Title

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Publication Date

1948-12-01

UCRL 255
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BERKELEY, CALIFORNIA

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Contract No. W-7405-eng-48A-II

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Delta E. Uphoff and Curt Stern

December 15, 1948

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It has been shown by Spencer and Stern (1948) that irradiation by X-rays at high intensity induces mutations in sperm of Drosophila melanogaster at dosages as low as 50 r and 25 r, and that the proportionality between r-dose and mutation frequency is maintained down to these low dosages. Earlier workers had established independence of induced mutation frequency from the intensity of irradiation at high and medium dosages. In contrast to these findings, Caspari and Stern (1948) obtained no significant difference in mutation rates between controls and experimentals, which had been subjected to a dose of 52.5 r in gamma-rays administered continuously for 21 days at a rate of 2.5 r per day.

This unexpected result required further tests. After consideration of various factors the following were regarded as possible causes for the apparent inactivity of irradiation in the experiment by Caspari and Stern: (1) low sensitivity to irradiation of aged sperm, (2) dependence of induced mutation frequency at low dosages on a time factor, and (3) errors of sampling which might have obscured a true difference between control and experimental rates. The first possibility was studied by administering 50 r in gamma-rays continuously over 24 hours to sperm which had been aged previously for 20 days in the spermathecae of females (Uphoff and Stern 1947). In this experiment the intensity of irradiation was raised several times over that used by Raychaudhuri (1944) who had found typical intensity independence of mutation rates. Any deviation from the effect of irradiation expected for 50 r at medium intensity would thus be due to a specific sensitivity or insensitivity of the aged sperm. The second possibility, interference by a time factor, was tested by increasing the intensity of irradiation, and the total dosage, by a factor of 2, that is, by administering 100 r instead of

about 50 r through continuous gamma-irradiation over 21 days. The third possibility, chance, was checked by a repetition of the original experiment, that is, by giving once more 52.5 r in gamma-rays over 21 days. Parallel with each experiment the spontaneous mutation rate was determined in a set of controls.

The data, together with the earlier ones by Spencer and Stern, and Caspari and Stern are summarized in Table 1. It is seen that all three new tests gave an increased frequency of mutations in the treated sperm as opposed to the controls. The experimental rate observed by Caspari and Stern is statistically in good agreement with later determinations. The control rate of 0.2489 percent found by Caspari and Stern is higher than anyone of the later control rates. By itself a rate of 0.2489 percent for sperm aged over 21 days as compared to 0.0974 percent for not aged sperm (Table 1, line 1) seemed in line with the degree of increase expected, according to the experience of other workers, after 21 days of aging. The new data on the control mutation rate in aged sperm suggest considerable variation of age accumulation of mutations in the Canton Special stock on which all tests were carried out.

A comparison of the differences in mutation frequencies between experimentals and controls in the chronic experiments (lines 2-5) with the difference in the acute experiment (line 1) should take into account the fact that the difference in the latter experiment is somewhat larger than expected on the basis of all of Spencer and Stern's data. The maximum likelihood calculation yields about 0.002 percent induced mutation per r which corresponds to an expected difference for the acute 50 r experiment of only 0.1000 percent. Viewing all experiments together it appears that irradiation at low dosages, administered at low intensity induces mutations in Drosophila sperm. A more detailed account of the work will be presented later.

The work described in this report was performed under the auspices of the Atomic Energy Commission

Information Division
12/16/48
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BIBLIOGRAPHY

Caspari, E. and Curt Stern, 1948: The Influence of Chronic Irradiation with Gamma-rays at Low Dosages on the Mutation Rate in Drosophila Melanogaster, Genetics 33: 75-95.

Raychaudhuri, S. P., 1944: The Validity of the Bunsen-Roscoe Law in the Production of Mutations by Radiation of Extremely Low Intensity. Proc. Royal Soc., Edinburgh, 62: 66-72.

Spencer, W. P. and Curt Stern, 1948: Experiments to Test the Validity of the Linear r-dose/mutation Frequency Relation in Drosophila at Low Dosage. Genetics 33: 43-74.

Uphoff, D. E. and Curt Stern, 1947: The Influence of Irradiation for 24 Hours with Gamma-rays at Low Dosage on the Mutation Rate in Drosophila. Atomic Energy Project Report II-188-7347.

TABLE I

Mutation Rates for Sex-linked Lethals in Sperm of Drosophila Melanogaster, After Different Types of Treatment

Treatment	No. of Controls	No. of Experimentals	Mutation rate percent		
			Controls	Experimentals	Diff.
50 r, 2.3-5 minutes exposure, not aged (Spencer and Stern)	73,901	31,560	0.0974	0.2440	0.1466
52.5 r†, 21 days exposure, aged (Caspari and Stern‡)	56,252	51,963	0.2489	0.2848	0.0359
50 r†, 24 hours exposure after 20 days aging	44,601	46,232	0.1682	0.2834	0.1152
100 r, 21 days exposure, aged	22,958	31,562	0.2352	0.4658	0.2306
52.5 r†, 21 days exposure, aged	36,184	29,424	0.1765	0.2542	0.0777

† Geometric errors in the administration of the radiation are larger than the difference between the values of 52.5 and 50 r.

‡ The mutation rates obtained by Caspari and Stern have been adjusted to the slightly different scoring of lethals used in the investigations reported in this paper.

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