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Post-replicative repair of an X-ray damaged chromosome following fertilization in **Drosophila melanogaster.**

During the course of an X-ray mutagenesis screen designed to find mutations in the scarlet (st: 3-44.0) region, we recovered a chromosome rearrangement whose properties suggested the occurrence of an unusual mutational event. In that screen, males of the genotype Ki roe $p^p$ were given an X-ray dose of 4000r and mass mated to $st^{82c3}$ e virgin females. After three days the bottles were cleared of parents, and the resulting progeny were subsequently scored for scarlet-eyed flies. Among the mutations obtained was an allele, $st^{g18}$, recovered in a scarlet-eyed $F_1$ male. This male, when mated to tester females carrying a deficiency for the scarlet region, $Df(3L)st^{81K17(2)}$ (73A2-73D1·2), balanced over TM6b, Hu Tb e ca, yielded no st Ki progeny. The lack of st Ki flies among the $F_2$ progeny could mean that the irradiated Ki roe $p^p$ chromosome, in addition to being mutant for st, is also mutant for an essential gene (or genes) that is not complemented by the $Df(3L)st^{81K17(2)}$ chromosome (for example, $st^{g18}$ could be a deficiency that deletes not only $st^+$ but also other essential loci in the 73A2-73D1·2 region). The appearance of $st^+$ Ki progeny in the $F_2$ suggested that the $F_1$ male was a $st^-//st^+$ mosaic in which the eyes were $st^-$ and at least part of the germ line was $st^+$.

While the production of mosaic flies from X-irradiated sperm is not that uncommon an occurrence, our cytogenetic observations on the $st^{+g18}$ chromosome indicated that the mutational event giving rise to the $st^{g18}//st^{+g18}$ $F_1$ male was, indeed, unusual. Salivary gland chromosome squashes were prepared from $st^{+g18}/+$ larvae. Figure 1a shows the bizarre pairing configuration that was observed in the 72E-75A region. Chromosome spreads in which the homologues were well-stretched and asynapsed revealed that this rearrangement is an inversion of region 72E1·2 to 74F4-75A1 that is tandemly duplicated. Since mature sperm (i.e., haploid) had been irradiated, the insertion of this duplicated material must have occurred after zygotic chromosome replication and, thus, could be related to the same event that generated the $st^-$ tissue in the $F_1$ mosaic male. This explanation is consistent with evidence demonstrating that chromosome breaks induced in spermatozoa do not rejoin before fertilization (Muller 1940; Helfer 1940; Kaufmann 1941). Under our hypothesis the material duplicated in one chromatid was donated at the expense of the other chromatid, implying that the genotype of the recovered mosaic male was:

$$Dp(3L)st^{+g18}/st^{82c3}\ e//Df(3L)st^{g18}/st^{82c3}\ e\ .$$

The existence of this deficiency chromosome was proven by the subsequent recovery of $st^-$ chromosomes from some of the Ki Hu Tb flies that were saved from the $F_2$ generation. The $F_1$ mosaic male must have therefore had a $st^-//st^+$ mosaic germline. Cytological analysis showed that this $st^{g18}$ chromosome is deleted for the same region (72E1·2 to 74F4-7A1) that is tandemly duplicated in $Dp(3L)st^{+g18}$ (Figure 1b).

The induction in mature sperm and recovery of both a deficiency and the complementary duplication chromosomes from the same individual can be explained by the occurrence of post-replicative repair of a broken chromosome in the zygote (Figure 2). In this case, the four broken ends were ligated back together in the


**Figure 1.** Photomicrographs of orcein-stained salivary gland chromosomes from: (a) $Dp(3;3)\ st^{+g18}/+$, and (b) $Df(3L)\ st^{g18}/+$ larvae. Arrows point to the 72E-75A region of chromosome arm 3L.

