# INDUCED MUTATION RATES IN SPERM TRANSMITTED TO SONS AND DAUGHTERS IN DROSOPHILA MELANOGASTER[1]

S. ABRAHAMSON AND E. HIMOE

*Department of Zoology, University of Wisconsin, Madison, Wisconsin*

Received April 29, 1963

EVIDENCE by many workers has been accumulating that the mutation process itself is subject to influence by both pre- and post-irradiation metabolic conditions as well as by the dose and dose rate of the irradiation (see for example the 1962 United Nations Report with reference to the work of SOBELS and others). The involvement of a synapsing homologue at the time of irradiation in the production of mutations was clearly demonstrated in the work of THOMPSON (1961, 1962). Results were also obtained in which significantly more sex-linked lethal equivalents were determined by transmitting irradiated X chromosomes from father to son (via attached-X matings) than from standard mating procedures (ABRAHAMSON 1961). His interpretation, like THOMPSON's, was that, even in the zygote, the homologue would function as a repairing agent. However, we are indebted to DR. DEAN PARKER for suggesting that ABRAHAMSON's experiments did not discriminate between a) the influence of a homologue in repair, or b) a differential repair by the particular sex which received the irradiated chromosome. Evidence of early physiological differentiation between the sexes is seen in the selective killing of Drosophila males in the blastoderm stage by the "sex-ratio" spirochaete (MALOGOLOWKIN and POULSON 1957; POULSON and SAKAGUCHI 1961). The fact that X-ray induced lethal mutations are not affected by the sex in which they develop has apparently never been demonstrated. The present experiment was designed to learn if the frequency of induced lethal mutations on the second chromosome is influenced by the sex of the zygote which receives the irradiated chromosome.

## MATERIALS AND METHODS

Young (less than three days old, wild-type) Canton-S males, requiring no longer than thirteen days for eclosion, were irradiated with approximately 3000r, and mass-mated to *Cy/Pm* females in quarter-pint milk bottle cultures. The marked second chromosomes used were *Ins(2LR)SM1*, $al^2$, *Cy*, $sp^2$ and *In(2LR)Pm*, $al^4$, $ds^{33k}$, $lt^-$ $bw^{V1}$, both carrying multiple inversions to prevent

[1] Supported by research grants from the National Science Foundation (G–19394) and the Wisconsin Alumni Research Foundation.

crossing over ($al^2$ and $al^4$ = aristaless, $Cy$ = Curly wing, $sp^2$ = speck, $Pm$ = Plum eye, $ds^{33k}$ = dachsous, $lt^-$ = light deficiency, $bw^{V1}$ = brown-Variegated). A nonirradiated control series was performed simultaneously. The irradiation was performed using a GE Maxitron X-ray machine with a 1mm Al filter, operating at 30ma and 250KVP with a dose rate of 585r/min at 37cm target distance. The dose was continuously monitored by an iometer which indicated that the dose rate was always within plus or minus two percent of the measured rate. All matings employed standard cornmeal, molasses and agar medium. $F_1$ $Cy/+$ virgin females and $F_1$ $Cy/+$ males from these crosses were singly back-crossed to $Cy/Pm$ flies in shell glass vials. Since single $F_1$ parents were used, all of the $F_2$ progeny in a single culture contain the same irradiated paternal second chromosome. $F_2$ matings were made in vial cultures, using three or four pairs of $F_2$ $Cy/+$ males and females. The progeny of these crosses were screened for lethals. No wild-type flies appearing in at least 40 progeny constituted a lethal culture. Confirmatory crosses were made on all suspected lethals.

## RESULTS AND DISCUSSION

A total of 1563 irradiated chromosomes developing in male zygotes, and 1713 irradiated chromosomes developing in female zygotes were analyzed and compared. The results are given in Table 1. Since the control lethal frequency ranged from about two to four percent, it is clear that these lethals are not entirely newly-arisen spontaneous lethals, but are mainly lethals already present in the stock, which were uncovered by the experiment. A recent survey of the literature indicates that the spontaneous mutation rate per generation for the second chromosome is about 0.5 percent, ranging from 0.38 to 1.37 percent (CROW and TEMIN in press). Therefore, it is expected that a certain amount of clustering is present in the lethals recovered. The variances for the control lethal frequencies, then, are not known, but it is probable that these values are greater than those given, which assume independence of chromosomes tested.

By inspection of Table 1, the frequencies in the irradiated series clearly represent the same frequency. The induced mutation rate was obtained by correcting for the control rates, which are not statistically different from one another, using the variances given. The fact that clustering has taken place can easily account for the apparent difference in the two control frequencies. The best

TABLE 1

*Lethals induced in the second chromosome by 3000r X-rays*

| Dose | Sex of $F_1$ | Lethals | Number of cultures | Uncorrected percentage | Percent of induced lethals |
|---|---|---|---|---|---|
| 3000r | male | 245 | 1563 | 15.68 ± 0.92 | 12.28 |
| 3000r | female | 266 | 1715 | 15.51 ± 0.71 | 12.11 |
| Control | male | 12 | 480 | 2.50 ± 0.87 | .... |
| Control | female | 22 | 519 | 4.24 ± 0.88 | .... |

estimate of the actual control rate can be obtained by taking a weighted average of the two control frequencies, which gives a frequency of 3.40 percent, with an unknown variance. Therefore, the induced rates are corrected by 3.40 percent. The corrected frequencies represent the same frequency, and one can conclude that the sex of the zygote, per se, does not influence differentially the yield of second-chromosome mutations induced in sperm.

## SUMMARY

Irradiated second chromosomes in wild-type *Drosophila melanogaster* males were scored for induced lethal frequencies when transmitted to male and female progeny. No difference was observed between these two groups, and it has been concluded that the sex of the zygote which receives the irradiated chromosome does not influence the frequency of lethal mutations recovered.

## ACKNOWLEDGMENT

We wish to acknowledge the very fine technical assistance of MRS. GLORIA DANIEL during parts of this experiment.

## LITERATURE CITED

ABRAHAMSON, S., 1961 Possible repair of X-ray induced mutation in *Drosophila melanogaster*. (Abstr.) Records Genet. Soc. Am. **30**: 55; Genetics **46**: 845.

CROW, J. F., and R. TEMIN Evidence for partial dominance of recessive lethal genes in natural populations of Drosophila. Am. Naturalist (in Press).

MALOGOLOWKIN, C., and D. F. POULSON, 1957 Infective transfer of maternally inherited abnormal sex-ratio in *Drosophila willistoni*. Science **126**: 32.

POULSON, D. F., and B. SAKAGUCHI, 1961 Nature of "sex-ratio" agent in Drosophila. Science **133**: 1489–1490.

THOMPSON, P. E., 1961 The effect of asynapsis on mutability in the testis of Drosophila. (Abstr.) Records Genet. Soc. Am. **30**: 114; Genetics **46**: 904.

1962 Asynapsis and mutability in *Drosophila melanogaster*. Genetics **47**: 337–349.

1962 Annex C. The hereditary effects of radiation. pp. 84–117. *Report of the United Nations Scientific Committee on the Effects of Atomic Radiation*. Supplement No. 16 (A/5216). United Nations, New York.