2. Crossing over in deficient TB-10a plants: Effect of male and female origin on the recovery of crossover chromatids.

As mentioned in the previous report, TB-10a was crossed to plants heterozygous for $\underline{y}_9$. Since the F_1's did not segregate for pale yellow seeds, it was assumed that $\underline{y}_9$ was proximal to the TB breakpoint in chromosome 10 (10L.35). To find the distance of $\underline{y}_9$ from the breakpoint, deficient plants were crossed to those homozygous for $\underline{y}_9$. The TB-10a plants were homozygous for the $\underline{R}_2^{scm}$ allele of $\underline{r}$, which gives a self colored endosperm in a single dose and also produces color in the scutellum. Therefore, purple seeds with colorless scutella were selected from the cross with TB-10a. These seeds had deficient embryos and since the plants pollinated were heterozygous, half of them carried $\underline{y}_9$ on the normal chromosome 10. Because only the normal chromosome 10 will be transmitted from deficient plants, most of the progeny seeds should be $\underline{y}_9$ when crossed with this stock, if $\underline{y}_9$ is close to the breakpoint. Crossing over between the breakpoint and the $\underline{y}_9$ locus will result in gametes carrying the normal allele. Thus, the percentage of yellow seeds in the cross between deficient and $\underline{y}_9$ plants will indicate the crossing over that has taken place between the TB-10a breakpoint and $\underline{y}_9$.

Table 1 gives the crossing over when the deficient plants were used as females. The grand total crossing over was 15.2 $\pm$ 1.05%. For individual crosses the crossing over ranged from 5.7% to 18.3%. The value of 5.7% for plant 8005-6 seems unusually low. It is at least half the value for the next lowest figure (11.9%). The difference between the percentages for these two crosses is just barely not significant at the 5% level. However, the difference between the percentage of 8005-6 and those of the other two crosses involving 8005 plants is significant at the 5% level. It is possible that there is something special about plant 8005-6 that is responsible for its unusually low level of crossing over. Because of 8005-6's low value, calculations have been made with and without the data from this plant.

Table 1

Crossovers recovered when plants heterozygous for y_9 and deficient for B^{10} are crossed as females with homozygous y_9 plants.

Parent Plants	C.O. Seeds (yellow)	Non-C.O. Seeds (pale yellow)	Total	%C.O.
8005-6/9005-7	6	99	105	5.7
8005-7/9006-6	17	89	106	16.0
8005-9/9006-5	18	133	151	11.9
8005-10/9005-7	16	76	92	17.4
Total	57	397	454	12.6 ± 1.6
Total minus 8005-6	51	298	349	14.6 ± 1.9
8006-4/9007-5	42	236	278	15.1
8006-6/9006-6	38	178	216	17.6
8006-9/9006-6	22	98	120	18.3
8006-10/9006-6	18	82	100	18.0
Total	120	594	714	16.8 ± 1.4
Grand Total	177	991	1168	15.2 ± 1.05
Grand Total minus 8005-6	171	892	1063	16.1 ± 1.1
Total pollinated by 9005	22	175	197	11.2 ± 2.2
Total pollinated by 9005 minus 8005-6	16	76	92	17.4 ± 3.9
Total pollinated by 9006	113	580	693	16.3 ± 1.4
Total pollinated by 9007	42	236	278	15.1 ± 2.1

Table 2

Crossover recovered when plants heterozygous for y_9 and deficient for B^{10} are crossed as males with homozygous y_9 plants.

Parent Plants	C.O. Seeds (yellow)	Non-C.O. Seeds (pale yellow)	Total	%C.O.
9005-2/8005-10	103	294	397	25.9
9005-3/8005-10	73	285	358	25.6
9005-5/8005-9	86	225	311	27.7
Total	262	804	1066	24.6 ± 1.3
9006-1/8005-9	57	165	222	25.7
9006-3/8005-7	60	165	225	26.7
9006-7/8005-6	12	93	105	11.4
Total	129	423	552	23.4 ± 1.8
Total minus 8005-6	117	330	447	26.2 ± 2.1
9007-2/8005-8	65	250	315	20.6
9007-4/8006-6	56	227	283	19.8
9007-5/8006-10	63	283	346	18.2
9007-6/8006-9	58	159	217	26.7
Total	242	919	1161	20.8 ± 1.2
Grand Total	633	2146	2779	22.8 ± 0.8
Grand Total minus 8005-6	621	2053	2674	23.2 ± 0.8
Total pollinated by 8005	456	1477	1933	23.6 ± 1.0
Total pollinated by 8005 minus 8005-6	444	1384	1828	24.3 ± 1.0
Total pollinated by 8006	177	669	846	20.9 ± 1.4