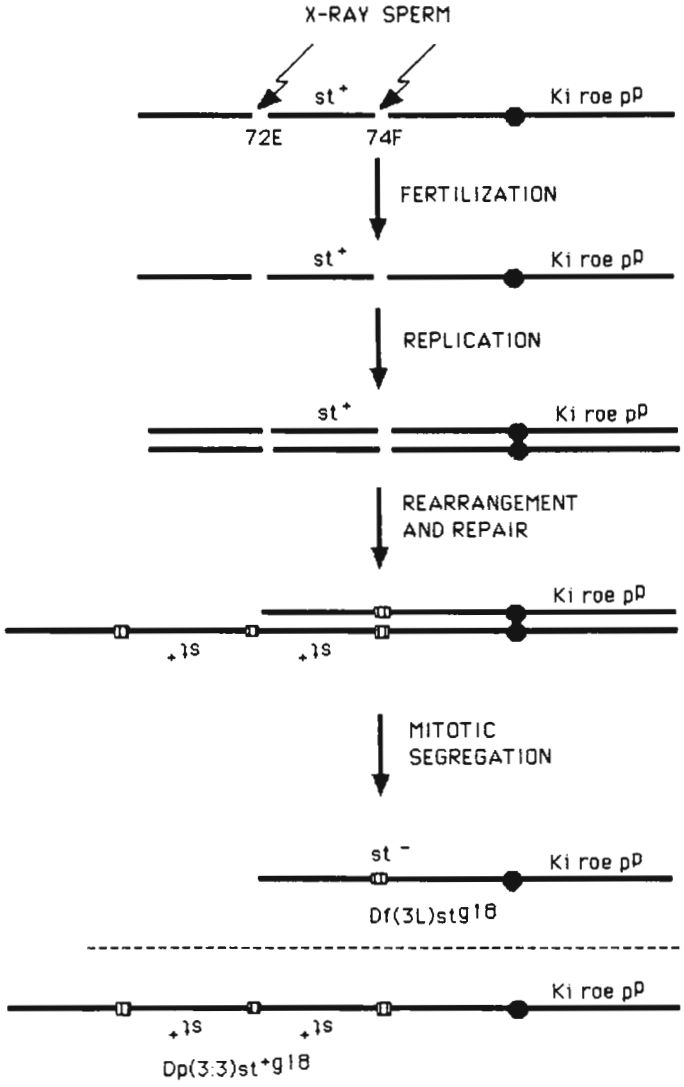


**Figure 2.** Model for the generation of the duplication and deficiency chromosomes shown in Figure 1.

wrong order, resulting in one chromatid with an inverted tandem duplication, and another chromatid with a deletion. Segregation of these sister chromatids at mitotic anaphase resulted in an individual that was mosaic for these chromosome rearrangements. The occurrence of post-replicative repair is also evident from the observation that the Df(3L)st$^{g18}$ chromosome carries an inversion between regions 65A1·2 and 99A1·2, whereas the Dp(3L)st$^{+g18}$ chromosome carries no such inversion (data not shown).

A similar interpretation invoking chromatid exchange occurring after replication in the zygote was proposed in 1969 by Leigh & Sobels (cited in Sankaranarayanan & Sobels 1976) to explain their recovery of homo-isochromosomes following irradiation of post-mitotic male germ cells.

Flies homozygous for the Dp(3L)st$^{+g18}$ chromosome can survive to the adult stage, although their viability is low. The observation that these flies exhibit normal sexual phenotypes and are fertile is noteworthy, since they should carry four wild-type doses of the transformer (tra, 3-45) locus, a sex determination regulatory gene whose function is required in females, but not in males, for normal sexual development (Sturtevant 1945; Baker & Ridge 1980).

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**References:** Helfer, R.G. 1940, PNAS 26:3; Kaufmann, B.P. 1941, PNAS 27:18; Muller, H.J. 1940, J. Genet. 40:1; Sankaranarayanan, K. & F. Sobels 1976, in:The Genetics and Biology of Drosophila, v1c:1089-1250; Sturtevant, A.H. 1945, Genetics 30:297; Baker, B.S. & K. Ridge 1980, Genetics 94:383.

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Temperature and efficiency of a disruptive selection for phototactism.

In a previous paper (Dubucq et al. 1984) it was assumed, as a tentative hypothesis, that a disruptive selection for phototactism, using the Benzer method (1967) or the Kekic method (1981), could be more efficient at 30°C than at 25°C. Indeed, the range of the final distribution of the flies in the various chambers (Kekic test) or test tubes (Benzer test) was greater at 30°C than at 25°C, and consequently it was hoped that it should be easier to separate the most phototactic flies from the less phototactic ones.

From the same initial population "Namur", four strains have been obtained by disruptive selection. We have used the Benzer method modified by Tompkins et al.(1978), and the tests were carried on at 30°C and at 25°C. All the flies were raised and maintained at 25°C, but for the "population I" the tests were done at 30°C from the 5th till the 15th generation, whereas they were always done at 25°C for the "population II". The selection intensity was always the same: 10% (the most phototactic ones or the less phototactic ones, respectively) of at least 100 flies of same sex tested together were taken as parents for the next generation. At the beginning (September 1983) and at the end (May 1984) of the selection experiments, 5 tests have been done using the non-selected population "Namur". In the same way, 5 tests were done with the four strains resulting from the selection procedure. The comparison between the experimental results