6. A cytogenetic analysis of a terminal deficiency in chromosome 3.

In our 1972 paper in Genetics on the high-loss phenomenon, we reported that 207 of the 208 cases of a modified chromosome 3 involved the deletion of the large heterochromatic knob in the long arm at position 0.6. The one exception, which may be causally unrelated to the high-loss mechanism, had a deficient chromosome 3. Cytological observations at pachynema disclosed that the break in 3L occurred near its distal tip with the terminal deficiency consisting of two or three minute chromomeres. Plants heterozygous for a normal 3 (N3) and the deficient 3 (Df3) produce normal sized pollen having the N3 chromosome and grains markedly reduced in size with the Df3 chromosome. The small pollen grains rarely, if ever, achieve fertilization in competition with normal pollen although they usually contain a considerable amount of starch. In contrast to the failure of the Df3 chromosome to be pollen transmitted is the ability of a varying fraction of Df3 megaspores to form functional embryo sacs, and thus be available for subsequent cytogenetic studies. The testcross data from a number of sib plants heterozygous for the $\underline{Gl}_6$, $\underline{Lg}_2$, and $\underline{A}_1$ loci and carrying a N3 and Df3 are given in Table 1. Individuals heterozygous for the Df3 chromosome have two sizes of pollen grains while homozygous N3 plants have full sized grains only.

The four point linkage data show that the deficiency lies approximately 19 crossover units to the right of the A locus and that the heterozygous deficiency apparently has no inhibitory effect on recombination in the long arm of 3. The terminal nature of the deficiency makes it possible to estimate with some accuracy the total genetic length of 3L. The glossy-6 locus lies within a few crossover units of the centromere, the Gl-Lg interval in the present data has 34 percent recombination, the Lg-A region 36% and the A-Df interval 19% of recombination. Making no allowance for undetected double exchanges in the relatively long Gl-Lg and Lg-A regions, we have a minimum map length of ca. 90 units. The true length is undoubtedly somewhat greater since we have no precise measure of crossing over in the centromere-Gl interval or in the segment comprising the deficiency, but these data provide a fairly good estimate.

Male recombination data were obtained from the reciprocal of the cross given in Table 1. Since no or little Df pollen successfully competes with normal pollen, the percentage of A offspring measures the frequency of

Table 1

Four point testcross data from the cross of $\frac{\underline{Gl}\ \underline{Lg}\ \underline{A}\ \underline{Df}}{gl\ lg\ a\ N}$ ears by $\underline{gl}\ \underline{lg}\ \underline{a}\ \underline{N}$ pollen.

(0)	(0)	(1)	(1)	(2)	(2)	(3)	(3)	(1-2)	(1-2)	(1-3)	(1-3)	(2-3)	(2-3)	(1-2-3)	(1-2-3)	
Gl Lg A Df	gl lg a N	Gl lg a N	gl Lg A Df	Gl Lg a N	gl lg A Df	Gl Lg A N	gl lg a Df	Gl lg A Df	gl Lg a N	Gl lg a Df	gl Lg A N	Gl Lg a Df	gl lg A N	Gl lg A N	gl Lg a Df	Σ
63	249	134	41	174	58	59	37	19	75	22	41	12	8	8	4	1004

Transmission frequencies: % $\underline{Gl}$ = 48.9 % $\underline{Lg}$ = 46.7 % $\underline{A}$ = 29.6 % $\underline{Df}$ = 25.5

Recombination frequencies: $\underline{Gl}$-$\underline{Lg}$ = 34.3% $\underline{Lg}$-$\underline{A}$ = 35.7% $\underline{A}$-$\underline{Df}$ = 19.0%

recombination between A and Df. The testcross data from field grown populations are given below with the crossover regions indicated in parentheses.

(3)	(1-2-3)	(1-3)	(2-3)	(2)	(1)	(1-2)	(0)	
Gl Lg A	Gl lg A	gl Lg A	gl lg A	Gl Lg a	Gl lg a	gl Lg a	gl lg a	Σ
174	34	62	79	461	261	204	538	1813

Transmission frequencies: % Gl = 51.3 % Lg = 49.7 % A = 19.2

Recombination frequencies: Gl-Lg = 30.9% Lg-A = 42.9% A-Df = 19.2%

The recombination between A and Df is the same in the male and female testcross data. The male data give a somewhat lower value for the Gl-Lg and a higher frequency for the Lg-A region than do the female data. The sum of the recombination values for the several regions is approximately the same in male and female meiocytes. Three point data from the testcross of A Et Df/a et N heterozygotes confirmed the location of Df close to the distal end and placed the Et locus nine crossover units proximal to Df.

The following transmission frequencies for the individual ears providing most of the data summarized in Table 1 indicate that modifying genes affect the development of Df megaspores into viable embryo sacs. In some progenies the number of F_1 individuals with the Df chromosome equalled the number with a normal 3, indicating that Df megaspores were as viable as those with N3, while other sib families had much lower frequencies of functioning Df ovules. Because of the linkage of A and Df, there is a strong correlation between the percentage of A kernels on the testcrossed ears and the percentage of functioning Df embryo sacs.

Plant	% A kernels on ear	% N/Df plants	Field population
30910-3	30.6	36.1	72
" 5	38.5	28.0	143
" 15	26.1	25.5	184
" a	46.8	45.8	203
" b	17.8	14.5	202
" c	46.3	51.2	123
" d	18.4	10.6	179
" e	22.0	17.1	205

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