Table 2 shows the crossover values for deficient plants used as males. The grand total crossing over is 22.8 ± 0.8%. For individuals the crossing over ranged from 11.4% to 27.7%. Again, the cross involving plant 8005-6 has the lowest value (11.4%). This is considerably lower than the next lowest value (18.2%). However, the difference between the percentages of these two crosses fall just short of being significant at the 5% level. The same is true of the difference between 8005-6 and the next highest crossover percentage (19.8%). However, the difference in percentage between 8005-6 and the next highest percentage (20.6%) is significant at the 5% level and the percentage of 8005-6 differs significantly from those of all other crosses at the 1% level. Thus, again there is evidence that plant 8005-6 has an unusually low level of crossing over and this is observed when it is crossed as a male or female.

Table 3 shows the total crossing over for both male and female transmission. The value is 20.5 ± .06% with the incorporation of data from plant 8005-6 and 21.2 ± 0.7 without.

Table 3

Total crossing over obtained by combining male and female transmission.

Parent Plants	C.O. Seeds (yellow)	Non-C.O. Seeds (pale yellow)	Total	%C.O.
Total crossed as ♀ (Table 1) and crossed as ♂ (Table 2)	810	3137	3947	20.5 ± 0.6
Total crossed as ♀ (Table 1) and crossed as ♂ (Table 2) minus 8005-6	792	2945	3737	21.2 ± 0.7

Table 4 lists comparisons between male and female transmission of crossovers. The grand percentages for male and female transmission differ significantly with and without the inclusion of 8005-6. Thus, there appears to be significantly more crossing over when F_1 plants are used as

Table 4

Comparisons of differences between male and female transmission of crossovers.

Classes Compared	% C.O. ♂	% C.O. ♀	% Difference
Grand Totals	22.8 ± .8	15.2 ± 1.05	7.6**
Grand Totals minus 8005-6	23.2 ± .8	16.1 ± 1.1	7.1**
Total: F_1's pollinated by 9005 *vs.* 9005 pollinated by F_1	24.6 ± 1.3	11.2 ± 2.2	13.4**
Total: F_1's pollinated by 9005 (minus 8005-6) *vs.* 9005 pollinated by F_1	24.6 ± 1.3	17.4 ± 3.9	7.2
Total: 8005 F_1's pollinated by homozygous $\bar{y}_9$ *vs.* homozygous y_9 pollinated by 8005 F_1's	23.6 ± 1.0	12.6 ± 1.6	11.0**
Total: 8005 F_1's (minus 8005-6) pollinated by homozygous y_9 *vs.* homozygous y_9 pollinated by 8005 (minus 8005-6) F_1's	24.3 ± 1.0	14.6 ± 1.9	9.7**
Total: F_1's pollinated by 9006 *vs.* 9006 pollinated by F_1	23.4 ± 1.8	16.3 ± 1.4	7.1**
Total: F_1's pollinated by 9006 *vs.* 9006 (minus 8005-6) pollinated by F_1	26.2 ± 2.1	16.3 ± 1.4	9.9**
Total: 8006 F_1's pollinated by homozygous $\bar{y}_9$ *vs* homozygous y_9 pollinated by 8006	20.9 ± 1.4	16.8 ± 1.4	4.1*
Total: F_1 pollinated by 9007 *vs.* 9007 pollinated by F_1	20.8 ± 1.2	15.1 ± 2.1	5.7*

*Significant at 5% level of probability.

**Significant at 1% level of probability.

males than when crossed as females. Such differences in crossing over have been found for other regions of the genome with and without the presence of abberrations (see Phillips, R. L., Genetics 61:117-127, 1969, for such data and review of earlier observations). Like most, but not all, previous studies there is more crossing over when heterozygous plants are crossed as males. Also in Table 4 reciprocal crosses are compared for individual F_1 and homozygous y_9 families. In all cases except one, significant differences are found with the male transmission being the highest. The one exception was the reciprocal cross involving the homozygous y_9 family 9005 after data from 8005-6 had been eliminated. When this was done, only one F_1 plant remained with a rather low number of seeds (92) and a high standard error (3.9%) which probably contributed to the lack of a significant difference.

In Table 5 comparisons are made between the percentages for the F_1 families and between the homozygous y_9 families. For the F_1 families a significant difference at the 5% level was observed between 8005 and 8006 but this was probably due to the incorporation of the unusually low value of 8005-6. When the data for this plant are removed, there is no longer a significant difference. For the homozygous y_9 families two significant differences are observed at the 5% level. Both involve family 9007, which had a lower crossover percentage than 9005 and 9006. This might have been just a chance fluctuation since one of the four crosses involving this family had a crossover percentage that was as high as those from families 9005 and 9006.

Table 5

Comparison between families of F_1's and families of homozygous y_9

Families 1	2	%C.O. Family 1	%C.O. Family 2	% Difference
F_1's:				
8005	8006	12.6 ± 1.6	16.8 ± 1.4	4.2*
8005 minus 8005-6	8006	14.6 ± 1.9	16.8 ± 1.4	2.2
Homozygous y_9:				
9005	9006	24.6 ± 1.3	23.4 ± 1.8	1.1
9005	9006 minus 8005-6	24.6 ± 1.3	26.2 + 2.1	1.6
9006	9007	23.4 ± 1.8	20.8 ± 1.2	2.6
9006 minus 8005-6	9007	26.2 ± 2.1	20.8 ± 1.2	5.4*
9005	9007	24.6 ± 1.3	20.8 ± 1.2	3.8*

*Significant at 5% level of probability.

In summary, it has been demonstrated that more crossovers are recovered from deficient TB-10a plants heterozygous for y_9 when they are crossed as males than when they are crossed as females. Also, there is evidence that some factor might be responsible for lowering the rate of both male and female transmission of crossovers in certain plants.

Further tests of these deficient plants will be made next year using exact reciprocal crosses to obtain more precise data. Also tests will be initiated to establish if there is a differential transmission of crossovers through the microspores and megaspores of plants heterozygous for normal chromosome 10. Previous tests by other workers have shown similar recombination frequencies in both sexes for chromosome 10.

Plants deficient for other A-B translocations will also be tested to determine if this phenomenon is common to all of them.

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1. A test for involvement of the polar nuclei in preferential fertilization.

Roman demonstrated (1948) that sperm carrying B^A chromosomes fertilize the egg more often than the polar nuclei when in competition with other sperm. Two general explanations for this phenomenon can be proposed:

1. Sperm with B-type chromosomes are more capable of fertilizing the egg than other sperm. Either a positional advantage in the embryo sac, or a specific chemical attribute of the sperm could be responsible.
2. Sperm containing B-type chromosomes are less able to fertilize the polar nuclei. This could result from the sperm position in the embryo sac, or from a specific chemical property.

The two ideas were tested by a method which eliminates any role of the polar nuclei in fertilization and allows competition between the sperm for the egg alone. Kernels were selected in which heterofertilization had occurred, and the polar nuclei were fertilized by sperm from a different pollen grain than the egg. Both sperm from one pollen grain are therefore able to compete for the egg. If preferential fertilization persists in this situation, the first hypothesis is supported. The second explanation predicts the absence of preferential fertilization.

Crosses were made between a chromosome 9 tester and the A-B translocation, TB-9b: $\underline{sh}\ \underline{bz}\ \underline{wx}\ \underline{B}\ \underline{Pl}$ X $9^{\underline{c}}\ \underline{sh}\ \underline{Bz}\ \underline{wx}\ 9^{B\underline{Wx}}\ B^{9\underline{wd}}\ \underline{C}\ \underline{sh}\ \underline{bz}$. The $\underline{Bz}\ \underline{wx}$ kernels (9,560) were selected and planted on the sand bench. Seedlings that appeared $\underline{bz}$ were transplanted to the field and grown to maturity. Presumably the endosperm was fertilized by sperm carrying