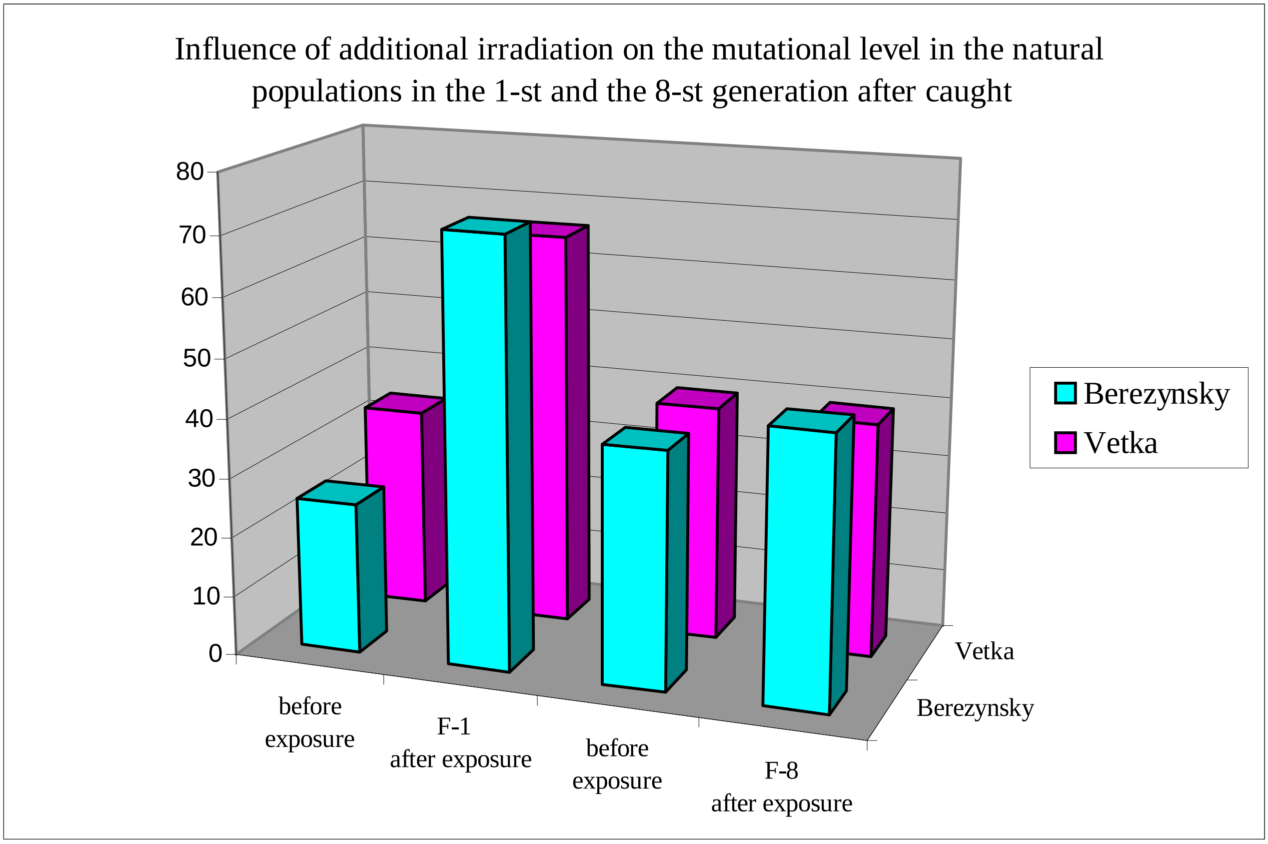
It means, that flies from radiocontaminated area are more resistant to radiation than insects from a "clean" region.

We received analogical data with help of RLM method (table). So, RLM level, induced by irradiation in the Berezynski population, was 12,6±1,1%. At the same time frequency of RLM, induced in Vetka population was 6,6±0,7%.

Thus, flies from radiocontaminated area were shown to be much more adapted to irradiation than insects from the control region.

These facts may be explained by an adaptation of exposed populations to radiation.

Then the population samples were kept under laboratory condition without irradiation. for 8 generations . It should be noted that the mutation level in both populations increased at keeping under such conditions. Acute 30 Gy irradiation was used after 8 generations. Adaptation of Vetka population to irradiation remained.. Besides the control population became also more resistant to ionizing radiation as well as Vetka population (fig.).



It means that keeping of natural drosophila populations under laboratory conditions is a strong stress (limited space, overpopulation, other than in nature temperature and light conditions), which increases mutation process and induces unspecific adaptation.

These facts should be taken into account in studying dynamics of the mutation level during radionuclide removal in animals caught in radiocontaminated regions and placed in vivarium conditions.

Conclusions

1.Natural insect populations from radiocontaminated areas are more resistant to additional irradiation than control populations.

2. Keeping of natural populations under laboratory or vivarium conditions is a strong stress (limited space, overpopulation, other than in nature temperature and light conditions), which increases mutation process and induces unspecific adaptation.

References:

1. Moss.e I.B., Makeeva E.N. Genetic monitoring of natural Drosophila populations from Belarus regions with a different level of radiation background.- Proc. of Int. Conf., "Nuclear Power and Industry". 1994. Obninsk, Russia. pp.279-281

2. Ayala, F.I.. Evolution of fitness. Improvement in the productive and size of irradiated populations of Dr. serrata and Dr. birchii.- Genetics. 1966. 53: 833-895.

3. Marques E.K . The development of radioresistance in irradiated Dros. nebulosa populations. – Mutat.Res. 1973..17: 59-72.

.4. Cordeiro A.R., . Marques E.K, Veiga-Neto A.J. Radioresistance of a natural population of Dros. willistoni, living in a radioactive environment.- Mutat. Res.1973, 19:325-329.

5 .Notel H. Investigations on radiosensitive and radioresistant populations of Drosophila melanogaster.-Mutat.Res.1976. 36:245-248.: