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Differential Mutagenic Response in Selected Lines of *Drosophila melanogaster*

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Summary. The mutagenic efficiency of ionizing radiations has been tested on different lines of *Drosophila melanogaster*. It has been shown that differential lethal effects are obtained when irradiated females from different lines are mated to flies carrying heterozygous lethal genes. The results seem not to be attributable to differential expression of the lethality in the various crosses performed with the irradiated flies. This might suggest that gene activity is involved in the expression of the mutagenic effects of radiations.

Key words: *Drosophila* - Mutants - Radiation - Lethals - Dose-Response

Introduction

It has recently been found (Abrahamson et al. 1973; Heddle and Athanasiou 1975) that the response to ionizing radiations may be "normalised" by adjusting the mutation frequency for the amount of DNA per nucleus. These results were interpreted as indicating that radiosensitivity takes one of the following patterns:

a) the nucleus and not the locus determines the target size;

b) the size of a locus, as measured by its mutability following irradiation, is proportional to the total genome size (DNA content) for the species;

c) the efficiency of repair of genetic damage is inversely proportional to genome size;

d) the size of mutational events is proportional to genome size.

Several studies may be listed supporting the above views (Judd et al. 1972; Sparrow et al. 1968; Underbrink et al. 1968; Britten and Davidson 1969; Crick 1971; Shannon et al. 1972).

Correlation between rate of mutation per locus and genome size strongly suggests that mutational events involve both structural and regulatory genes. A further hypothesis is that genome size could be related in a broad sense to regulation of gene activity rather than to the number of structural genes. Such an hypothesis is difficult to verify; however, a partially supporting experiment can be designed to investigate the relationship between radiosensitivity and regulation of gene activity.

Materials and Methods

In order to investigate the existence of such a control of mutagenicity a test was devised involving three *Drosophila melanogaster* lines: two strains, Canton and b cn vg, and a line (K) derived from these strains by crossing at each generation wild type and vestigial flies, and selecting the wild type for short wing. Line K segregates vestigial and wild type flies in about the same proportions. Wild type K flies carry some lethal genes, linked to the 2nd chromosome marked by the vg^+ allele, that are not present on the homologous vg-marked chromosome.

The key experiment described in the present paper consisted of irradiating, at different X-ray doses, vestigial gametes from both the K line and the b cn vg strain; the irradiated vestigial females were mated to heterozygous males from K line (which carry lethal genes on the vg^+ 2nd chromosome). Induced recessive lethals on the vg-marked 2nd chromosome, that are allelic to the vg^+-carried lethals, would determine the lethality of the resulting vg^+/vg zygote (wild type). As a result the proportion of vestigial and wild type flies in the progeny will be altered in the sense of a decreased wild type frequency.

The X-irradiation was performed by treating virgin vestigial females, one day old, from K line and b cn vg strain, with four doses: 1.5, 3.0, 4.5, 6.0 Kr.; ten replicates of the treatment were used unirradiated flies were kept as a control.

A test of radiosensitivity was performed by observing the hatchability of eggs from the irradiated vestigial females mated to vestigial males from the same line. In each of ten replicated treatments 500 eggs were observed.

Results

The obtained results are shown in Fig. 1 as the difference between the percentage of wild-type and vestigial flies observed, and in Table 1 as the coefficients of the dose-response curve. It is evident that the irradiation of vestigial females from K lines and from b cn vg strain resulted in quite different effects. In fact the difference between wild type and vestigial flies frequencies in the progenies of irradiated females mated to wild type K males resulted in dose-response relationships which are strikingly different: higher for K × K than for b cn vg × K progenies.

In Table 2 the coefficients of the dose-response curve are reported as observed when the irradiated vestigial females from K line and b cn vg strain were mated to males from the same line. It may be noticed that no response is detectable following the X-ray treatments performed.

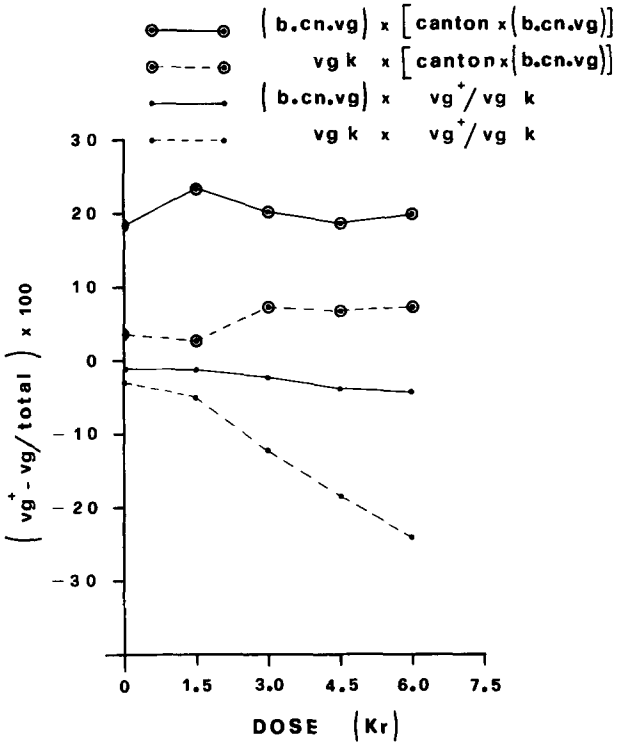

Fig. 1. Dose response curves of progenies from crosses between irradiated vg K and b cn vg females, and Canton and K males

Discussion

A simple interpretation of the data reported above is not easy. However, it may be considered that:

a) There is a differing efficiency of X-rays in inducing lethals in individuals from the two lines. This view seems not to be supported by the results of a control experiment also reported in Table 1, nor by the results of egg hatchability data, after irradiation, shown in Table 2. These results seem to suggest that the different mutagenicity of the treatment on K and b cn vg females is related to the presence of the lethals carried in the vg^+ 2nd chromosome of the K line.

b) There is a differing efficiency of X-rays in inducing specific recessive lethals on the vg-marked 2nd chromosome (those allelic to the vg^+ 2nd chromosome lethals carried by wild type fliws of the K line), or, alternatively, a different efficiency of the lethals induced, in determining the zygotic lethality.

Differential repair mechanisms are not supported by results in Table 2.

All these views imply some kind of control of the mutagenic effects of ionizing radiations.

The view that differences of mutagenicity are somewhat related to regulatory mechanisms would fit well with a previous genetical analysis of the lines used in the present research (Palenzona and Alicchio 1973), suggesting that a large part of the differences result-

Table 1. Regression (b ± s.e.) and correlation (r) coefficients estimating the relationship between the X-ray dose applied and the differential mortality between wild type and vestigial flies

irradiated ♀♀ vg/vg	crosses	♂♂ +/vg	d.f	b ± s.e.	r
b cn vg	×		3	-0.675 ± 0.16+	-0.93
K	×		3	-5.396 ± 0.66++	-0.98
b cn vg	×	F (Canton × b cn vg)	3	-0.750 ± 2.20	-0.20
K	×	F (Canton × b cn vg)	3	1.19 ± 1.12	+0.15

+ = $P < 0.05$
++ = $P < 0.01$

Table 2. Regression (b ± s.e.) and correlation (r) coefficients, referred to the percentage of hatched eggs over the X-ray dose irradiated vestigial females mated to untreated vestigial males

line	b ± s.e	r
K, vestigial	-0.896 ± 0.07	0.97
strain, b cn vg	-1.122 ± 0.12	0.98

comparison between the two b, : $t_{6\,d.f.} = 1.69$ ($P > 0.10$)

ing from the selection performed are attributable to changes of gene activity or developmental variability.

Since it has been assumed (Britten and Davidson 1969) that the amount of DNA is related to the regulation of gene activity, the hypotheses proposed in b) may be read as suggesting that there is a relationship between amount of DNA and specific mutation rate at a given locus.

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